Cluster Identification and Cooperation Activities in a European Metropolitan Region – The Case of Nuremberg

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Abstract

This paper tracks the question of how to identify, analyse, characterise and visualise clusters in an economic space. At the example of the German Metropolitan Region of Nuremberg we suggest a cluster identifying method based on (1) semi-structured in-depth interviews with experts from institutions and companies, and (2) a survey of 900 companies in cluster-relevant industries and services along regional supply chains. To decide if regional clusters are at work, for each field of functional specialisation we look at its concentration in space, potential for labour market pooling, the existence of "leading companies" (technology leaders, market leaders, image carriers) as well as the presence of supporting institutions and network activities.

In line with other studies on the region, we find five fields of specialisation and are able to identify two more potential clusters in the region. We also have evidence for the notion that clusters are not isolated conglomerates within their particular field but interlinked, albeit to varying extents. In addition, we observe economic integration within the Metropolitan Region enhanced by the region's cluster activities.

Regarding cooperation between companies as well as between companies and institutions in the region, we analyse joint activities with other companies, institutions and universities within or outside the region. We estimate determinants of cooperation activities (depending on e.g. industry or cluster, functional affiliation, firm size, strength of competition). We find evidence for the hypothesis that the intensity of regional cooperation is a driving force for innovative activities, economic performance and regional competitiveness. These mechanisms have important consequences for the local labour market.

Keywords: Regional clustering, cluster identification, co-operation, European Metropolitan Region

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1. Introduction

The blurry definitions of the term "cluster" open a range of possibilities on how to approach this phenomenon. Clusters are dealt with in a vast spectrum ranging from highly formalised models of regional economic theory to practical training units for business development institutions. Still, the variety of definitions and the lack of a sharp outline offer hitches to use well-established methods of economic theory to try and shape a comprehensive picture of individual clusters.

We developed a methodology to identify, analyse, characterise and visualise clusters in an economic area that encompasses different approaches offered by literature. As the full range of cluster definitions has geographic proximity of economic actors at its core our analysis concentrates on the regional contacts between companies as well as between companies and institutions.

The methodology is based on semi-structured interviews with experts from institutions and companies, supported by a large survey of all companies in cluster-relevant industries and services along regional supply chains. A set of five criteria is used to check whether fields of functional specialisation can be considered as working clusters or, alternatively, as supply chains with potential for clustering. The focus of study is on Central Franconia, the core of the European Metropolitan Region Nuremberg. In the late 1990s, the regional development authorities in the agglomeration started with cluster management activities, making it an interesting economic space for research.

The questionnaire developed for the survey contains, among others, sections inquiring about customer-supplier-relationships and existing or already terminated cooperation activities, joint projects e.g. in the fields of development of human capital or research, functional versus industry affiliation but also products and services offered, the core competencies, innovations, the size by turnover and employees and company structure. It has been answered by roughly 900 firms.

In this paper we concentrate on the criterion of cooperation between companies as well as between companies and institutions. We present a range of cooperation-related descriptive results of the survey. The firms' cooperation culture is indicated through joint activities with other companies, universities, research institutes or other institutions within or outside the region. Their cooperative behaviour is influenced e.g. by firm size and cluster affiliation. We give information on cooperation patterns, obstacles and advantages of cluster membership as well as on factors for establishing cooperation.

The paper is organised as follows. Section 2 provides an overview of the cooperation aspects in cluster literature. Section 3 contains a description of the methodology of cluster identification we developed. Section 4 starts with an introduction to the region we are studying in this paper, followed by the application of the methodology to collect and analyse data and information on our database. Chapter 5 on empirical results is first dealing with cooperation patterns, followed by activities in clusters and information on cooperation and firm culture and ending with factors for establishing cooperation and presents first steps of a model to show the propensity to cooperate with different partners. Section 6 concludes and gives an outlook.

2. Clusters and cooperation

According to Feser and Sweeney[1], "…industry clusters are typically defined as significant geographic concentrations of major end-market industries, their extended supply chains, other sectors that share close technological or human capital affinities, and various specialized supporting institutions". Alternatively, a cluster can be understood as "…a geographically proximate group of interconnected companies, suppliers, service providers and associated institutions in a particular field, linked by externalities of various types."[2]

The definitions were picked out of the wide variety of explanations of the term "cluster". Taking a closer look on these statements, the concept seems blurred. One could picture a black box with no sharp outlines, unknown size and unspecific complexity that might be encircled and approached from several directions. However, what pervades all definitions is the focus on geographical proximity for the interaction of different economic actors, even if the radius of action cannot precisely be indicated.

For the emergence of successful regional innovation clusters the role of proximity is emphasised in the literature from the field of regional economics. The advantages result from agglomeration effects or network effects. Literature differentiates between two major types of agglomeration advantages: localisation economies as the advantages caused by the concentration of companies of one industry on a location, and urbanisation economies as the spatial concentration of companies from different industries. The interaction of these factors leads to the named agglomeration advantages that can also be measured empirically: For the USA, Ciccone and Hall (1996) estimate a productivity growth of 4 to 6 percent with the doubling of population density, for Europe a similar effect is shown.[3] As Baptista puts it: "…large urban markets provide local economies of scale and urbanization lowers transport costs. However, urban density also allows for a more rapid spread of knowledge: it helps companies learn what their consumers need and what their competitors are up to, and provides beginners with a wider variety of opportunities and role models."[4]

The latter quote already indicates where reasons for the emergence of clusters might lie: the first aspect is the interaction between companies and their demanding customers and consumers. Critical and locally based customers are one of the four cornerstones of Porter's "diamond model of competitiveness"[5]. In addition, Krugman's core-periphery model[6] (that was extended and modified several times[7]) describes the interplay of production, consumption and localisation decisions of companies. In certain constellations it can develop centripetal forces that lead to a centralisation of production. However, empirical studies show that the specialisation of regions tends to decline,[8] at least as long as it is measured along the conventional industry classifications. But there is evidence that the importance of functional specialisation, i.e. specialisation along intersectoral regional value chains, is growing[9]. The

[1] Feser and Sweeney (2002), p. 111
[2] Porter (2003), p. 562
[3] Ciccone and Cingano (2003), Baptista (2003), Möller and Haas (2003)
[4] Baptista (2003), p. 166
[5] Porter (1990 and ensuing papers)
[6] it discusses models based on monopolistic competition (Dixit and Stiglitz (1977), Ethier (1982)) in a world with transport costs in the widest sense, scale economies and externalities of market size (e.g. Krugman (1991), Ottaviano and Puga (1997), Fujita, Krugman and Venables (1999), Fujita and Thisse (2002), Head and Mayer (2003))
[7] e.g. Krugman and Venables (1995), Helpman (1998), Puga (1999), Forslid and Ottaviano (2003)
[8] Kim (1995) for USA, Möller and Tassinopoulos (2000) and Haas and Südekum (2005) for Germany
[9] See Möller and Litzel (2008) for applying cluster data from the Eastern Bavarian research project CORIS (cluster-oriented regional information system, www.coris.eu) to established measurements of regional specialisation and spatial concentration of economic activities.

characteristic feature of value chains or supply chains is vertical integration with its forward and backward linkages, externalities that affect a company either because of changes in suppliers' or customers' actions (Hirschman 1958).

For instance, Simmie et al. (2002) in their study of five innovative European city regions (selected out of the ten cities with the highest relative R&D investments) show that indeed clients and customers are the most important type of collaborator for positively influencing a company's innovation process. However, differentiating along regional aspects shows that companies located in the capitals and world cities London and Paris rate their local customers as less important for innovation than the international ones, but for the regional cities of Milan and Stuttgart as well as for Amsterdam (as the capital of a smaller country) the result is reverse. The authors conclude "… that networked local production theory has tended to over-generalize the importance of local supplier/ customer production networks."[10] One explanation provided is that so far most case studies focused on 'ordinary' regional cities and not on the very innovative core metropolitan regions. In addition, one has to consider that especially in high-tech industries it is less likely to produce for the local market, cutting-edge companies find their clients internationally – again this orientation is eased by being closely located to an international airport. For supplier relationships Simmie et al. (2002) find the same pattern.

Fritsch (2001) sheds some light on the manufacturing sector in the three German regions of Baden, Hanover and Saxony. His data concerning cooperation activities reveal that on average one third of relationships to both customers and suppliers are regional, meaning that they are less important than close contacts with other local companies. Also Grotz and Braun (1997) use a design of three German regions differing largely in their industrial structure and endowment with R&D institutions – Aachen, Lüneburg-Celle and Neckar-Alb – they also focus on the mechanical engineering industry. The authors assume that the type of region largely influences the intensity of innovation networks (not clusters), but find hardly any differences. In addition, they could not find much evidence for strong local bonds and state "…that the significance of regional cooperation among firms should not be overestimated. Apart from traditional backward and forward linkages, the largest group of firms does not have any stable relationships to other firms within their region."[11] But taking a closer look on specific innovation projects reveals that in the early stage of new product development – when an idea is generated or taking shape – the regular customers are the most important source of information.

