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The identification and analysis of clusters in Eastern Bavaria and Central Franconia

Nicole Litzel

Dissertationen

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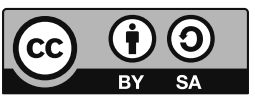

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Schee is gwen, owa hirt
Martin Ortmeier, Buch und Ausstellung
„Alte Bilder aus dem Bayerischen Wald"

Danksagung

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Regensburg, Februar 2015
Nicole Litzel

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Introduction

Clusters have attracted a great deal of attention for more than two decades. The interest in these 'geographically proximate group[s] of interconnected companies, suppliers, service providers and associated institutions in a particular field, linked by externalities of various types' (Porter 2003: 562) comes from two major fields: regional economics and regional economic policy.

One reason why regional economists study clusters is that the concept is close to topics traditionally discussed in theoretical and empirical regional science and is thus at the heart of the subject. Before Michael E. Porter published his seminal book, 'The Competitive Advantage of Nations' in 1990, which made the cluster concept popular, cluster features were already part of approaches like industrial districts, innovative milieux, learning regions, regional innovation systems and networks, which all treat with different emphasis questions concerning agglomeration economies, knowledge spillovers, concentration, specialisation, division of labour including forward and backward linkages, university-industry links, labour market pooling or regions in the context of globalisation, for instance. An economics toolkit for analysis does exist, but it is still a challenge to study clusters, as only fuzzy definitions are provided, making it hard to pin them down. In addition, there is considerable variance between clusters even within one economic space. There are differences, for instance, in their stage of development, hierarchical structures, grade of organisation, co-operation and competition, geographical reach, openness or the parts of the value-added chain that are covered (Enright 2003, Steinle/Schiele 2002, Guinet 1999). This broad spectrum and these many facets make clusters a rather interesting field to study.

Porter's 'diamond model of competitiveness' (1998a, Chapter 7, referring to 1990), coming from strategic management, is connected to his cluster definition and describes the interplay between competition and location. He suggests that to be innovative and productive, looking at competition merely at the company level is too simplistic. As firms are embedded in regions, their competitive advantage also depends on local conditions, namely factor inputs, demand conditions, rivalry with its norms and rules and the presence of capable suppliers and related industries. These factors become more and more important as progressing international economic integration makes it easier to do business globally, hence increasing competition. Porter argues that if these four interconnected factors are well developed, the regional economy will gain competitive advantage and be successful.

This appeals to practitioners in regional economic policy, as the concept describes and discloses many possible fields of operation. Today, there is hardly a region in a developed or emerging country that is not affected by cluster policy on

the local, regional, national or supra-national level. There are well-designed and successful cluster strategies in some regions, while measures are quite arbitrary in others. In a classification of clusters into five groups, for instance, Enright (2003) includes two problematic categories, namely 'policy driven' and 'wishful thinking' clusters. A considerable amount of public money is spent on implementing cluster policies and benefits are not easily attributable to them. Therefore, this has given rise to criticism of both the vagueness of the definition and the naïve transfer of the concept into practice (Maier/Trippl 2012, Duranton 2011, Kiese/Wrobel 2011, Benneworth/Henry 2004, Martin/Sunley 2003) with its 'constructive view of the world' (Sölvell 2008: 91) since the early 2000s. Feser (2008: 198) argues that it is not 'building clusters' that should be the policy focus but 'leveraging synergies' by preparing rich soil for cluster prerequisites to grow (see discussion Section 2.3.1). This calls for regional scientists to perform the necessary analysis to unearth and identify these regional specific preconditions for sound cluster policy.

However, due to the vagueness of the concept and policy aims, there is tension between the two poles of research on the one hand and political practice on the other. Economists find no preset path or well-developed methodology to follow, apart from practical training units for business development institutions; and practitioners – with some notable exceptions – are often dependent on political aims. However, this again makes clusters a rather interesting field to study. Aside from all the critical aspects, it can also be seen as an example of how new concepts of applied research find their way quickly into political practice.

The cluster-oriented regional information system CORIS is located at this interface between research and policy. This research project is designed, first, to generate unique data for research based on a scientific identification of clusters in an economic space and second, to establish a web-based cluster database with a methodology developed on the basis of recent findings in regional economics. The information system enhances transparency of the cluster-oriented structures of the economic spaces under analysis, allowing variety between the regions' clusters. On the one hand, this serves practitioners. They can draw on in-depth cluster-specific information to develop sound regional economic policy measures. On the other hand, academia can convince establishment and institutional representatives to disclose their cluster-relevant information and supply their data, as they benefit from being visible as part of the clusters. The data collected far exceeds what can be gleaned from statistics and provides a unique and detailed basis for research.

This doctoral thesis is built on CORIS and its data, which was gathered expressly for the research presented in this thesis and other contributions by the same authors. Chapter 1 is dedicated to the description of the cluster identification methodology prepared and developed by the project team at the University of

Regensburg in 1999/2000, which included the author. The methodology is implemented in two economic spaces: in Eastern Bavaria since 2001, with an extension to districts along the Danube in 2005, and in the Nuremberg region in Central Franconia and adjacent districts since 2006. The research and data collection were carried out by two project teams, including the author. The chapter also summarises information on the regions covered and the clusters identified. The result of the work introduced here is an exceptional in-depth cluster-oriented database which provides a valuable and unique insight into regional forward and backward linkages and co-operation activities. It can be implemented for research and lays the ground for the scientific work presented in this doctoral thesis. Chapters 2, 3 and 4 have the format of self-contained articles. They are included in chronological order of publication.

Chapter 2 is a contribution to the International Handbook on the Economics of Integration. As it is the only text in the three volumes dedicated solely to clusters, a broad approach is taken. We discuss at length the literature on the role which clusters can play in the progressing integration of markets. The emphasis is on the international division of labour that accompanies it. Increasing disintegration of production with outsourcing and offshoring involves the relocation of activities, requiring more co-ordination between business partners, so both forward and backward linkages and informal co-operation gain importance. Relocating businesses are attracted by locations offering favourable regional conditions, which are often found not in places with cheap production factors, but in locations with a supply of the necessary skilled labour, opportunities for co-operation, local suppliers and customers as well as research institutions – in other words, in locations with clusters. Hence, to make economic strengths, advantages and distinctive features visible in the fierce competition between locations to attract firms and qualified labour, one regional economic strategy is to promote clusters.

In this context we look at the intra- and inter-regional integration in the Nuremberg region. This is not just an economic space with a coherent cluster strategy developed early by German standards, but it was also designated as a European metropolitan region (EMR) in 2005. This concept, loosely related to spatial planning but with a strong emphasis on economic issues, refers to agglomerations with their functional surroundings, including rural areas, and puts them on the international stage. In Germany, EMRs are founded to stimulate interregional competition, to sustain Germany's competitiveness and to speed up European integration by fostering intra-regional integration (Knieling 2009). Hence, EMRs and clusters complement each other. For the Nuremberg region, which was the initial core of the EMR Nuremberg, we find that both backward and forward linkages within the economic space are strong. This is remarkable when

one also considers that the Nuremberg region is geographically close to low-wage countries, the new EU member states admitted in 2004. Establishments affiliated with the regional clusters are also more regionally oriented than non-affiliates and co-operate more frequently. We show that intra-regional integration is well developed both between establishments and between firms and institutions. With the admission of Nuremberg as an EMR in 2005, which was also a result of the region's cluster policy efforts, its performance in international rankings climbed several positions. Hence, intra-regional integration is a key element for strengthening economic spaces in the international competition between locations. As Enright (2003: 100) puts it, 'even as competition and economic activity globalize, [...] competitive advantage can be localized'.

Chapter 3 focuses on intra-regional co-operation as one of the main features of clusters. Research shows that successful co-operation can trigger economic and employment growth (Schröder 2013, Malecki 2010). Hence, it is of great importance to understand the drivers of co-operation. However, empirical evidence concerning the influence of cluster affiliation on the co-operation of establishments with other actors is scarce. With CORIS data we can find out more about these relationships and we study this based on the example of the Nuremberg region. Our survey allows us to differentiate between cluster affiliation and cluster awareness. The first notion refers to the allocation of establishments to clusters based purely on functional criteria like products and core competencies, hence this is a 'technical' top-down approach to forming the eight clusters in the region. Cluster awareness, in contrast, encompasses establishments that see themselves as cluster members, independent of their functional affiliation. We hypothesise that it is not so much the formal or technical affiliation that influences the propensity to co-operate as the establishment's awareness of the cluster structures in the region. These firms are supposed to be better informed about the potential rewards of co-operation, so they invest more resources in finding out about possible partners and are more open to co-operation. Our results strongly confirm this hypothesis: more than three quarters of the establishments in the Nuremberg region are involved in co-operations. This is also driven by establishment characteristics like firm size, affiliation with the service sector, a high share of highly qualified employees and the presence of an in-house R&D department. We also analysed co-operation with different partners in more detail than most studies and include six groups of potential counterparts. Our results show that there is still potential in most clusters for expanding both networking and R&D co-operation. The finding that it is mainly cluster awareness that is conducive to co-operation should be of concern to regional economic policy with cluster creation as its aim. It supports contributions (Duranton (2011) or Feser (2008), for example) that warn of 'building

clusters', but argue for a policy that boosts transparency concerning co-operation potential, possible new customers and suppliers and promotes best practice leading to regional added value through co-operation.