Vertical interlinkages are one prerequisite for clustering. Also diagonal links with e.g. research institutions and service partners gain importance for successful innovation. Referring again to the study of Fritsch (2001), around 55 percent of manufacturing companies rely on regional public research institutes. This strong local perspective exists also vice versa: research institutes in the regions considered stated that the major part of their project partners in manufacturing are local. Fritsch concludes that geographical proximity is conducive for cooperating. However, the study of Grotz and Braun (1997) reveals that in their three regions under consideration the contact to regional R&D facilities is "…surprisingly weak"[12]. "For high-profile technology transfer (…) spatial proximity obviously is irrelevant".[13] Simmie et al. (2002) again find that mainly in the international cities London, Paris and Amsterdam

[10] Simmie et al. (2001), p. 56
[11] Grotz and Braun (1997), p. 549
[12] Grotz and Braun (1997), p. 549
[13] Grotz and Braun (1997), p. 550

academics as well as universities are seen a major source of information and prominent location factor.

Yet another approach to look at clusters is the analysis of horizontal links between companies. To refer again to Grotz and Braun (1997), in no-one of their three regions under consideration they find only weak hints for horizontal cooperation e.g. for product or process development. Simmie et al. (2002) investigate the location of the highly innovative companies' competitors and show that in their sample the major competitors are even situated in another country – mainly again for the international cities. They conclude that the overall competition is enhancing innovation, not the local one.

The existing and emerging interlinkages between companies are not necessarily reflecting price mechanisms at work. As Richardson (1972) describes from an industrial organisation point of view, the coordination of the division of labour can take place both within a firm and via market transactions. However, internally a firm often focuses on similar activities, but when complementary capabilities (Richardson uses the notion 'capabilities' to combine knowledge, experience and skills[14]) are needed – for instance to strengthen its market position – it is often not possible to purchase them on the market. Therefore, horizontal, vertical and diagonal links also occur in the form of cooperation that he defines as follows: "The essence of co-operative arrangements (…) would seem to be the fact that the parties to them accept some degree of obligation – and therefore give some degree of assurance – with respect to their future conduct."[15] The stability of relationship and the mutual purpose makes the difference between a mere market transaction and cooperation, no matter how formal or informal the latter is organised. Also sociology is going beyond economic reasons to help explain why companies cooperate with others, which framework they prefer, what their expectations are or how strong the cluster awareness within a region is.

Against the background of cooperation also two other modes of entrepreneurial behaviour – collaboration and competition – can be regarded. Polenske (2004) analyses the possible constellations and interconnections between these three types of restructuring strategies of companies facing globalisation. According to the strength and nature of relations between Polenske's '3Cs' in possible frameworks of region and network types she discusses three alternative models to successfully adapt to changing market situations – the regionally-oriented and SME-dominated Italian model, the Japanese model with a dominant customer and a just-in-time-supplier and the Global model characterised by mainly multinationals that cooperate on a world-wide scale. As for the cluster issue, the Italian model seems to be prevalent, perhaps because – as the author mentions – many early cluster studies scrutinised the Third Italy. However, e.g. Perkmann (2006) provides evidence that successful regions are not necessarily characterised by territorial embeddedness and regional clusters. His area under consideration is South Tyrol, an economic space with stable development and where many multinational branch-plants with just a few corporate R&D departments are located. The author observes that the local links of these externally owned firms are weak, but that the region profits of the inflow of external knowledge – e.g. because in twice as many multinational plants than in locally owned firms investments in human resource development took place. The skill level in the region is positively influenced and eases the introduction of product and process innovation.

To make the step to successful innovation clusters, Feldman and Audretsch (1999) stress three factors referring to horizontal interconnections. First, complementary activities should be to a certain extent diverse and if possible share a thematical platform. This recurs on empirical

[14] Richardson (1972), p. 888
[15] Richardson (1972), p. 886

results e.g. by Glaeser et al. (1992), finding that diversity proves to be more conducive than specialisation. Second, they state that competition is spurring innovation more than a monopoly.[16] It is not just the fact of competition stimulating technological developments, but also the cooperation among competitors. For this constellation, Brandenburger and Nalebuff (1996) created the notion *co-opetition*. Third, they find that the endowment with technological potential in the past is just partly explaining the development of innovation clusters. For a successful progress it seems to be far more important to efficiently organise the existing structures and networks: „The underlying economic and institutional structure matters, as do the microeconomic linkages across agents and firms."[17] And Van den Berg et al. state on the basis of an empirical study on growing clusters in nine European cities: "There are many indications that, increasingly, urban economic growth seems to emerge from fruitful co-operation between economic actors, who form innovative complexes of firms and organisations."[18] These indications are for instance provided by Czarnitzki and Fier (2004). They investigate the German policies of publicly funded incentives for collaborative (as opposed to individual) R&D projects. Most likely to generate innovative output measured by the number of resulting patents are the companies that are involved in funded joint research projects with other companies.

Along with cooperation and networking – be it between horizontally, vertically or diagonally interlinked companies and institutions – comes the exchange of information and knowledge, as already observed by Marshall (1890). „'Knowledge' differs from 'information' in that it is creative and informed by meaning and understanding, whereas information is passive and, without the application of knowledge, meaningless".[19] Implicit knowledge has got the character of being 'sticky'[20] or tacit, it is hard or even impossible to codify and is bound to individuals and therefore to locations and regions. Local knowledge spillovers, also termed spatially bound knowledge externalities, are strongly connected to implicit or sticky knowledge. The latter can be considered as a local pool of knowledge that is nurtured through social interaction that is typically happening more frequently in geographic proximity.

Knowledge spillovers are seen as an important part of economic growth, but still the process as such as well as the possibly selective transmission of knowledge is conceptually not clear and has not been sufficiently modelled or measured – it is a black box. „Indeed, most of the metrics imply the imparting of knowledge, but do not actually measure it."[21] However, there is a strand of literature on the possibilities of pinning down the 'invisible' effects of knowledge transfer. In this context, Jaffe et al. (1993) try to localise and quantify these effects by analysing the 'paper trail' left by patent citations.[22] And for instance Simmie et al. (2002) show with qualitative data that both for international as well as for regional cities the local labour pool of specialists is highly relevant for innovation. Other studies find different evidence, e.g. Gallié (2008) studying the French biotechnology sector with the objective to put cooperation into the knowledge production function. The author finds in her model "… that the influence of geographic dimension is null within cooperations when partners are located in France or the European Union."[23] But Gallié also concludes that even if

[16] Glaeser et al. (1992), Audretsch and Feldman (1996)
[17] Audretsch (2003), p. 19
[18] Van den Berg et al. (2001), p. 185
[19] Cooke (2005), footnote 1
[20] Von Hippel (1994) introduces the notion "sticky", Audretsch (2003) adapts it to "sticky knowledge".
[21] Howells (2002), p. 876
[22] A reference to Krugman's often quoted lines (1991: 53 f.): „(…) knowledge flows, by contrast, are invisible; they leave no paper trail by which they may be measured and tracked, and there is nothing to prevent the theorist from assuming anything about them that she likes."
[23] Gallié (2008), p. 10

cooperation partners are located far apart, they can still work face-to-face in business meetings. According to Torre (2008a) – who also questions the need for co-location and the frequency of face-to-face contact necessary for knowledge spillovers and innovation – these meetings are even necessary in epistemic communities. In addition, both Boschma (2005)[24] and Torre (2008b) warn of possible negative effects on innovation in being located close to suppliers, customers and cooperation partners, the most prominent one being "… the problem of lock-in, meaning a lack of openness and flexibility"[25] as well as industrial espionage and poaching.

In addition, sociological literature challenges the "automatism" that regular personal contact and direct interaction creates trust and reciprocity within clusters.[26] Questions that arise are, for instance, which formal and informal rules enable the cohesion of clusters, if a certain collective behaviour can be observed in a cluster context and how collective identity is created and sustained within clusters. Cluster structures can be seen as specialised networks with power and control playing a central role.[27] Network analysis can contribute to the discussion with statements to cohesion, the density of relation and connectivity or the degree of centralisation, e.g. if certain clusters are dominated by one agent or "leading company".[28] The often-drawn scenario of "self-fulfilling harmony" in regional clusters will get some additional twists.

Several authors emphasize the considerable differences between the structures of clusters that should not be neglected in data collection and analysis. As Guinet puts it: "Clusters are inherently different between countries (or regions), between technological areas, and ultimately between individual clusters themselves."[29] So the manifold methods to approach clusters should be combined and used to get a concise picture of the individual regional clusters to provide a valuable basis for sound (regional) economic policy.

3. Methodology of cluster identification

To identify a region's clusters and to encompass different approaches offered by literature we developed a methodology[30] to systematically register the value-chain-oriented structures and functional specialisation in an economic space. However, sharing Simmie's (2004) view "…that clusters cannot be defined as geographical objects of study. Instead, it is necessary to start with the kinds of linkages that competitive firms use and then to assess how far these are confined within particular localities (…)"[31] we conduct the survey along the core competencies of individual companies and institutions and their interactions that can be observed on the micro-level – customer-supplier-relationships, cooperation and membership in networks. Cluster-relevant individual firm data are collected and backed by geographic information. We develop the geographical scopes of individual clusters out of the information on interlinkages and thus allow different cluster-specific economic spaces.

The detailed questionnaire covered the range of topics illustrated in Figure 1 that tries to capture the most important aspects of clustering. Again, it becomes clear that the concept with

[24] Boschma (2005) gives a very broad picture of the interplay of five dimensions of proximity: cognitive, organizational, social, institutional and geographical proximity
[25] Boschma (2005), p. 62
[26] Shrum and Wuthnow (1988)
[27] Hakanson and Johanson (1993), Uzzi (1997), Abraham (2001), Blumberg (2001)
[28] Jansen (1999, 2002). Examples of applied network analysis in the cluster context can be found in Cantner and Graf (2004) and Wrobel (2004).
[29] Guinet (2001), p. 5
[30] This section is based largely on section 8.3.1 in Möller and Litzel (2008).
[31] Simmie (2004), p. 1096

its different approaches is blurry and encircles company-oriented questions. Both our different interview guidelines and the questionnaire are designed to approach and encircle the topic from business aspects familiar to management staff. Company representatives are able to answer detailed questions concerning cluster-related topics as depicted in Figure 1. The term 'cluster' is introduced only at the very end with a question concerning cluster awareness. Major practical problems arising from being unacquainted with the fuzzy 'cluster' notion can thus be avoided.

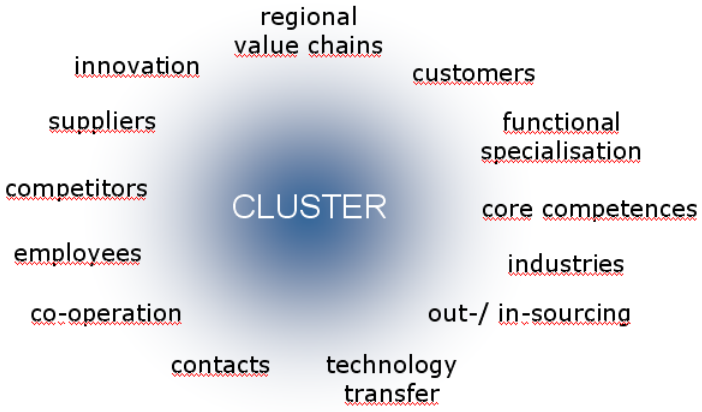

Figure 1: The complexity of cluster-related aspects
Source: own illustration

The methodology involves several interconnected elements. To gain a first insight into the economic structures and to identify the leading companies in the region semi-structured in-depth interviews with experts from different institutions are conducted. In the following, members of the managing board of the leading companies are interviewed as well, leading among others to information about further relevant firms and institutions in the region that are also considered for further interviews. As many different fields of interest have to be taken into account, a detailed manual for each type of interview has been developed.

After this stage, a rough outline of the region's main value chains is visible – including first indications about the segments covered by regional competencies – and a share of the relevant companies and institutions are identified. Also, the cluster-specific extent of the economic space – that very often does not correspond to administrative borders and should if possible be defined by functional considerations[32] – is becoming clear.

On the basis of this first information about potential regional clusters, main vertical, horizontal and diagonal links between companies and between firms and institutions and some strengths and weaknesses of the location a company survey is conducted among manufacturing companies and the service industry. The questionnaire is focusing on deepening the cluster-specific information. It contains sections inquiring about customer-supplier-relationships and co-operations, joint projects e.g. in the fields of development of human capital or research, functional versus industry affiliation but also products and services offered, the core competencies, innovations, the size by turnover and employees, company

[32] Feser et al. (2001) also work on the conceptual problem of clusters neglecting administrative borders. As a basis for further quantitative and qualitative analyses they developed a methodology that combines a non-spatial technique revealing inter-industry links with an analysis of employment patterns in economic space.

structure etc. The detailed firm-specific information is backed by a focused analysis of secondary statistical data.

For the identification of cluster potential in a region we developed a set of five criteria this data is applied to. It is used to check whether fields of functional specialisation can be considered as working clusters or, alternatively, as supply chains with potential for clustering. These criteria are concentration in space, labour market pooling, existence of "leading companies" (technology leaders, market leaders, image carriers), of supporting institutions and network activities.

First, this methodology was implemented in Eastern Bavaria in 2000 and 2001 with an extension along the river Danube between Regensburg and the Austrian border in 2006. In 2006 we then adapted the methodology to the specific needs of the survey in the core of the European Metropolitan Region Nuremberg. For this paper, we use data of the latter project (see data description in Section 4.2).

4. The region and the data base for cluster identification

In this section we first introduce the region we are studying in this paper. Then we describe the application of the methodology outlined in Section 3 to collect and analyse data, followed by information on the database.

4.1 The region

In 2005 the Nuremberg region was admitted as European Metropolitan Region (EMR), underlining its importance on national and international scale. The agglomeration forms – after Greater Munich area – the second largest economic centre in Bavaria and is found among the ten strongest technology regions in Germany. European Metropolitan Regions are considered as "the motors of social and cultural development. They are taken for spatial and functional locations whose outstanding functions on international scale are radiating also across the national borders".[33]

Our study focuses on the core of the EMR Nuremberg, being the Bavarian district of Central Franconia and the two adjacent counties Forchheim (in Upper Franconia) and Neumarkt (part of Upper Palatinate), coloured yellow and red in Figure 2.

[33] Adam et al. (2005), p. 417, translation by the authors.

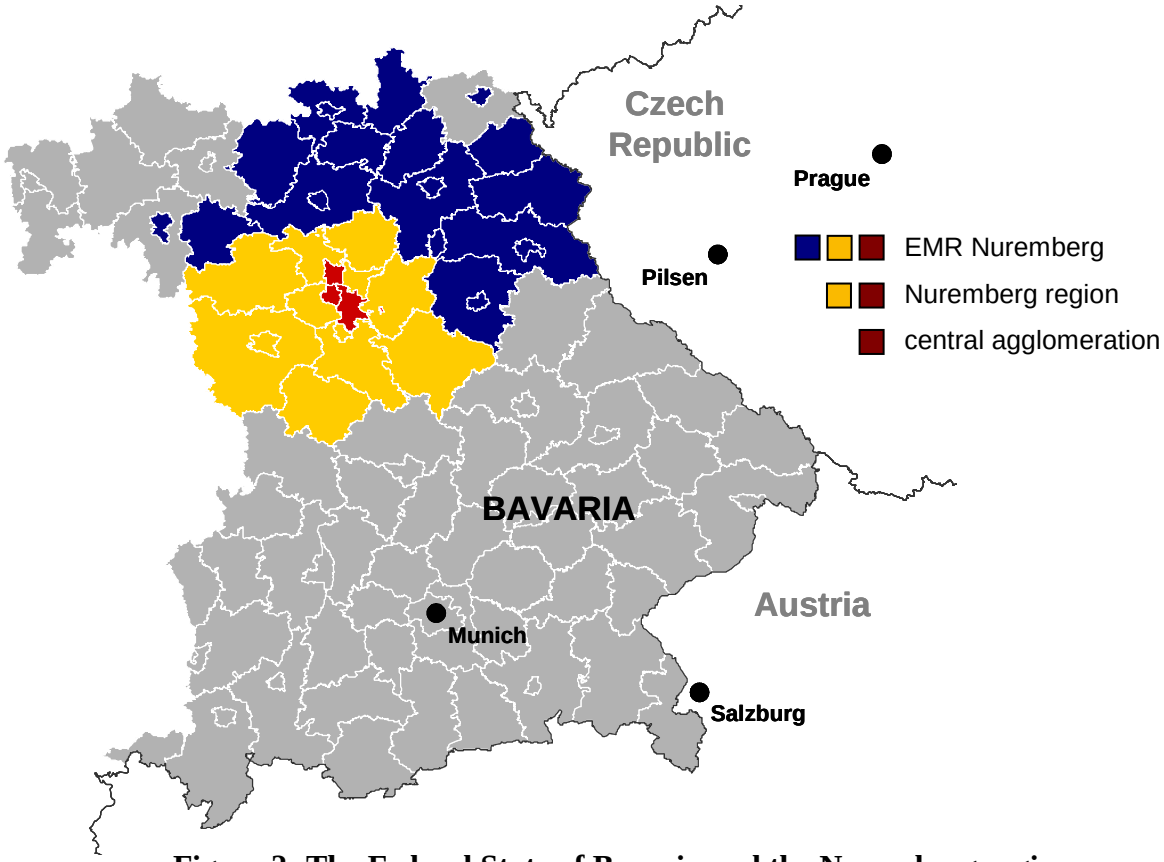

Figure 2: The Federal State of Bavaria and the Nuremberg region
Source: own illustration, we thank Stefan Böhme from IAB for his support

The region with its two million inhabitants is characterized by the triangle of the cities Nuremberg-Fuerth-Erlangen (coloured red). This agglomeration is surrounded by counties with high population and industry density, the counties further away are rural areas. Today the entire Metropolitan Region comprises 21 counties, 12 cities and represents roughly 3.5 million inhabitants (blue, yellow and red in Figure 2).