Chapter 4 investigates the impacts of clusters on establishments directly. For this purpose, a unique cluster-oriented database was created by merging two data sources. The first one is CORIS Eastern Bavaria. As this information system is designed to visualise the embeddedness of economic actors in the region and all interested parties can enter their information for free independent of size or industry affiliation, CORIS stands for the practitioners' interest in demonstrating their pragmatic participation in regional value-added chains. It is linked with the second source, the IAB Establishment History Panel, which comprises all of the region's establishments and draws on the highly reliable German social security notifications. With CORIS data the cluster practitioners – in contrast to top-down affiliations or member lists of cluster organisations with high entry barriers – can be identified in the total sample of regional establishments. This allows a strict evaluation design based on a control group approach, with 1,176 establishments as the treatment and over 50,000 firms as the control group. It is revealed that the economic performance of establishments demonstrating their cluster participation is significantly better than that of firms that do not position themselves in clusters. For the period between 2001 and 2010, cluster establishments display higher survival rates and higher employment growth than those not involved in clusters. The results are achieved with a novel approach that returns to the origin of the cluster concept, where it is not technical affiliation that counts, but the practical participation of economic actors in regional value-added chains. They clearly underline the positive effects that can be expected by using and participating in the forward and backward linkages and co-operation opportunities which the economic space has to offer.

1 The cluster-oriented regional information system CORIS

CORIS is a research project that is designed to unearth and visualise the cluster structures in an economic space. Collecting and exploiting profound data constitutes the fundamental work underlying the research presented in Chapters 2, 3 and 4. In the following, the preparation and the development of the CORIS methodology is presented, as is the practical data collection. The chapter also summarises information on the regions covered and the clusters identified.

Preliminary work started in 1999, hence many writings, documents, presentations and publications have been prepared over the years. Some sections in this chapter draw on this previous work and are earmarked accordingly. To keep some paragraphs short they refer to the more detailed information presented in the three research chapters.

1.1 The origins of CORIS

More than two decades ago, clusters, the 'geographic concentrations of interconnected companies, specialized suppliers, service providers, companies in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate' (Porter 2000: 15) gained importance in the international competition between locations. For economic spaces there emerged the need to position themselves as an 'automobile region', 'chemistry belt' or the like (see Chapter 2.2).

Becoming aware of these developments, two groups of institutional actors from the Regensburg region developed a major interest in the topic of clusters in the late 1990s. One was the 'Co-operation University and Economy', a group of professors from different disciplines at the University of Regensburg and managers of research-oriented regional companies, who aimed to establish new university-industry links and strengthen existing ones. The second was an informal group consisting of the City of Regensburg's Department of Economic Development, the Chamber of Crafts and the Chamber of Industry and Commerce, the district government, a technology transfer institute, a regionally-focused bank and a consultancy firm. Having the presumed positive effects of clusters on regions and establishments in mind, they started working on an economic policy of supporting the strengths of the Regensburg region.

Both initiatives came to the conclusion that sound future activities first needed transparency with regard to the shape and extent of the regional forward and backward linkages along value-added chains as well as the already existing networks between companies and between companies and institutions. This

information goes beyond of what statistics and existing databases contain. After initial explorations conducted by the members of these groups, the decision was made to address the Chair for Empirical Macroeconomics and Regional Economics at the University of Regensburg (Prof. Dr. Joachim Möller) to conduct a research project on the region's cluster potential and to set up a database depicting these structures. After designing the cluster-oriented regional information system CORIS, sponsors could be interested in funding this research.[1] The notion 'cluster-oriented' indicates that it is not clusters that have already been organised and managed which the analysis is aiming at. The focus here is on the regional structures that display characteristics of clusters and hence the potential to play a major role in regional economic policy.

1.2 Project implementation

This is a section to outline the basis for all data collection activities in the subsequent steps of the project in Eastern Bavaria and the Nuremberg region.

1.2.1 The aims of CORIS[2]

The overall aim of the cluster-oriented regional information system is to enhance transparency of the economic space under analysis. More specifically, against the background of the recent literature on cluster theory and policy, the dedicated aims formulated in the project proposal were (a) the detection of existing regional economic core competencies; (b) the identification and depiction of the region's cluster-oriented structures; (c) the compilation of detailed information on all economic actors within the clusters; (d) the depiction of the cluster-constituting co-operations and interlinkages; (e) the conception of an information system for the visualisation of these structures and (f) the provision of this information for interested users.

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1 Financial funds for project step 1 (cluster identification, development of the basic version of the software solution) were provided by BMW AG, Elektromanufaktur Zangenstein Hanauer (emz) GmbH & Co. KGaA, Hans-Lindner-Stiftung, Infineon Technologies AG, Linn High Therm GmbH, Maschinenfabrik Reinhausen GmbH, Nachtmann Crystal AG, Porzellanfabrik Mitterteich AG, Regensburg Business Development GmbH, Regierung der Oberpfalz/ Bayerisches Staatsministerium für Wirtschaft, Verkehr und Technologie, Schott-Rohrglas GmbH Mitterteich, Wilden AG, WITRON Logistik + Informatik GmbH. The CORIS software was implemented and partially funded by XWS GmbH Cross Wide Internet Solutions. Organisational support was given by the Lower Bavaria • Upper Palatinate Chamber of Crafts, the Upper Palatinate and Kelheim Chamber of Industry and Commerce, FUTUR (University of Regensburg technology transfer) and OTTI (Eastern Bavarian Technology Transfer Institute).
Step 2 (introducing the information system to the region, putting the software into practice) was supported by BMW AG, the Upper Palatinate and Kelheim Chamber of Industry and Commerce, Elektromanufaktur Zangenstein Hanauer (emz) GmbH & Co. KGaA, Maschinenfabrik Reinhausen GmbH and Regionalmarketing Oberpfalz.

2 This section draws on the project's final report (Endbericht 2001) issued in December 2001, written jointly with Joachim Möller and with the co-operation of Manfred Sargl.

Hence, CORIS is first designed to serve economic actors like firms looking for suppliers, co-operation partners from industry and academia or customers as well as entrepreneurs and relocating plants in search of a suitable location. Second, it supports institutions involved in regional economic policy by providing a unique data source. Third, it helps job-seekers to identify potential employers within the region to prevent brain drain, and finally, the data collected is used for research and this doctoral thesis (see Chapters 2, 3 and 4). The project's orientation towards practical aspects enables the CORIS project team to convince establishments and institutions to submit their information more easily. Instead of invoking scientific output, which is of minor interest for many establishments, as the experience of many survey projects shows, it is possible to argue with the practical benefits of being visible as an embedded economic actor in the regional economy.[3]

1.2.2 The methodology[4]

To identify a region's clusters we developed a methodology to register the value-chain-oriented structures and functional specialisation in an economic space systematically. The collection of required data is done with a method mix consisting of several interconnected elements. The preliminary work involves top-down screening of statistical data and a range of documents on the economic structure of the region. However, the main emphasis is on bottom-up methods.

As clusters cross the boundaries of industries by definition (Martin/Sunley 2003, Feser/Sweeney 2002), are often found in emerging fields like nanotechnology or interdisciplinary fields like sensor technology and are quite different from one another (Guinet 2003, 1999, Steinle/Schiele 2002), we follow the view that top-down approaches can give valuable indications as to where to look for cluster structures more closely or where to find horizontal clusters. However, bottom-up methods also focussing on cross-industry structures of value-added chains, vertical clustering and the interconnections between the economic and institutional actors have to be used to complement the information (Sternberg/Litzenberger 2006). Atherton/Johnston (2008: 93) also state that from a cluster formation point of view 'the approach taken [...] has tended to be top-down in analytical and

3 For instance, many small and medium-sized enterprises disclose their customers. Their list of references, in many cases containing large and leading enterprises, is vital for attracting new business.

4 This section adapts and largely follows Eigenhüller et al. (2010) and Möller/Litzel (2008). Section 2.3.2 of this document also contains a discussion of cluster identification methods and Section 2.3.3 explains the elements of the CORIS methodology.

planning terms, [but] such an approach does not reflect the dynamics of clusters formation as a function of increasing collaboration between firms.'

Data collection

Data collection starts with expert interviews to be carried out with representatives of institutions with presumed knowledge of the regional economic structures. The interviews are mainly conducted to compile information on the region's economic foci and value-added chains. Most experts have a very detailed knowledge of either the industry they are responsible for or the overall structures of the economy in the city or district in which they are active. Hence, the interview guidelines are designed to get in-depth information on the development and structure of the value-added chains, on infrastructure from transport to communication, on framework conditions like education and administration, on local labour market issues, on technology transfer and on networking. Aggregating the information from these interviews renders the cornerstones for the cluster-oriented structures. The picture becomes more finely grained later during the second wave of interviews.

In addition, these first expert interviews help to identify the leading companies and relevant institutions located in the region. Members of the managing boards of these firms are to be interviewed as well, one aim being to unearth further relevant establishments. As the groups addressed are distinct, we developed different manuals for the semi-structured interviews. The establishment versions focus on revealing more in-depth cluster-specific information, inquiring about customer-supplier-relationships and co-operations, joint projects in the fields of development of human capital or research, for example, functional versus industry affiliation, but also products and services offered, the core competencies, innovations, the size by turnover and employees, company structure, and so on. The version for institutions contains similar questions about their field of activity and the regional embeddedness. After assembling and analysing the fragmented information from the expert interviews, the segments of the characteristic value-added chains covered by regional competencies and, thus, the potential regional clusters take shape.