Nuremberg is the dominant city, where roughly one quarter of the population is living, but where 37 percent of employees subject to social security are working and where about 37 percent of the region's GDP is also generated. In addition, 37 percent of the unemployed are registered in the city of Nuremberg.[34]

Concerning skill structure, the region under consideration follows roughly the West German pattern, e.g. the national share of high-skilled graduated employees is 8.7 percent, compared to 9 percent in the European Metropolitan Region Nuremberg. Outstanding is the value for the city of Erlangen with 25 percent of employees holding a degree. The reason for this lies in the concentration of employers like Friedrich-Alexander-University Erlangen-Nuremberg, several headquarter facilities of a world-renowned multinational company and a wide range of high-tech firms grouped around them. On the other hand, the region's share of workers without vocational qualification (14.2 percent) is also considerably higher than in the national average (12.9 percent).

Within the European Metropolitan Region Nuremberg the cultural interconnections and economic integration are strong, as can be seen e.g. by the intra- and interregional commuting

[34] Data source for his section: Bavarian State Office for Statistics and Data Processing and the statistical information offered by the Federal Employment Agency (BA).

patterns focused on the agglomeration, by the double-location of the Friedrich-Alexander-University Erlangen-Nuremberg and the distribution of headquarters in the cities and production sites in the outskirts.

What makes the economic space around Nuremberg particularly interesting for cluster studies is the advanced level of coordinated network activities in the region. They emerged in the 1990s, after two decades with a massive structural change taking place. Traditional industries like metal and electrical industry switched importance with services. "The proportion of industrial employees fell from 61 percent to 39 percent, whilst the proportion of service employees rose from 38 percent to 61 percent."[35] To face these challenges, the regional development authorities in the agglomeration started with a strategy referring to cluster concepts – to strengthen existing potentials and the regional labour market by initiating cooperation and networks between companies as well as between companies and institutions.

A central feature was the development of a 'Master Concept of Development' (*Entwicklungs-leitbild*) that was first passed in 1998 and then updated in 2005. Taking into account existing or already terminated relationships to network partners and interested companies it was aiming at identifying regional fields of competence, i.e. clusters. These were to be organised in "competence initiatives" – different kinds of organisations managing cluster activities to individual extents – in order to shape Central Franconia's national and international profile.[36]

In the first place, cluster management activities have been implemented in five fields of competence: Transport and Logistics, Information and Communication, Medicine and Health, Energy and Environment and New Materials. In 2005, the sixth field of Automation and Production Technology was started. A range of subclusters focus on certain aspects of the individual competence initiatives. To take account of the dominant production-related service industry with national and international importance (e.g. companies like the already mentioned Datev and Gesellschaft für Konsumforschung (GfK)) the field of Innovative Services was also named as a regional core competence with strong potential for future growth.

4.2 Database

We use data collected in the research project "Clusters and Inter-Firm Networks in the Region of Nuremberg". This is a joint work of the Institute for Employment Research (IAB), Nuremberg, and the University of Regensburg (UR), chair of Economics. Part of this research project is the implementation of the methodology of cluster identification described in Chapter 3 in the economic space named in Section 4.1.

For the survey, all firms without employees subject to social security and companies in a non-active status were excluded. In addition, a selection was made according to the affiliation of firms to NACE industries and methods of stratified random sampling were applied. Some sectors that are not of interest in the cluster context were excluded entirely, e.g. antique shops and private child care facilities. The questionnaire was sent to about 8,700 companies in the region and was returned by 888 (10.2 percent). They are the population of the following analysis. We use only company information. As some of them are affiliated to more than one cluster the total number of observations for cluster-related questions is 1,397. The sample represents roughly 88,000 employees, or again a little more than 10 percent of all dependent workers.

[35] Heidenreich (2005), p. 746 – also see IHK Industrie- und Handelskammer Mittelfranken (2005), Stadt Nürnberg (2003).

[36] Please see Neumann (1996), Stadt Nürnberg (2003), Entwicklungsleitbild der Wirtschaftsregion Nürnberg (2005) for information on the development and implementation of the process.

4.3 Application of the cluster-identification methodology

The data described above we apply to a set of five criteria. It is used to check whether fields of functional specialisation can be considered as working clusters or, alternatively, as supply chains with potential for clustering. These criteria are concentration in space, labour market pooling, existence of "leading companies" (technology leaders, market leaders, image carriers), of supporting institutions and network activities.

Table 1: Overview of the criteria for cluster identification and how strongly they are fulfilled by

Cluster	concen-tration	leading companies	labour market pooling	supporting institutions	net-working
MED	++	+++	+++	+++	+++
AUT	+	++	+	++	++
L&T	++	+++	++	+++	+++
I&C	+	++	++	++	+++
PLA	++	++	++	+++	+++
MAC	++	++	++	++	+
EL	++	++	++	++	++
ETE	+	++	+	++	++
Toy	++	+	o	+	o

Notes: +++ very strong, ++ strong, + weak, o very weak or not fulfilled

Coming along with the interviews and the survey is information on the spatial dimension of the fields of functional specialisation under consideration. Possibly certain value chains are strongly concentrated in a location within the economic space, or some cluster-relevant companies or institutions are located outside the region.

The eight value chains we identified for this economic space as clusters (see Table 1) operate in Automotive [AUT], Electronics [EL], Environmental technology & energy [ETE], Information technology & communication services [I&C], Logistics & transport technology [L&T], Specialised automation [MAC], Medical technology & health [MED] and Plastics industry [PLA],. Obviously our results back the fields of competence in which network organisations in Central Franconia are active. To some extent, our research leads to different and additional subclusters and we also identify two more potential clusters. After the first expert interviews some other fields, for instance toy industry [Toy], have been considered as well, but their cluster prerequisites could not sufficiently be supported by the information.

In the following we briefly describe the five criteria we used for the identification of clusters and reference to some examples from Central Franconia plus the two adjacent counties Forchheim and Neumarkt.[37]

First, we consider the economic activities in the region and see if they have particular elements. Along with that comes a structuring of each value chain according to the main competences covered by the regional players. It proves to be useful – especially when also using the database for economic policy guidelines and network management – to move beyond the obvious categories producer, supplier and institution, but to further differentiate the parts of the value chain. In some clusters it is possible to refer to the NACE codes for a description of the different main functions, but for others it makes sense to depict them in more detail. Taking the automotive industry, for instance, the NACE codes DM.34.00 cover manufacture of motor vehicles (DM.34.10), manufacture of bodies (coachwork) for motor vehicles (…) (DM.34.20) and manufacture of parts and accessories for motor vehicles and their engines (DM.34.30). In CORIS the automotive industry is divided up into ten categories: car manufacturers, first tier suppliers of plastics, of electronics, of metals and of further systems, second tier suppliers of plastics, of electronics and of further components, further suppliers of services and machinery, supporting institutions and services. This is one possibility to shed some light on the hierarchical structures in a value chain and at the same time to further describe and analyse the region's economic competencies.

Second, we look for the existence of 'leading companies' in the industries under consideration. We speak of a leading company if a local firm shows at least two of the three following characteristics: it is highly dynamic and leading in the development of technologies and manufacturing processes (technology leader); it has got a leading market position in certain segments (market leader); its name is closely connected to a certain product or technology at a national and/ or international level (image). For the core of the European Metropolitan Region Nuremberg, we find e.g. in Medical technology & health a leading company that produces medical systems for diagnostic imaging, IT and therapy, having all central company functions, especially R&D in the region; and two leading pharmaceutical companies, all with close regional connections.

Third, the phenomenon of labour market pooling is taken into account. Can the existence of a specialised workforce be observed? In some areas an obvious pooling of skills is found, e.g. highly specialised craftsmen in glass industry or industrial occupations and engineers in electronics and robotics. Interviews reveal that employers are aware of the improved possibilities of matching in a functionally specialised region.[38] Also, there is evidence for poaching incidents as described by Combes and Duranton (2001) and Fosfuri and Rønde (2003). Indications for the assessment of the trade-off between pooling and poaching can be derived from a range of cooperation projects that include the intense cross-company exchange of employees.

In addition, we consider the existence of supporting institutions and their sectoral importance. Vital contributors to cluster structures are among others universities and universities of applied sciences with cluster-relevant faculties and fields of research and the willingness to cooperate, research institutes, technical and vocational schools, technology transfer institutions, regional development agencies, working committees and network management. All of these can be found in the economic space analysed.

[37] The general descriptions in this section are based on section 8.3.1 in Möller and Litzel (2008), a paper where the methodology was applied to data from Eastern Bavaria.

[38] as observed as well e.g. by Andersson et al. (2004)

The last criterion – and the one we are focussing on in this paper – is the evidence of cooperation between firms and between companies and institutions. Of some importance are also joint actions in the sense of coopetition[39], the cooperation between competitors. The latter can be observed e.g. in joint R&D-projects of porcelain manufacturers located in the neighbouring region of Eastern Bavaria – usually fierce competitors in their end markets – and a research institution that is located in Central Franconia. Many different kinds of cooperation occur in the managed networks.