The subsequent step is a written establishment survey among both the manufacturing and the service industries. The questionnaire aims at more in-depth cluster-specific information. As the notion of 'clusters' is fuzzy, it is avoided in both the interview manuals and the questionnaires and is only introduced right at the end, but the cluster-constituting elements are investigated in depth.[5] The

5 See Figure 2.1 and Section 2.3.2.

questionnaire contains sections inquiring about customer-supplier-relationships and co-operations, joint projects in the fields of development of human capital or research, for instance, products and services offered, the core competencies, innovations, the size by turnover and employees and company structure. Results from the interviews are integrated in the questions about functional versus industry affiliation. Both are lists to tick, with the possibility of adding missing sectors. Industry affiliation is straightforward, as this requires the establishments' WZ codes[6] from the Professional Register. Functional affiliation, in contrast, refers to the value-added chains that were named in the interviews. Establishments are asked to say whether they were part of one or more of these, be it as a producer, service partner, supplier or customer.

Cluster identification

To identify clusters and cluster potential in a region we developed a set of five criteria derived from the regional economic literature as discussed in the Introduction. By applying the data to the criteria we can check whether fields of functional specialisation can be considered working clusters or, alternatively, value-added chains with the potential for clustering. These criteria are outlined in the following.

The first criterion is concentration in space of an activity that is a regional characteristic. The top-down methods of cluster identification use this feature as a starting point for their research (for instance Sternberg/Litzenberger 2006) and it stands at the core of all cluster definitions (Porter 2003, 2000, 1998b, Feser/Sweeney 2002, for example). It also demarcates the difference between clusters and networks that are not defined by geographical limits (Kiese 2008a).

Labour market pooling or, in other words, the existence of a specialised labour force is considered as a second criterion (Marshall 2009 [1890], Rosenthal/Strange 2004). Positive effects are induced by improved matching between employers and potential employees. Changing jobs raises productivity. Deep labour markets mitigate risk for both firms and employees as a good alternative can be found more easily in the case of job loss. This also attracts new personnel with cluster-specific skills or motivates people to acquire new knowledge, which again extends the pool of labour (Duranton/Puga 2004, Rosenthal/Strange 2004). However, in interviews and the written surveys it is ascertained whether employers are also aware of poaching incidents (Combes/Duranton 2006, Fosfuri/Rønde 2004).

6 WZ: Classification of Economic Activities (latest edition), Federal Statistic Office of Germany, which is based on the international 'Nomenclature générale des activités économiques dans les Communautés Européennes (NACE)'.

Third, we check whether there are 'leading companies' present in the industries under consideration. Studies show that to implement successful clusters, the momentum created by 'key actors' (Van den Berg et al. 2001; see also Carlsson 2006) can be decisive. We denote leading company a firm that shows two of these three characteristics: it is highly dynamic and leading in the development of technologies and manufacturing processes (technology leader); it has an outstanding 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) (Simon 2007). Companies with these features are supposed to have a high potential to pull other economic actors along with them. This is also of interest for connectivity to global pipelines for bringing in new knowledge and technologies from outside as well as pulling cluster partners into global markets (Lorenzen/Mudambi 2013, Bathelt et al. 2004).

Fourth, the presence of supporting institutions with sectoral importance is named as a key location factor in all cluster definitions. They encompass, for instance, universities and universities of applied sciences with relevant degrees and chairs with matching fields of research and willingness to co-operate, research institutes, technical colleges and vocational schools, regional development agencies and business incubators as well as technology and innovation parks with fitting focus and technology transfer institutions. They are vital partners for knowledge spillovers (Goldstein 2009, Rosenthal/Strange 2004, Jaffe 1989, Marshall 2009 [1890]).

The last criterion is the evidence of co-operation and networking activities, which also encompasses co-opetition, the co-operation among competitors (Porter 1998b, Brandenburger/Nalebuff 1996). This is a wide field from informal co-operation between two partners to associations for joint trainee programmes or network initiatives. Co-operation is a necessary condition for clusters, hence, there is no cluster which does not have strong co-operative links between different kinds of economic actors. Again, this is mentioned in all cluster definitions and many studies show that these interlinkages and associated knowledge spillovers are crucial for the depth of the cluster (Saxenian 1994, for instance).

If four or all of these criteria are fulfilled by the regional value-added chains, we consider these economic structures to be (potential) clusters.

1.2.3 The web-based information system www.coris.eu[7]

One of the aims of the project was the development of a web-based tool to visualise the cluster structures in the economic space under analysis and make the

7 This section is adapted from Litzel/Möller (2005).

information accessible for all interested users.[8] It was designed as a multi-layered system that follows the concept of clusters thoroughly. Hence, it aims at depicting the competencies of regional economic actors, visualising the interlinkages between establishments and between establishments and institutions and showing their co-operation activities. In addition, and also different from most simple cluster databases, CORIS reveals the interlinkages between the clusters. They are not isolated in their respective fields, but are embedded in the regional economy.

CORIS consists of interconnected elements. Structured information on establishments and institutions is kept in individual data sheets. They display, first, the basic facts such as address, products and services offered (free text allocated to predefined topics) and core competencies that can also be found in other data sources. Second, they hold more in-depth information on other plants or branches (in case of companies with more than one establishment), former names or brand names of the company, contact persons, employment (divided into subgroups like employment in this establishment and in the company as a whole, apprentices, etc.), turnover (including the share of exports and of regional sales), research and development activities, certificates and prizes won and the company history. Third, and most relevant for clusters, are the indications of cluster affiliation, customers, suppliers, co-operation partners and university contacts. If the partners located are in the same economic space and are also listed in CORIS, hyperlinks between the data sheets are activated. Hence, the user can click from one establishment to a connected one.

Data sheets on co-operation projects with three or more partners are arranged slightly differently. They contain intra-CORIS hyperlinks to the participating establishments and institutions, information on what the co-operation is working on and aiming at, the cluster affiliation and some miscellaneous additional information on formal or informal organisation or financial support, for instance.

All this individual data is fed into interactive location maps.[9] Each cluster is visualised in an individual map containing one symbol at the geo-coded location of each affiliated establishment (depicted as a circle), institution (square symbol) and co-operation project (triangle). The size of the establishment symbol indicates the size class measured by employment, while the other symbols are standardised. The different colours depict the cluster sub-category (see Table 1.2 for Eastern Bavaria and Table 1.7 for the Nuremberg region) in which the clusters' participants are

8 The web-based solution was developed by the first CORIS team: Joachim Möller (who also did the programming for the first draft version), Nicole Litzel and Manfred Sargl. The technical implementation was carried out (partly as sponsorship) by XWS Cross Wide Internet Solutions GmbH.

9 Google Maps® is implemented as a basic map. Due to copyright issues no cluster map is reproduced in this document. Please refer directly to the website, e.g. http://ostbayern.coris.eu → Cluster → Automobil → Clusterkarte.

mainly active. Hence, the geographic dispersion and the specialisation of certain locations in the economic space become visible at a glance. Clicking on the symbols leads to the data sheets.

To make the information systematically accessible for the user, all facts contained in the data sheets are covered by a search function. The free text function allows for a broad search. For all structured data entries (on products, cluster affiliation, employment or geographic details, for example) there are filters available that can be combined in logic and/or-operations.

The online tool for data entry and update is designed with low hurdles. It is free of charge and has few compulsory input fields. Data entry is possible for all interested economic actors independent of their industry affiliation, cluster membership or size. If establishments or institutions are not part of the region's clusters, they are integrated in the 'Others' section. Hence, affiliation in the CORIS database stands for the practitioners' interest in making their embeddedness in the regional economy visible.

The cluster structures are visualised by the combination of these elements. Background information deducted from the analysis and aggregation of the individual pieces of information is offered as an accompanying text. This includes, for instance, the distinctive features of the clusters, their leading companies and main products, the geographic distribution and interlinkages with other clusters.

1.3 Cluster identification in Eastern Bavaria

This section illustrates the implementation of the CORIS methodology in the economic space around Regensburg, Eastern Bavaria. Data on this region is used for the research presented in Chapter 4.

1.3.1 Data collection[10]

Expert interviews

From May 2000 to June 2001 we conducted over 100 expert interviews.[11] Of the relevant institutions the full sample was selected, encompassing representatives of economic development departments in cities, districts and counties, chambers of crafts and chambers of industry and commerce, technology transfer organisations of universities and universities of applied sciences, existing network initiatives, technology parks and a regional newspaper. These are all experts in their respective

10 Largely based on the project's final report (Endbericht 2001).

11 The interviews were done by the project team Joachim Möller, Manfred Sargl and the author.

geographic area or industry and disclosed a great deal of information that was conflated into a first characterisation of the economic space under analysis. A total of 72 leading companies and other relevant establishments were identified and interviewed as a result of these interviews and additional documents. Most of these in-depth discussions took far longer than one hour. All the information was recorded in the form of detailed minutes for further analysis.

With the information from the 104 interviews, we compiled a first list of potential clusters. It contained automobile production, biotechnology, porcelain, electrical engineering, food processing technology, glass, information technology, logistics and plastics processing, most of them with a shape that was still blurred.

Written establishment survey

On the basis of the outlines of the main vertical, horizontal and diagonal links between companies and between firms and institutions, we conducted a written establishment survey of both the manufacturing and service industries. From the interviews, we derived 17 value-added chains that were included as functional affiliations in the questionnaire described above.

We implemented the written survey in co-operation with a range of institutions[12], each of which was planning its own investigation during the same period as CORIS. Hence, the decision was made to do one joint survey and include all the topics the co-operation partners were interested in. The CORIS team created a joint questionnaire with a focus on cluster-relevant topics. The fact that the establishments would only be addressed once instead of five times was also presumed to be more likely to arouse interest and boost feedback. The written survey was carried out in December 2000 and January 2001. As it was a joint project, no sample selection was done by the project team. The chamber of industry and commerce's membership database contained 1,831 establishments of all sizes and from all industries. They all received a questionnaire and 365 were returned (19.9 per cent). This constituted the base for cluster identification.

Completive data collection

It turned out that the database used was thin concerning the field of information and communication technology, meaning that the relevant establishments were filed in different industry subclasses and could hardly be identified. However,

12 The Upper Palatinate and Kelheim Chamber of Industry and Commerce, the Lower Bavaria • Upper Palatinate Chamber of Crafts, FUTUR (University of Regensburg technology transfer), OTTI (Eastern Bavarian Institute for Technology Transfer) and the CORIS project.

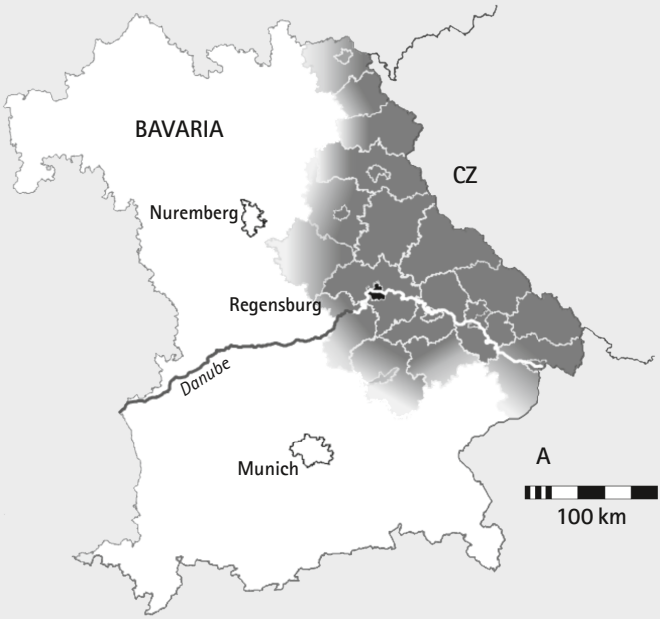
there was evidence from the interviews and from our attendance at several network meetings that quite a range of respective firms existed. This field could not sufficiently be covered by interviews and the written survey. Some aspects relevant for cluster identification were missing. Hence, we asked institutions like City Marketing, the Department for Economic Development and the University of Regensburg Chair for Innovation Management to provide their compilations of IT firms and the Internet was searched systematically. It was not possible to include the data gathered in this way in the first analysis, but it was used later to ask the establishments to provide their data for the website. CORIS went online with 586 entries. Via the online tool implemented on the website and further interviews and marketing, the database has been growing continually ever since.[13]

1.3.2 The shape of region studied

After the first expert interviews it turned out that the study region originally envisaged – Greater Regensburg – was not the right unit to characterise and depict the region's cluster structures. The functional specialisations and value-added chains extend far beyond the agglomeration and could be traced along the economic actors' interlinkages during the course of research. The demarcation of the region of Eastern Bavaria (Figure 1.1) is not an administrative one but follows functional considerations (Feser et al. 2001). The only clear boundaries are the national borders to Austria and the Czech Republic. The delineation to the neighbouring districts in Bavaria is softer and the economic space fades out. To the south the gravitation of Munich and its international airport pulls economic activities. To the west the tri-city area Nuremberg-Fürth-Erlangen is a strong agglomeration that can be reached comfortably by motorways and public transport. Some additional characteristics of Eastern Bavaria are contained in Section 4.3.1.

13 In December 2001, for instance, we already had 375 IT establishments listed. This was one database used for an application of the City of Regensburg to successfully attract an IT incubator centre to Regensburg in a Bavaria-wide competition.

Figure 1.1: The economic space of Eastern Bavaria



Notes: The region encompasses the entire district of Upper Palatinate, the eastern part of Upper Franconia and the areas along the Danube and the Bavarian Forest in Lower Bavaria.

Source: Author's own illustration, basic map by Klara Kaufmann (IAB).

1.3.3 Cluster identification and analysis

Complying with the five criteria[14]

First, the results of how Eastern Bavarian data fit the five criteria are displayed (Table 1.1). The details behind the symbols are listed in the Appendix. The nine value-added chains we identified for this economic space as clusters are in the Automotive Industry [AUT], Biotechnology [BIO], Electronics and Electrical Engineering [EE], Glass and Glass Processing Industry [G], Information Technology [IT], Logistics and Specialised Trade [LOG], Specialised Machinery [MAC], Plastics Industry [PLA] and Porcelain and Ceramics [P&C]. After the first expert interviews, some other fields such as Construction [CONST] and Food Processing Technology [FPT], were also considered, but their cluster prerequisites were not sufficiently supported by the information (see next paragraph).

14 Again, this is largely based on Möller/Litzel (2008), Section 8.3.3.

Table 1.1: Cluster identification criteria and application to Eastern Bavarian data

Cluster	Criterion				
	Concentration	Leading companies	Labour market pooling	Supporting institutions	Co-operation & networks
AUT	++	+++	++	++	+++
BIO	+++	+	++	++	+++
EE	+	+++	+++	++	++
G	+++	+++	+++	++	+
IT	++	o	+	++	++
LOG	+	++	+	+	+
MAC	++	++	+++	++	++
P&C	+++	+++	+++	+++	+
PLA	+	+++	++	+	+
(CONST)	o	++	+	+	o
(FPT)	++	+	+	o	o

Notes: +++ very strongly fulfilled, ++ strongly, + weakly, o very weakly or not fulfilled; N = 365.
Abbreviations: AUT = Automotive Industry, BIO = Biotechnology, CONST = Construction, EE = Electronics & Electrical Engineering, FPT = food processing technology, G = Glass & Glass Processing Industry, IT = Information Technology, LOG = Logistics & Specialised Trade, MAC = Specialised Machinery, P&C = Porcelain & Ceramics, PLA = Plastics Industry.

Source: Eastern Bavarian establishment survey.

Industry versus functional affiliation[15]

The company survey conducted in Eastern Bavaria included two questions aimed at highlighting divergences between an establishment's official industry classification and its functional affiliations in regional value-added chains. The outcomes are depicted in Figures 1.2 and 1.3.

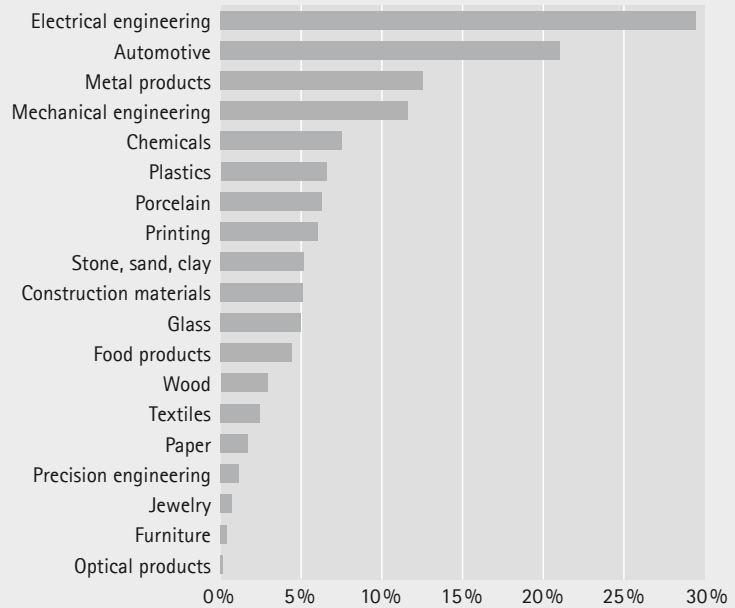
Figure 1.2 displays the answers to the question 'Which industry is your establishment working in?'. It reveals that electrical engineering dominates with nearly one third of all employees in the region. The second-largest industry was automobile construction with more than 20 per cent, followed by metals and mechanical engineering. The plastics industry, porcelain and glass also rank quite highly.

In order to capture the complexity of functional affiliations, the question 'Eastern Bavaria has a range of economic foci. In which of these is your establishment working, be it as a producer, a supplier or a service company?' offered firms the option of choosing more than one industry. The results of this question, displayed

15 Again, this is largely based on Möller/Litzel (2008), Section 8.3.3.

in Figure 1.3, suggest that the dominant industry was automobiles and components with more than 40 per cent of employees connected to it, followed by electronics and automation with roughly one fifth of employees.