5. Empirical results

In this chapter we first present descriptive results of our analysis, concentrating on the aspects of cooperation between companies as well as between companies and institutions. In a second section we present the first version of a model giving an indication about the

5.1 Descriptive evidence on cooperation activities in the core of the EMR Nuremberg

Of the companies answering the cluster questionnaire, roughly 70 percent stated to cooperate with other companies. More than one fifth are involved only in regional cooperation activities with other firms. However, the share of just supra-regional cooperation projects is as high as 29.2 percent and 17.5 percent are involved both in regional and supra-regional joint activities with other companies (see Figure 3).

The second most important field for companies' cooperation is with networks and initiatives, where the share of 18.2 percent indicates a regional focus. But still, more than 60 percent of the companies are not in close touch with networks. Concerning joint activities with locally oriented partners like Chambers of Industry and Commerce, Chambers of Crafts and municipalities, the regional share with 19 and 14.7 percent respectively is certainly higher than the supra-regional one, only few address both regional and supra-regional institutions.

Taking a look at fields connected to joint research activities, it turns out that contacts to local universities and universities of applied sciences are established by 109 companies of our population of 790 (the rest of the 888 participants missing), being 13.9 percent. 7.6 percent are cooperating with universities on both regional and national level, more than 9 percent act only supra-regionally. For projects with research institutions, the situation is reversed: only 4.6 percent of the companies find research capacities locally, whereas nearly 12 percent of the companies in our survey work jointly with research facilities outside the economic space. However, the majority of between 70 and 80 percent of the companies indicated to have never cooperated with universities, chambers, municipalities or research institutions.

[39] Brandenburger and Nalebuff (1996)

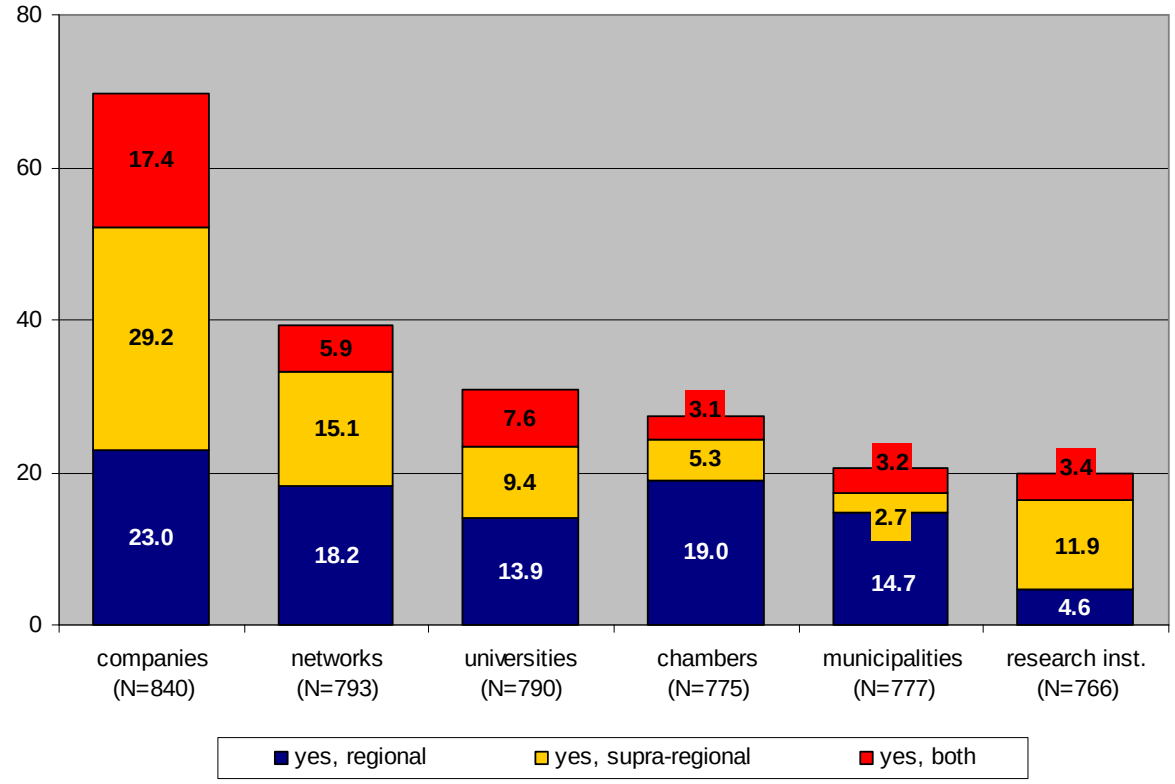

Figure 3: Answers to the question: „Has your company already cooperated with the following partners?“

Source: IAB & UR company survey 2006/ 2007, EMR Nuremberg

A set of questions aimed at finding out the companies' awareness of being part of a cluster. In the questionnaire we gave a brief definition of a cluster as a regional and (more or less) loose network of companies and supporting institutions in a specialised field of production or services, possibly spreading to several industries. 14.9 percent state they are an active member of at least one regional cluster and 8.6 percent of a Bavarian/ supra-regional cluster. The results correspond to the replies above, were the shares of network activities of all kinds is higher. We were also asking about potential membership in a cluster, trying to find out the level of information about the existing structures and an interest in these offers. 24.1 percent of the companies see themselves as a potential member of a regional and 20.2 percent of a Bavarian cluster. However, the option of giving additional open information reveals some extent of uncertainty about the nature of clusters, which has to be taken into account.

As can be expected, the cooperation culture of active cluster members is more developed than in other companies. Of all non-cooperating companies, only 5.5 percent are active cluster members and around 18 percent potential members. Figure 4 depicts some details. 87.8 percent of active cluster members are involved in cooperation activities with other firms, the corresponding share of potential cluster members is 76.9 percent and a little more than 60 percent of non-members. The differences are even more evident when looking at cooperation with networks and institutions. 71.2 percent of the active members have joint projects with organisations, the share being nearly three times as high as of non-members, where less than one fourth cooperates with institutions.

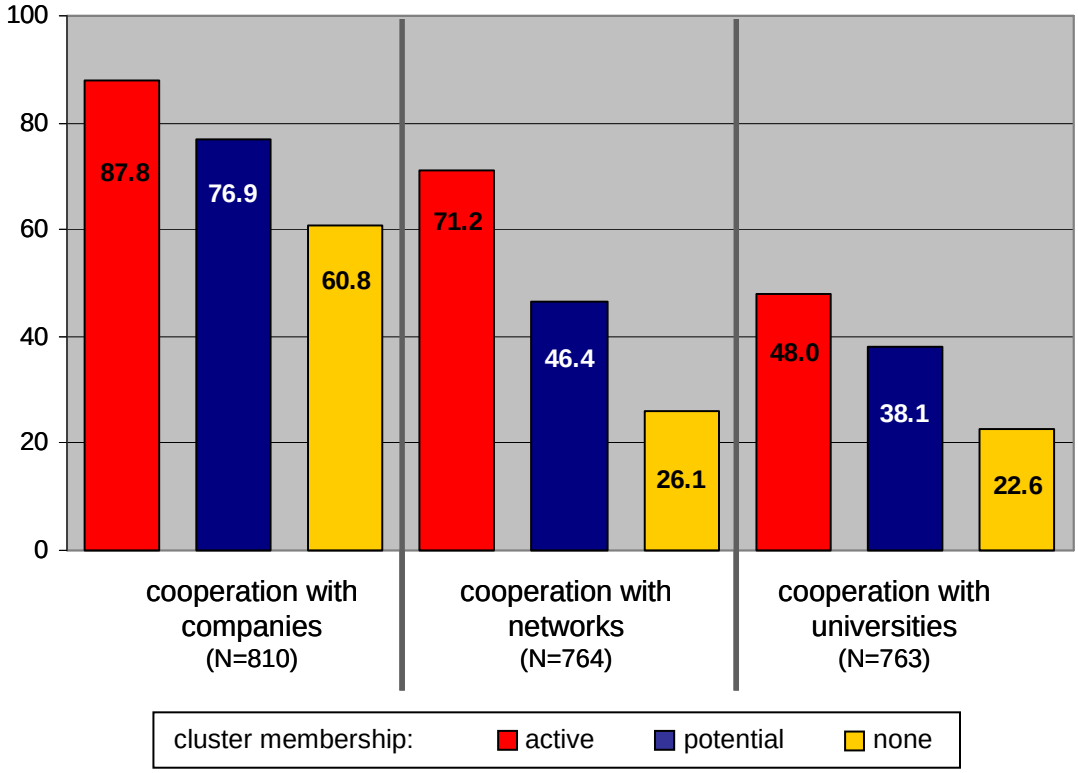

Figure 4: Cooperation activities of active and potential cluster members and firms with no connections to clusters, N=888.
Source: IAB & UR company survey 2006/ 2007)

However, joining clusters and the activities offered does not come without problems for the participants (see Figure 5). 42 percent of regional cluster members think that the additional time requirements and coordination efforts within the company are a negative side of being actively involved. The lack of information about potential partners for joint activities is an obstacle for more than one third of the companies involved, whereas nearly 18 percent claim that there are no suitable cooperation partners within the regional cluster. Still roughly 30 percent cannot see a great benefit for own business. A share of 9.4 percent of active cluster members strongly fears knowledge disclosure to cluster partners or competitors, whereas 47.9 percent do not consider this an obstacle for cluster participation. The factor causing least problems is the possibly too strong dependence on other companies.