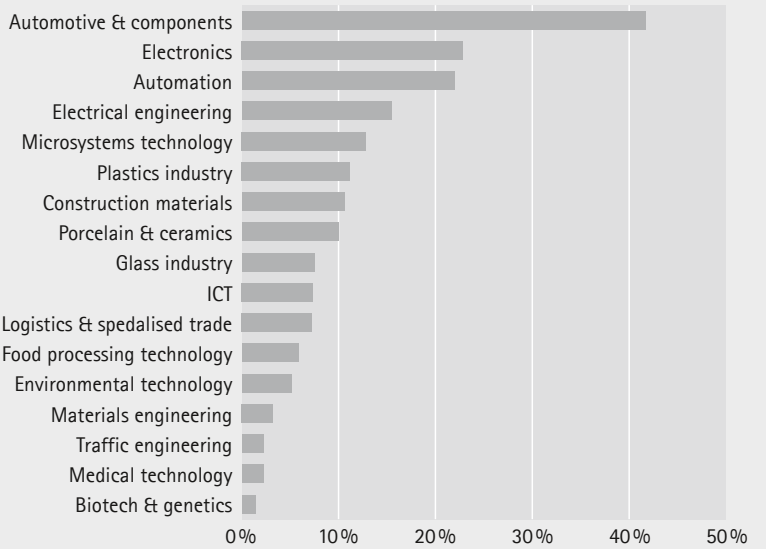
Figure 1.2: Industry affiliations of establishments by share of employees



Notes: Establishments weighted by number of employees; option of choosing more than one industry; N = 365.
Source: Eastern Bavarian establishment survey.

The results revealed that the economic weight of automobile production was underrated when considering the statistical industry affiliation usually employed. One practical example of this allocation was a company working in electronics but with the majority of its research and development as well as output going into car production. Hence, to depict the real impact of this establishment, it was listed both in electronics and automotive. The second most important value-added chains were electronics and automation, involving nearly a quarter of all establishments each. They were followed by electrical engineering and microsystems technology with roughly 15 per cent each, and plastics, construction and porcelain with around 10 per cent. Glass and logistics came in with 8 per cent, respectively, as well as information and communication technology that did could not be shown individually in Figure 1.2.

Figure 1.3: Functional affiliations of establishments by share of employees



Notes: Establishments weighted by number of employees, option of choosing more than one industry; ICT = information and communication technology; N = 365.

Source: Eastern Bavarian establishment survey.

The first steps towards constructing the later clusters were the following decisions, taken on the basis of the expert interviews: Electronics was grouped with microsystems and electrical engineering to form one potential cluster, as many joint development projects and labour market pooling can be observed. Construction materials that could be found in the mid-range of Figure 1.3 were not considered a potential cluster, as analysis of the returned questionnaires with respect to products, services, competencies, customers and suppliers revealed that most activities did not constitute a regional singularity. In contrast, biotechnology and medical technology were included as a potential cluster, as the regional structures and developments were distinct and highly dynamic. Food processing technology was named by several experts as a potential cluster. The main argument was the presence of the world market leader in a certain field of food processing, but other criteria were only weakly fulfilled (see next paragraph). However, there was some indication that the specialised labour force necessary for production, for instance, shares the base with automation. The universities, universities of applied science and vocational schools offer the same qualifications and the co-operation and networking activities as well as the suppliers also bridge the gap to automation that is very prominent in Eastern Bavaria, therefore food processing technology was incorporated into the value-added chain 'Specialised Machinery'.

Table 1.2: Cluster categories and singularities of Eastern Bavarian clusters

Cluster	Cluster categories	Singularities
AUT Automotive industry	1st tier supply for automotive components 1st tier supply for plastic parts 1st tier supply for electronic parts 1st tier supply for metal parts 2nd tier supply for plastic parts 2nd tier supply for electronic parts Other 2nd tier supply Downstream supply Supply machinery & equipment Supporting institutions & service provision	Leading car manufacturers within the economic space or in neighbouring regions Many firms founded in 1950s developed towards automotive Marked value-added chain, mix of regional firms and branches of international companies Professionals from outside attracted to the economic space, good location for professional careers, high quality of life
BIO Biotechnology	Biotechnology Research & development Renewable energies Medical technology Services, supply of machinery & equipment Supporting institutions	Strongly concentrated in the BioPark on the campus of the University of Regensburg In many regions a 'wishful-thinking cluster', here sound policy with accommodating university spin-offs and attracting outside companies
EE Electronics & Electrical Engineering	Electronics & sensor technology Power electronics Electrical engineering Power engineering Electro-mechanical parts Semiconductor production & supply Supply of parts and systems R&D, education, training & supporting institutions	Many traditional companies with high growth rates, highly specialised Headquarters of internationally renowned firms Power engineering and semiconductor industry: concentrated around Regensburg, market leaders Electro-mechanical parts concentrated around Amberg and Cham Many large companies in peripheral regions Growing share of electronics in final products, good opportunities for suppliers
G Glass & Glass Processing Industry	Technical glass & flat glass Machine-produced hollow glass Manually produced hollow glass Glass workshops, studios and galleries Glass processing & finishing Supply of machinery & plant engineering, tools Supply and services – raw materials and others Supporting institutions	One of the world's leading glass regions (together with Murano and Bohemia) Strong developments in the field of advanced materials for, e.g., OLEDs, solar technology, sensor technology
IT Information Technology	E-commerce Internet services & providing Portals Software development Systems houses Data systems technology Market research Supporting institutions IT-savvy firms	Concentration of establishments in cities with universities/universities of applied sciences; but some important firms in periphery Specialisation in fields like IT security, IT for logistics and sensors

Table 1.2 continued

Cluster	Cluster categories	Singularities
LOG Logistics & Specialised Trade	Logistics services (transport, cargo handling) Logistics consulting & other services Logistics systems Construction of packaging & containers Specialised trade Supporting institutions, suppliers & logistics-savvy firms	Concentration of large traditional and specialised trade companies in the north of the region (infrastructure) Many headquarters of firms in specialised trade E-commerce in traditional trading companies
MAC Specialised Machinery	Food processing technology Automation technology & robotics Packaging machinery Automatic placement machines & semiconductor technology Plant manufacturing Other inputs & services Supporting institutions	Food processing technology concentrated around Neutraubling, automation & robotics around Amberg Concentration on regional customers (machines for glass, china, electronics production) Many spin-offs of these large producers
P&C Porcelain & Ceramics	Porcelain production & finishing Technical ceramics & advanced materials Workshops, studios and galleries Supply of raw materials Supply of machinery & plant engineering, tools Other inputs & services Supporting institutions	One of the world's strongest porcelain regions, many world market leaders Advanced products also in 'traditional' markets, e.g. induction plates for hospitals, canteens and nursery homes Good prospects in the field of advanced materials for, e.g.: electronics, high-temperature applications, pharmaceutical, technical foils
PLA Plastics industry	Plastics – production & processing Supply – tool manufacturing & mould construction Supply – machinery & equipment Other inputs & service provision Supporting institutions	In Eastern Bavaria more companies with over 100 employees than in other regions Many companies founded in the 1950s, developing into specialists e.g. for car supplies High vertical range of manufacture Growing share of plastics in final products, good opportunities for suppliers
SE Sensor technology	Production of sensors and sensor systems Component production Sensor application Research & development Supply, engineering & services Supporting institutions	Regional focus on microsystems, chemical and biosensors – good business prospects Competencies developed over decades, closely related to regional industry/ customers
Others	Manufacturing, service provision, building sector, institutions	

Notes: SE is already included in this table for reasons of convenience. The cluster was introduced in 2006, which is described in Section 1.4.2. The cluster categories had to be slightly adapted to capture the economic development between 2001 and 2010. What is displayed here is the latest version also used for the research presented in Chapter 4. More details on the clusters in the Appendix.

Source: CORIS data, expert interviews, author's own illustration.

Summing up the experience to that point, expert interviews and data analysis revealed that the intra-cluster differentiation of producer-supplier-supporting institutions was too rough to depict the regionally distinct features and

characteristics of the respective value-added chains. Consequently, the clusters were structured with their individual and regionally unique categories as displayed in the second column of Table 1.2. This categorisation was done in several steps with feedback from the relevant experts to approve that the structures chosen for visualisation were functional and appropriate. Table 1.2 also comprises some outlines of the regional clusters' singularities to demonstrate what makes them distinct from similarly-named clusters in other economic spaces.

Interlinkages between clusters

In addition to examining the individual clusters we also explored the interlinkages between them. Clusters are not isolated conglomerates in their respective fields, but are related to the other regional value-added chains.

Table 1.3: Numbers and average frequency of multiple cluster affiliations

Cluster	AUT	BIO	EE	G	IT	LOG	MAC	P&C	PLA	Average frequency
AUT	**164**									1.915
BIO	6	**29**								2.931
EE	73	22	**185**							1.703
G	26	6	24	**151**						1.265
IT	24	5	30	18	**64**					2.672
LOG	30	3	26	21	28	**57**				3.316
MAC	56	12	71	31	28	34	**131**			2.405
P&C	24	6	24	37	19	22	36	**129**		1.539
PLA	65	15	45	28	19	25	47	30	**103**	2.660

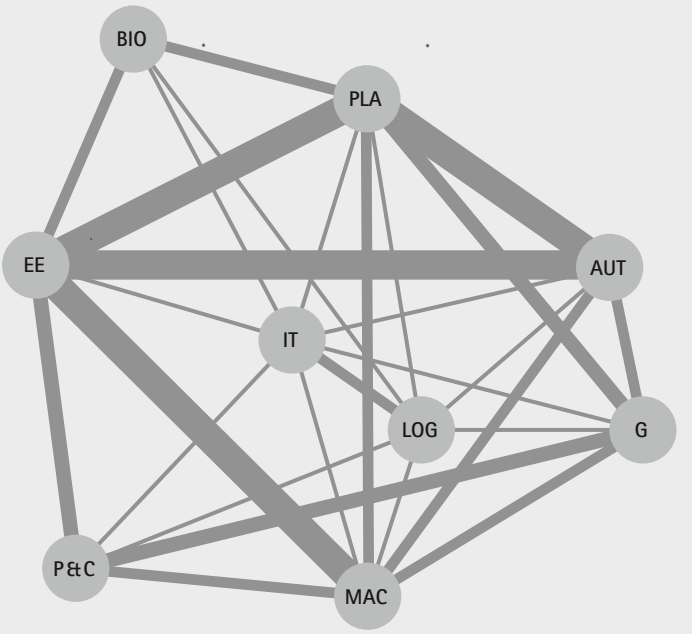
Abbreviations: see Table 1.1.
Notes: N = 586, number affiliations = 1,013 (effective end 2001).

We counted the multiple affiliations in clusters (see Table 1.3) as well as the co-operation activities between affiliates from different clusters. The two factors taken together are visualised in an approximate manner in Figure 1.4. The strong links between the Automotive Industry (AUT) and the Plastics Industry (PLA) and between the AUT and Electronics and Electrical Engineering (EE), for instance, originate from the many first and second tier suppliers for the automobile

producers that are located close to the plant for just-in-time and just-in-sequence deliveries. The links between PLA and EE stand for the importance of electronic devices needing casing. Connections between Porcelain and Ceramics (P&C) and Specialised Machinery (MAC) and between Glass and Glass Processing Industry (G) and MAC depict the many producers of special machines for the porcelain and the glass industries. This reflects specialised knowledge of the difficult materials handled, the high temperatures needed and the trend towards automation of production processes and handling. Behind the links between P&C and EE stands the importance of technical ceramics for high-voltage systems, for instance. G and AUT are connected because of the cutting-edge competencies of regional manufacturers in bending and coating glass and mirrors.

The average frequency in Table 1.3 indicates the multiple affiliation of an aggregated cluster to other regional clusters. It is evident that the clusters focused on intermediate goods and services for other companies (LOG, IT, PLA, MAC) are also the ones that are most interlinked. BIO is an exception, which reflects the peculiarities of the regional structures (see Table 1.1 and the Appendix).

Figure 1.4: Interlinkages between the nine Eastern Bavarian clusters



Abbreviations: see Table 1.1

Concentration of clusters in space[16]

The nine clusters are not evenly distributed in space and the patterns do not necessarily correlate with population density.

Table 1.4: The distribution of the clusters in space (Gini coefficients)

Clusters	Gini
EE	0.287
AUT	0.290
MAC	0.419
IT	0.473
PLA	0.481
BIO	0.585
G	0.647
LOG	0.647
P&C	0.769

Abbreviations: see Table 1.1

Table 1.4 displays the Gini coefficients of the nine clusters.[17] It measures the equality of establishment distribution in space. A Gini coefficient of zero indicates perfectly even distribution and a coefficient of one would mean perfect concentration of all activity in one spot. The Glass and Glass Processing Industry (G), for example, – one of the traditional industries of Eastern Bavaria – is strongly concentrated in the less populated rural areas of the Northern Upper Palatinate with an emphasis on technical glass and specialised in handmade glass in the Bavarian Forest. Another heavily concentrated cluster is Porcelain and Ceramics which is traditionally located in the north of the economic space with hardly any manufacturers outside this region. Other supply chains are either more uniformly distributed in space (Electronics & Electrical Engineering and Automotive) or are concentrated in urban areas (Biotechnology and Information

16 See Möller/Litzel (2008, Section 8.4.2) for details about the following paragraph.

17 In the chapter we also calculated the Herfindahl- and Krugman-indices.

Technology), thereby roughly reflecting the distribution of the population.[18] These results also suggest that clusters do not only occur in what are known as 'high-tech' value-added chains, for example the information technology, electronics or biotechnology, but are sometimes even more spatially concentrated in what are so-called 'traditional' industries.[19]

1.4 Project extension Eastern Bavaria: Donaustädte[20]

In 2005, the author, a member of the CORIS project team, was commissioned by the 'ARGE Wirtschaftsregion Donaustädte'[21] to intensify and update the cluster analysis for their region. The ARGE is a syndicate of five cities along the Danube, namely Regensburg, Straubing, Deggendorf and Passau in Bavaria and Linz in Upper Austria. It was formed in 1995 to promote cross-border co-operation of the five economic hubs and touch EU funds, to emphasise the joint strengths of the five cities in the fields of science, employment, research and economy and to shape the region's profile in the international competition between locations. The ARGE was a subproject of the international European Union project 'INTERREG IIIB CADSES Project Network DonauHanse'[22] (2003–2006). CORIS Donaustädte was carried out in 2005 and 2006.

The task was to repeat the analysis using the CORIS methodology in the economic space depicted in Figure 1.5. The geographic focus was not just on the four towns and cities, but also on the districts between and next to them. This also came with finding out more in-depth information for the area on the south-eastern periphery of the economic space scrutinised in the first round of CORIS. In addition, some major cluster-relevant developments in Eastern Bavaria were observed. Hence, an update of the information was required and could thus be connected to the DonauHanse project.

18 In G about 50 per cent of the firms are located in two sub-regions, representing roughly six per cent of the total economic activity (as measured by the number of firms). For the EE supply chain we find half of the firms located in sub-regions, representing about one third of the total activity.

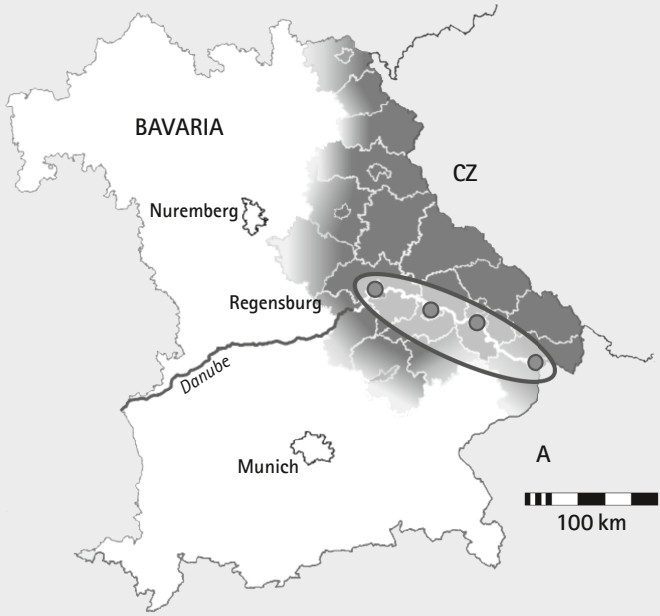
19 These notions, however, should be used with great caution. As Porter (1998a: 209) states: 'Firms can be more productive in any industry – shoes, agriculture, or semiconductors – if they employ sophisticated methods, use advanced technology, and offer unique products and services. All industries can employ high technology, all industries can be knowledge intensive.'

20 This section is largely based on the project's unpublished final report (Donaustädte 2006).

21 http://www.donaustaedte.com.

22 http://www.donauhanse.net.

Figure 1.5: The economic space along the Danube ('Wirtschaftsregion Donaustädte')



Notes: Highlighted are the towns and cities Regensburg, Straubing, Deggendorf, Passau (from west to east).
Source: Author's own illustration, basic map by Klara Kaufmann (IAB).

1.4.1 Data collection

As described in Section 1.2.2, the first step was to address regional development departments and networkers to be able to conduct structured expert interviews. Twelve of these in-depth interviews were carried out in late 2005. On the basis of the information obtained establishments were selected for further interviews. Local economic development authorities provided valuable support to identify and contact interview partners in the establishments' management boards.

As a member of the CORIS team, I conducted 22 establishment interviews in the regions of Straubing and Passau (October 2005 to July 2006). In Deggendorf, ten company representatives were interviewed in co-operation with the RISE project by the 'managementcenter deggendorf'. All information was recorded in minutes and – as detailed as allowed by the interviewees – added to the establishment-specific data sheets on the CORIS website for public access. In addition, data from different sources was collected for completion and also put into the information system.

1.4.2 Results

For the region between Straubing and Passau 145 new data sheets were especially created to broaden the information on the nine clusters already analysed and depicted in CORIS. In the process, existing data sheets were updated and the new aspects analysed.

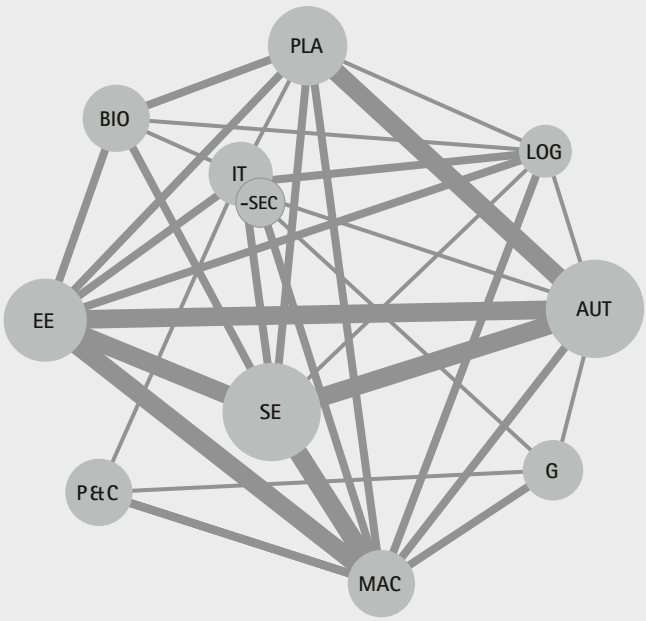
Some examples of refinements are briefly described in the following. (a) In a village near Straubing a concentration of three major service companies in the field of electromagnetic compliance were now be interested in participating in interviews. Their competencies and co-operations were added to the database and the clusters. (b) In and around Straubing in the early 2000s the Competence Centre for Renewable Resources was implemented, producers and service companies attracted and branch offices and laboratories of chairs affiliated to large universities resettled. Hence, a new feature of an existing cluster (BIO) developed and was integrated in CORIS. (c) Many student firms were outsourced from the Deggendorf University of Applied Sciences (FH) and a technology centre was established. These new features of the Deggendorf FH's regional embedding were visualised. (d) Besides the supplier structures of the Regensburg BMW plant the structures around the Dingolfing BMW plant were also recorded. (e) Intercultural competencies is a major field of the University of Passau. It was extended in the early 2000s with a major company developing in the city and a growing number of student projects. (f) Contact was established to the IT vocational school of the district of Deggendorf and the extensive co-operation projects with local employers were covered in CORIS. (g) Some 'hidden champions' in specialised machinery in the Straubing region that had not participated in the first round of data collection in 2001 were now interested in participating in the CORIS research project. (h) As for the highly developed cluster competences in Upper Austria, the respective links were established between the Austrian and the Eastern Bavarian cluster websites.