Taking a look on the positive consequences of joining a cluster (see Figure 6), the 'contact issues' seem to be the major reason for getting involved. Asking about the advantage of access to cluster-specific information, more than three quarters state that this option applies or applies strongly, and not a single participant gave the answer "applies not at all". A better image for the industry or value chain the cluster is working in – and hence the own image – is also a positive consequence of clustering for nearly three quarters of cluster companies. To establish contact to new customers is a major advantage for over 60 percent of participants, new contacts to cooperation partners for research and development for over 40 percent and new contacts to suppliers for over one third. The advantage of eased access to qualified personnel is possibly hard to grasp, as nearly 30 percent are "undecided". Access to loan capital and funds or subsidies does not seem to be an advantage of joining in a cluster. Taking

both questions together, the level of agreement with the questionnaire items offered is persistently higher for the pros in comparison to the cons.

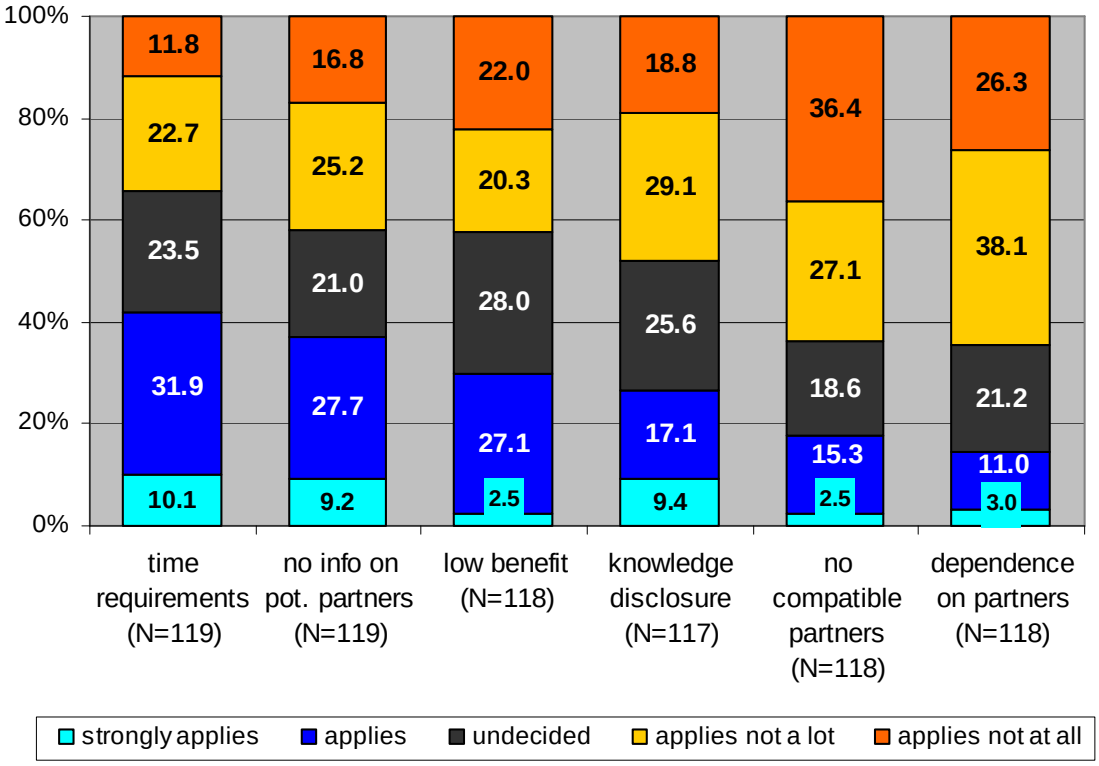

Figure 5: Obstacles and problems in joining a cluster.
Source: IAB & UR company survey 2006/ 2007, EMR Nuremberg

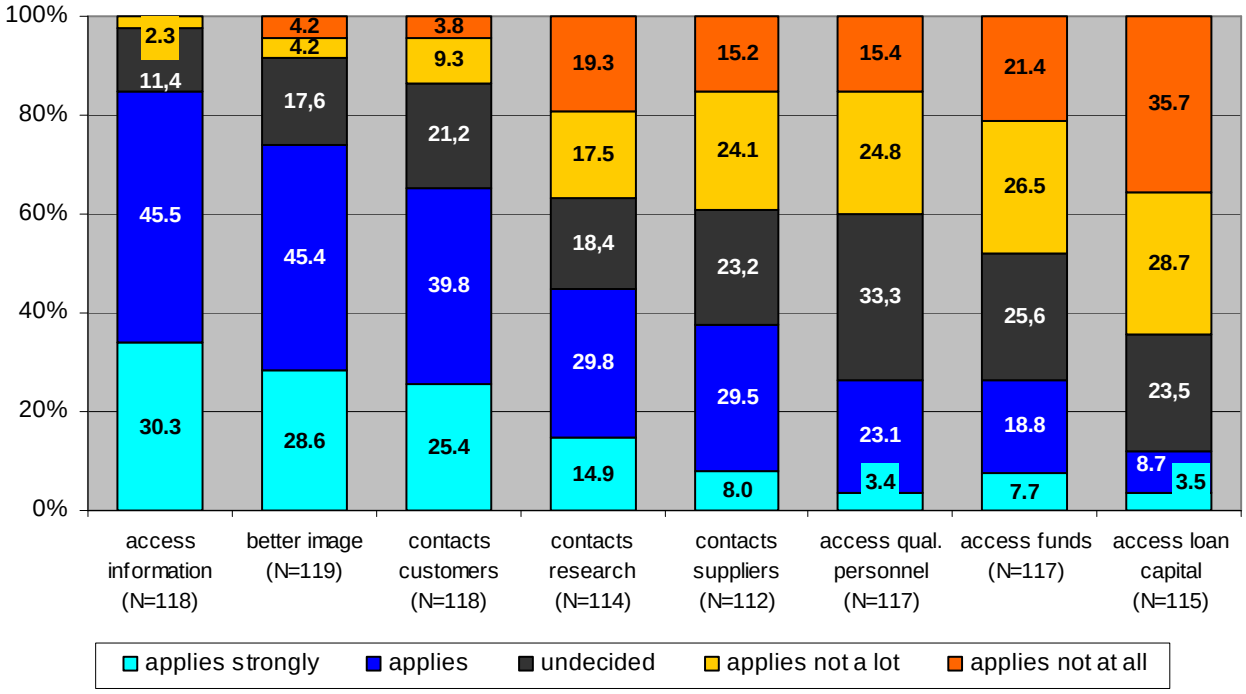

Figure 6: Advantages and positive consequences of joining a cluster.
Source: IAB & UR company survey 2006/ 2007, EMR Nuremberg

Looking at the frequency of cooperative relationships in different clusters[40], it is expected that companies working in technology-oriented value chains are cooperating more often with other companies and especially with universities and research institutions than others[41], whereas clusters dominated by industry-related services should be concentrated on joint activities on the inter-firm level. Figure 7 shows that roughly three quarters of firms affiliated with the cluster Information technology & communication services (I&C) have already cooperated with another company. They are also leading concerning cooperation with networks and initiatives with 45 percent of active firms involved. Concerning exchange with universities, universities of applied sciences and research institutions, I&C is found on the last but one position. Very close to research is the field of Medical technology & health (MED) with 38 percent of all cluster members involved in joint projects with universities. MED is also strong in cooperating with other companies – around 70 percent of cluster members are active in this field.