The main change to the CORIS database was a tenth cluster, 'Sensor technology' [SE], see extension of Figure 1.6.

Before the project extension began in 2005, it became apparent that the SE competencies were developing strongly in the region's firms and institutions, by the establishment of endowed chairs, for instance. The City of Regensburg Department of Economic Development grasped this trend and started a cluster management organisation in this field. In the course of CORIS Donaustädte the database was broadened with regard to relevant establishments. In addition, as sensor technology is an interdisciplinary technology, it was rewarding to scrutinise existing competencies of the already listed establishments and institutions as

potential partners for the emerging cluster. To visualise the interlinkages with the other nine clusters, the figure created in 2001 was extended (see Figure 1.6). The interdisciplinarity of SE can be seen by its strong interlinkages with EL, AUT and MAC. The characteristics of SE are included in Table 1.2 and the Appendix.

Figure 1.6: Interlinkages between the ten clusters



Abbreviations: see Table 1.1, SE = Sensor technology.
Notes: In this version, the size of the circles representing the clusters give a rough indication of their size (number of economic actors). What is also depicted is IT-Sec as an extension of IT. This is a managed cluster in IT Security. Data was included in the information system without using the CORIS methodology, hence IT-Sec and its cluster members are not included in the analyses. Effective 2006.

Table 1.5 is the updated version of Table 1.3 and presents the interlinkages between the clusters in 2010, now including SE. This is an interdisciplinary technology, which is clearly visible by the high value of average frequency of affiliation with other clusters of 3.01 and strong connections to AUT and MAC. With EE, sensor technology shares nearly 80 per cent of cluster participants, showing that the regional competencies in this field are well developed traditionally. This is evidently no 'wishful thinking' or 'policy driven' cluster (Enright 2003). As CORIS is a web-based and easily accessible system, users have the opportunity to enter and alter their data, hence there are some developments in the numbers and interlinkages.

Table 1.5: Numbers and average frequency of multiple cluster affiliations

Cluster	AUT	BIO	EE	G	IT	LOG	MAC	P&C	PLA	SE
AUT	**263**									
BIO	30	**78**								
EE	130	33	**262**							
G	36	13	31	**100**						
IT	44	9	54	16	**239**					
LOG	48	10	49	21	40	**118**				
MAC	113	26	117	40	39	50	**224**			
P&C	35	12	36	39	18	26	39	**95**		
PLA	101	24	69	32	25	33	67	36	**154**	
SE	84	20	129	26	43	32	88	27	41	**163**
Average frequency	2.36	2.27	2.47	2.54	1.21	2.62	2.58	2.82	2.78	3.01

Abbreviations: see Table 1.1.
Notes: N = 1,514, number of affiliations = 1,614 (referring to establishments only, effective December 2010; Figure 1.6 is based on all economic actors including institutions and co-operations).

The number of affiliated IT companies tripled, which can be explained by the low coverage of these firms in the chamber's database in 2001 when the first survey was done. IT is the cluster with the lowest average frequency (1.21) of multiple cluster affiliations, hence they do not have 'typical' customers for their products and services, but their offers can be used flexibly for different applications. As many IT companies offer business-related services, they can benefit of supplying their data to and being present in an information system that visualises regional embeddedness and allows showing references and customers. Average frequency of cross-cluster interlinkages of the glass industry [G] as well as porcelain [P&C] increased impressively between 2001 and 2010, from 1.27 to 2.54 and 1.54 to 2.82 respectively. This can be explained by the trend towards high-tech in these two traditional industries. On the one hand, high investments in automated production processes in a formerly labour intensive production took place, as well as investments in new high-temperature furnaces with reduced energy consumption. Eastern Bavarian G and P&C companies are the most modern producers worldwide. Many specialised machinery producers are located here, hence the linkages between both G and P&C with MAC are strong.

On the other hand, modern applications of these heat-resistant materials become more important, in solar panel or OLED production, in surface technology or as electronics and sensors casings, for instance.

For the research presented in Chapter 4, the data from December 2010 is used. As the database is growing continually through online data entries, 1,514 establishments, 226 institutions and 138 co-operations can be applied for analysis.

1.5 Cluster identification in the Nuremberg region

In 2005, a co-operation started between the IAB Institute for Employment Research (Regional Research Network and IAB Bavaria[23]) and the CORIS research team at the University of Regensburg (Chair for Empirical Macroeconomics and Regional Economics[24]). The joint project carries the title 'Industrial Clusters and Company Networks in the Nuremberg Region – identification and analysis with a special focus on their labour market impact'. As a by-product, the CORIS website was technologically updated to incorporate two regions with interlinked search functions. Data on the economic space is used for the research presented in Chapters 2 and 3.

1.5.1 Regional background[25]

In the Nuremberg region the cluster situation in 2005 was different from Eastern Bavaria in 2000. In the latter, no organised clusters existed at the time our research started, but the value-added chains and characteristics were present and needed to be collected and exposed. All the cluster managements in Eastern Bavaria developed after the cluster-oriented regional information system CORIS was implemented.

In marked contrast to this fairly late start, Central Franconia, the district dominated by the tri-city area Nuremberg-Fürth-Erlangen, kicked off co-ordinated cluster activities as early as the 1990s and is thus seen as a pioneer. In a joint effort of regional authorities the 'Regional Development Model' (RDM; *Entwicklungsleitbild*) was prepared in 1998 and updated in 2005 and 2010. After a sharp structural change and economic decline, the regional economic policy was realigned and concentrated on regional 'fields of competence' (*Kompetenzfelder*), i.e. clusters.

23 Lutz Eigenhüller, Stefan Fuchs.

24 Prof. Dr. Joachim Möller, Nicole Litzel.

25 Please see Chapter 3.3 for more information and literature.

Hence, the research in the Nuremberg region started from a high level of cluster activity. The purpose was explicitly not to create an exact copy of the 'competence initiatives' (the managed clusters) and to portray them on the information system. We implemented the CORIS methodology and hypothesised that the clusters should be traceable when conducting an analysis independent of the competence initiatives. In addition, we aimed at unearthing additional features of the regional clusters. Cluster membership, which comes with a fee and networking activities in most competence initiatives, is only of interest to a section of the potentially suitable establishments. There is a difference between the politically created clusters with organised membership and the practical cluster structures found when the customer-supplier relations and co-operation activities were examined (see also the line of argument in Chapter 4).

For the shape of the economic space we are studying, the Nuremberg region, please refer to Sections 2.4.1 and 3.3.1. It comprises the entire Bavarian district of Central Franconia plus the adjacent counties Forchheim (Upper Franconia) and Neumarkt (Upper Palatinate). We chose to follow the regional definition of the first RDM (1998), which corresponds to the core of the European Metropolitan Region Nuremberg. It was admitted in 2005 and has been growing geographically ever since.

1.5.2 Data collection

The research started with document analysis. Even if the study was not conducted along the existing competence initiatives, the RDM was examined in detail and proved to be a valuable source of information. Subsequently, in late 2005 and early 2006, 50 semi-structured expert interviews were carried out[26], about half of them with representatives of local institutions involved in regional policy and half with representatives of establishments.

For the written establishment survey the questionnaire was sent to 8,693 establishments. By early 2007 we received completed questionnaires from 888 establishments (10.2 per cent). The information was used for analysis and, as far as it was allowed by the enterprises, is contained in CORIS MittelfrankenPlus, which has been online since May 2008.

See Section 3.3.2 for more details of data collection and discussion with experts as well as a sample selection for the written establishment survey.

26 Some selected expert interviews were carried out by the project team Lutz Eigenhüller, Stefan Fuchs and Nicole Litzel. Most of the interviews with representatives of establishments were accomplished by the Pro-IAB team.

1.5.3 Results

Complying with the five criteria

For cluster identification, we checked whether the five criteria of the CORIS methodology were met by regional value-added chains. Table 1.6 presents the results. Details behind the symbols are listed in Table 1.8, Appendix 3.C, in Tables 3.1 and 3.2. Additional in-depth descriptive information on co-operation was published in Eigenhüller et al. (2010).