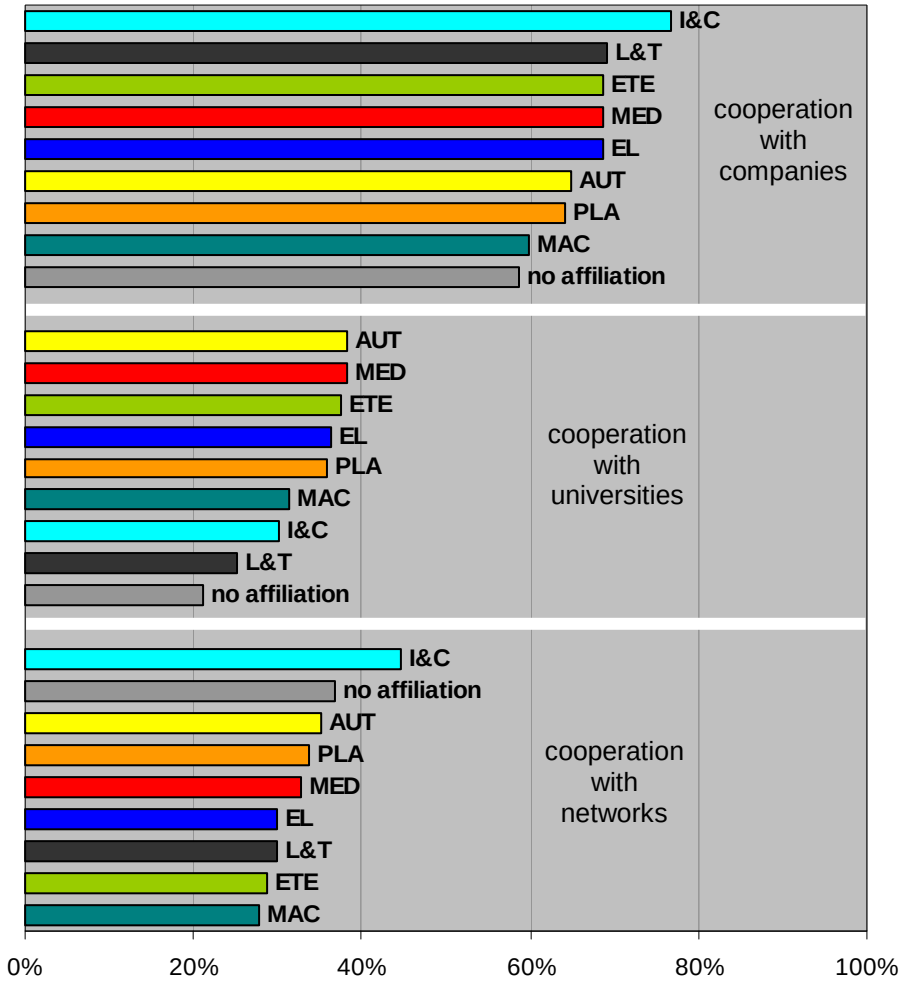

Figure 7: Cooperation activities (frequency) in different clusters, N=1385.

(*source: IAB & UR company survey 2006/ 2007, EMR Nuremberg)* – regional and supra-regional cooperations are aggregated to "yes, we cooperate".

abbr.: AUT – Automotive/ EL – Electronics/ ETE – Environmental technology & energy/ I&C – Information technology & communication services/ L&T – Logistics & transport technology/ MAC – Specialised automation/ Specialised automation/ MED – Medical technology & health/ PLA – Plastics industry – all the other companies participating in the survey are allocated to the group "no cluster affiliation".

[40] The companies were affiliated with clusters after the identification. Affiliation decisions were made according to functional considerations based on a range of indications in the questionnaire.

[41] See, for instance, de Noronha Vaz and Nijkamp (2009).

The automotive industry is a value chain with a highly progressed degree of production integration. So it would be expected that the pattern of cooperation frequency looks different than our results. Only 64.9 percent of AUT-members are stating that they are cooperating with companies, but with nearly 40 percent they are no. 1 in joint projects with research and development. Also, the companies are close to network initiatives. This pattern can partly be explained by the structure of the automotive industry in the region of analysis. In Central Franconia no car producer is located, but a strong phalanx of first and second tier suppliers. These firms have a high level of R&D. In addition, central network initiatives also for the Bavarian automobile cluster are based in Nuremberg, so geographic proximity might ease the close contact to these organisations.

As for the number of cooperation partners named in the questionnaire, there are also differences between the clusters as depicted in Figure 8. In Environmental technology & energy (ETE) more than three quarters of all cluster members are involved in two or more explicitly named cooperation partners, most other clusters are a little less active with around 60 percent of members joined two or more cooperative relationships.

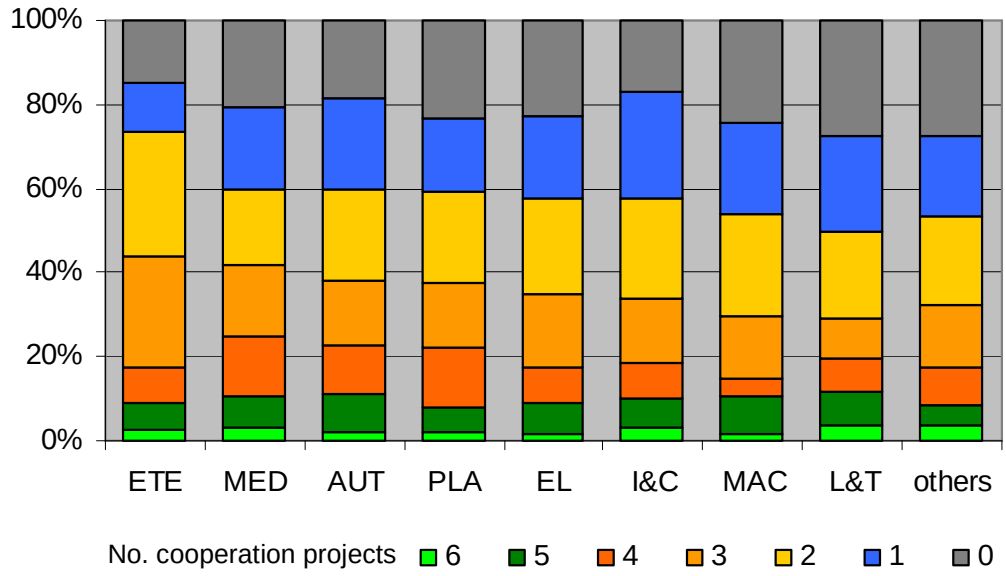

Figure 8: The number of cooperation partners named by the members of different clusters (shares), N=1380.

Source: IAB & UR company survey 2006/ 2007, EMR Nuremberg) – regional and supra-regional cooperations are aggregated to "yes, we cooperate". *abbr.: see notes Figure 7*

We also shed some light on the contacts between members of the different clusters. Clusters are not isolated conglomerates in their respective fields, but are interlinked, although to different extents, as is depicted in Figure 9. Our data show that for instance the interlinkages between the local clusters Specialised automation (MAC) and Medical technology & health (MED) are strong, as well as between MAC and Electronics (EL) and Automotive (AUT) respectively. In Central Franconia and adjacent districts MAC as producers of capital goods are specialised in these fields, as a number of joint developments shows. However, the links between MAC and I&C (Information technology & communication services) are not as strong as might be expected, thinking of the growing importance of programmable controllers and embedded systems in automation. Logistics & transport technology (L&T) can be seen as a cross-sectional technology interlinked with all other value chains. In the core of the European Metropolitan Region the links to I&C are stronger than expected. The reason might lie in the

specialisation of Nuremberg on transport technology, e.g. the development and implementation of the driverless underground train with a high share of software and sensors.

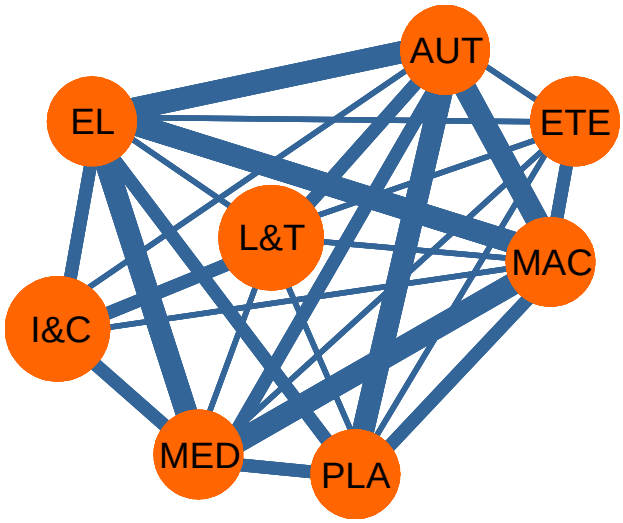

Figure 9: differently strong interlinkages between clusters
Source: IAB & UR company survey 2006/ 2007 and expert interviews, EMR Nuremberg
abbr.: see notes Figure 7

Concerning cooperation behaviour of differently-sized firms we anticipate that big companies with over 250 employees cooperate more frequently than medium-sized or small companies with less than 20 employees[42]. Indeed, 72 percent of the latter are involved in at least one cooperation project, as well as more than three quarters of medium-sized firms (20 to 249 employees) and 91.4 percent of big companies[43].

Some more detailed results are depicted in Figure 10. For cooperation with other companies firm size hardly seems to matter – in all three categories the share of cooperating companies is between 67 and 81 percent. Looking at contacts to networks and initiatives, the difference between big companies (54.7 percent) and small and medium-sized firms (both a little more than one third) is higher, but in any category cooperation activity is less frequent than with companies. The most striking discrepancy can be found in cooperation with universities and research institutions. It was expected that for big companies access to R&D-capacities is easier than for SMEs. In our survey, 78.9 percent of firms with more than 250 employees state that they cooperate with universities. Just one third of medium-sized companies are involved, and as few as 21.2 percent of firms with less than 20 employees cooperate with universities.

Referring to Figure 4 it is interesting to note that in contrast the active and potential cluster members as well as the non-affiliated ones consistently have a higher share of cooperation activities with networks than with universities.

[42] see also Schmidt (2007) who gives a broad literature review of studies that show that bigger firms cooperate more frequently than SMEs.
[43] Of 888 answering companies, 222 stated to have no cooperation at all and 666 to have at least one cooperation partner (missings counted as none).

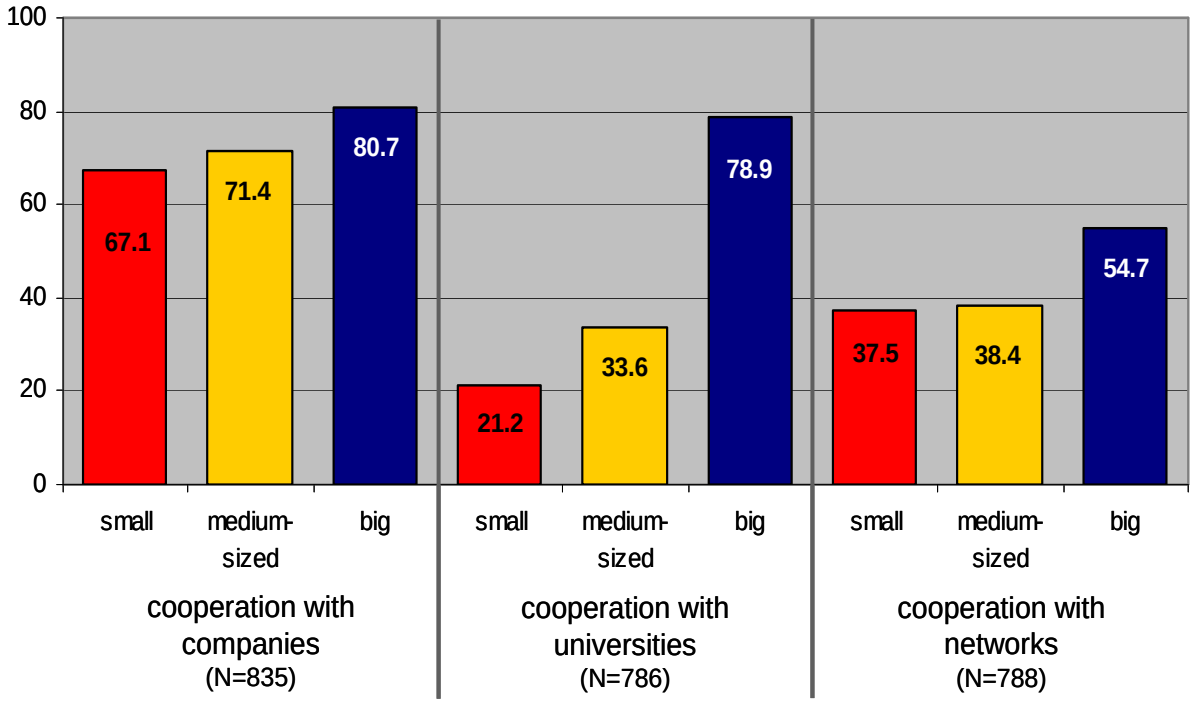

Figure 10: Cooperation activities of differently sized companies with other companies, universities and universities of applied science as well as with networks and initiatives.

Source: IAB & UR company survey 2006/ 2007, EMR Nuremberg)

small enterprises = 0 to 19 employees, medium-sized enterprises = 20 to 249

5.2 A model on cooperation activities

= preliminary version, to be elaborated =

Putting the descriptive evidence in a logit model we evaluate the propensity to cooperate in a multivariate model with a binary dependent variable, being cooperation activities. As in the descriptive section (Section 5.1) we choose three approaches: cooperation with companies, with universities and networks respectively.

Table 2: The propensity to cooperate with different partners

	cooperation with companies		cooperation with universities		cooperation with networks	
	A	B	A	B	A	B
_cons	.144	.351**	-2.609***	-2.522***	-1.359***	-.618***
number employees (log)	1.109**	1.095*	1.544***	1.508***	1.112**	1.093**
member regional cluster	2.734***		2.524***		3.609***	
member any cluster		1.392**		1.802***		.880

Notes: Estimates of logit coefficients (odds ratios)
* statistically significant at the 10 percent level

** statistically significant at the 5 percent level
*** statistically significant at the 1 percent level

For each approach we differentiate between model A (if the company under consideration is classifying itself as an active or potential member of a cluster in the Nuremberg region) and model B (companies participating in the survey affiliated to the identified clusters by the authors on the basis of a wide range of information from the questionnaires).

The results in Table 2 show that the coefficients of model A are constantly higher than those of model B, indicating that a company that classifies itself as an active or potential member of a cluster in the Nuremberg region – standing for cluster awareness – has a stronger effect on the companies' propensity to get involved in cooperation activities than the functional affiliation to a regional cluster. This might also explain why the odds ratio of model B for cooperative relationships with networks and initiatives is not significant – some of these initiatives might be cluster managements and the like.

As expected the size of the companies – measured by employment – positively influences the propensity to cooperate, especially concerning joint projects with local universities and universities of applied sciences. The odds ratios or chances to cooperate with universities are nearly 40 percent higher than for the other cooperation partners.

Table 3: The propensity of cluster members to cooperate with different partners

	cooperation with companies		cooperation with universities		cooperation with networks	
	C	D	C	D	C	D
_cons	.137	-.175	-2.556***	-2.947***	-.902***	-1.488***
number employees (log)	1.132**	1.132**	1.541***	1.553***	1.123**	1.146***
member regional cluster		2.581***		2.382***		3.564***
AUT	1.111	1.130	1.554	1.464	1.522	1.683*
EL	1.009	1.078	1.376	1.503*	.664*	.658*
ETE	1.980**	1.902**	2.154***	2.163***	1.161	1.108
I&C	2.637***	2.270***	1.613**	1.417*	1.998***	1.749***
L&T	1.231	1.300	.626*	.681	.793	.879
MAC	.826	.786	.897	.902	.688*	.598**
MED	1.382	1.300	2.242***	2.197***	1.053	1.043
PLA	1.078	.893	1.065	.917	1.165	.890

Notes: Estimates of logit coefficients (odds ratios)
* statistically significant at the 10 percent level
** statistically significant at the 5 percent level
*** statistically significant at the 1 percent level

In Table 3 we break down the estimates of Table 2 from the aggregated variable "member any cluster" of model B to the individual clusters identified for the Nuremberg region. In model D we also include the variable "member regional cluster" as an indication for cluster awareness. Again, the number of employees is highly significant, the gap between its influence on cooperation with companies or networks and cooperation with universities is even larger than in models A and B. The influence of affiliation to individual clusters on cooperation activity

in most cases is fairly weak. Just the I&C cluster has statistically significant odds ratios for all model versions and also generates the highest values for cooperation with companies as well as with networks and initiatives – the high propensity of I&C companies to cooperate with different partners was already visible in Figure 7. The only difference is in cooperation with universities: I&C values and significance levels are topped by both ETE (Environmental technology & energy) as well as MED (Medical technology & health) and partly by EL (Electronics).

6. Résumé and perspectives

In this paper we presented descriptive results and a first model of the research project "Clusters and Inter-Firm Networks in the Region of Nuremberg", a joint work of the Institute of Employment Research (IAB) and the University of Regensburg. In this project we use a methodology of identifying and analysing clusters in a not yet exactly specified economic space, encompassing different approaches offered by literature.

The focus of study presented here is on Central Franconia, the core of the European Metropolitan Region Nuremberg. In the late 1990s, the regional development authorities in the agglomeration started with cluster management activities, by now implemented in five fields and starting in a sixth. These fields of specialisation are backed by our research which also identified two more potential clusters.

In this paper we pick out cooperation between companies as well as between companies and institutions as one section of the study. We find cooperation patterns: the share of companies working jointly with other companies – be it from the point of view of firm size, active or potential cluster membership or the affiliation to individual clusters – is a lot higher than with networks and institutions or universities, universities of applied science or research institutions. We were asking about the pros and cons in participating in a cluster. Obstacles and problems are considered persistently as less intense than the advantages.

Cooperation behaviour also changes between clusters, although in some value chains we expected a somewhat different picture. A range of our results can also not support the critical studies quoted from literature. Furthermore, we present evidence for the fact that clusters are not isolated conglomerates in their respective fields, but are interlinked to different extents. The cross-analysis of firm size and preferred cooperation partners shows the results we anticipated – big companies are cooperating more frequently than small or medium-sized firms. However, these differences are only striking in the field of cooperation with universities and research institutions. For joint projects with other companies and networks the activities of all firm sizes are roughly on the same level.

In the first steps of a model that links the propensity to cooperate with characteristics of the firm (industry or cluster, functional affiliation, firm size). We also think that the intensity of regional cooperation is a driving force for innovative activities and economic performance and that these mechanisms have important consequences for the local labour market.

In future steps we will include for instance information on the strength of competition, company functions on the location, outsourcing and performance in innovation in the model. Links to the labour market will be established by looking on pooling of specialised workforce and employment development of cluster members versus non-cluster members. Further fields of research are also from the sociological point of view, e.g. the position of companies in a cluster or if certain clusters are dominated by one agent.

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