Table 1.6: Cluster identification criteria and application to the Nuremberg region

	Criterion				
Cluster	Concentration	Leading companies	Labour market pooling	Supporting institutions	Co-operation & networks
AUT	+	++	+	++	++
EL	++	++	++	++	++
ETE	+	++	+	++	++
I&C	+	++	++	++	+++
L&T	++	+++	++	+++	+++
MED	++	+++	+++	+++	+++
PLA	++	++	++	+++	+++
SPA	++	++	++	++	+
(Toy)	++	+	o	+	o

Notes: +++ very strong, ++ strong, + weak, o very weak or not fulfilled.
Abbreviations: AUT = Automotive, EL = Electronics, ETE = Environmental Technology & Energy, I&C: Information Technology & Communication Services, L&T: Logistics & Transport Technology, MED: Medical Technology & Health, PLA: Plastics Industry, SPA: Specialised Automation.

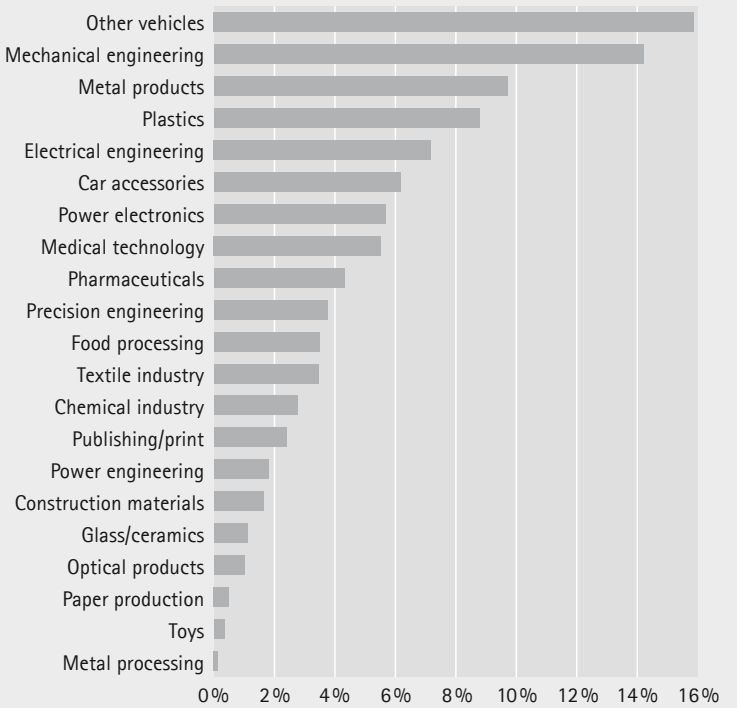
Source: Nuremberg region establishment survey.

The eight value-added chains we identified for this economic space as clusters are in Automotive [AUT], Electronics [EL], Environmental Technology & Energy [ETE], Information Technology & Communication Services [I&C], Logistics & Transport Technology [L&T], Medical Technology & Health [MED], Plastics Industry [PLA] and Specialised Automation [SPA]. In the Nuremberg region the Toy industry did not sufficiently fulfil our criteria.

Industry versus functional affiliation

The questions on the distinction between establishments' officially listed industry classification and their functional affiliations in regional value-added chains were adapted to Central Franconia and included in the Nuremberg region written establishment survey. Figures 1.7 and 1.8 display the outcomes for the industry affiliation, for manufacturing and services respectively.

Figure 1.7: Industry affiliations of establishments (manufacturing) by share of employees

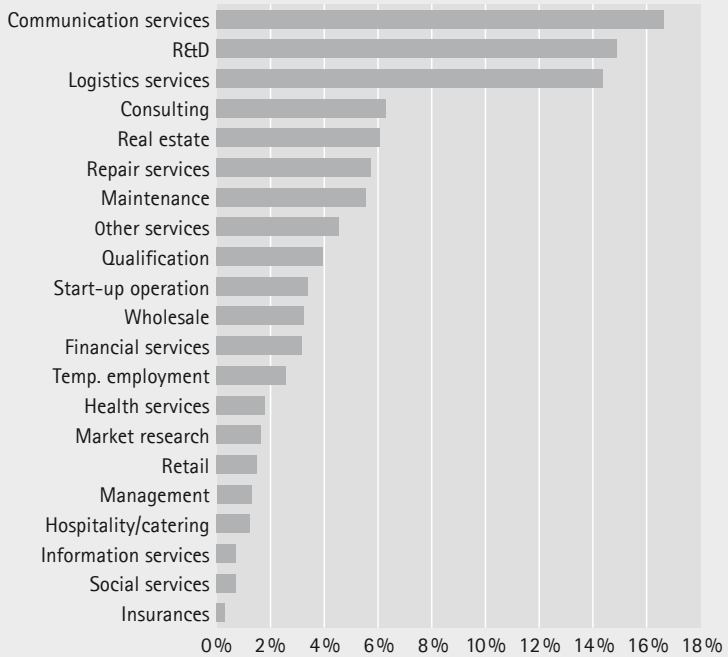


Notes: Establishments weighted by the number of employees; option of choosing more than one industry; N = 332.
Source: Nuremberg region establishment survey.

Figure 1.7 displays the answers to the question 'Which industry is your establishment working in?'. The top rank is occupied by 'Other vehicles' with 15.9 per cent of employees, as a major manufacturer of urban transport with about 10,000 employees is located in the Nuremberg region. The other higher ranks are dominated by engineering and different industries in electronics, and the plastics industry also has over 6,000 employees. Medical technology with almost 4,000 persons employed is also remarkably strong. The toy industry that was named by many experts as one of the leading industries in and around Nuremberg is listed here with roughly 250 employees. It is possible, though, that some leading manufacturers are affiliated to the plastics industry or metal products instead.

Figure 1.8 contains the information for the services. It reflects the importance of company-related services. Communication with over 20,000 employees and research and development as well as logistics with almost 20,000 employees are the largest service fields offered in the Nuremberg region and exceed manufacturing employment. This mirrors the structural change from manufacturing to services which the economic space has faced since the 1980s (Heidenreich 2005).

Figure 1.8: Industry affiliations of establishments (services) by share of employees



Notes: Establishments weighted by the number of employees; option of choosing more than one industry; N = 702.
Source: Nuremberg region establishment survey.

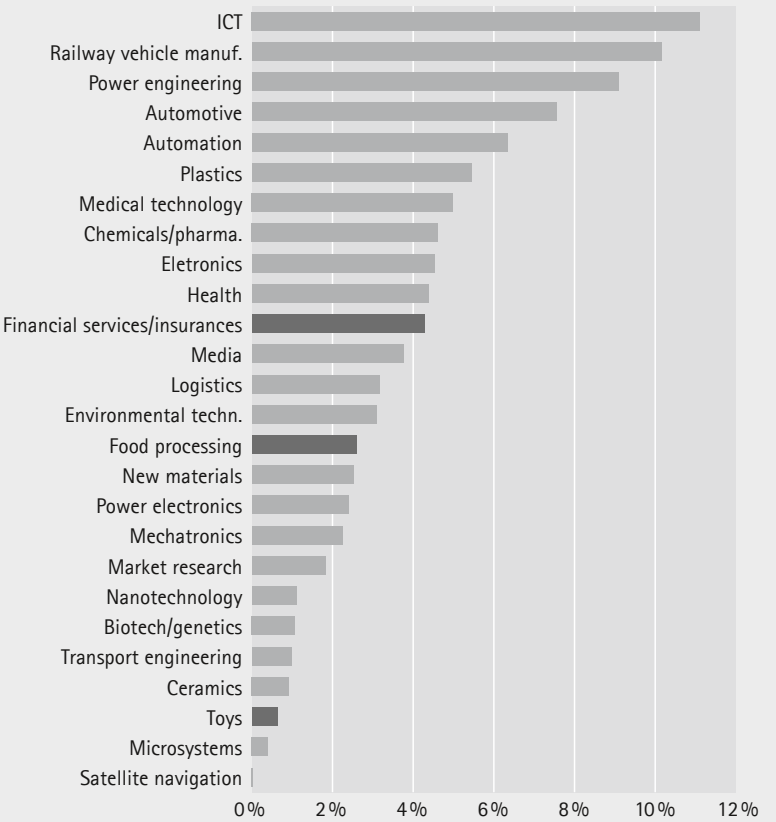
As for functional affiliation, survey participants were asked to answer the question, 'The Nuremberg region has a range of economic foci. In which of these is your establishment working, be it as a producer, a supplier or a service company?'. The 26 regional value-added chains listed in the questionnaire were derived from the initial document and interview analysis and included the fields of competence from the RDM as well as other value-added chains named by experts. The results of this question are displayed in Figure 1.9.

Of the 26 value-added chains offered in the questionnaire, 21 were grouped into eight clusters. The denotations can be traced in the categories of the clusters in the Nuremberg region displayed in Table 1.7. This categorisation was done after the expert interviews and with feedback from specialists to approve that the structures chosen were appropriate.

The results in Figure 1.9 show that taken separately the ICT sector with roughly 11 per cent of the employees is the largest in our sample. A singularity of the Information Technology & Communication Services [I&C] cluster is the functional interlinkages with market research and print & publishing, hence this was grouped in one cluster. The Nuremberg region's traditional specialisation in transport

technology is visible in the second rank of railway vehicle production. It can also be viewed together with transport engineering, whereby logistics services play a less prominent role. This is also considered in the singularities of the L&T cluster. Power engineering and power electronics are major fields in the regional economy (Dögl/März (2004) conclude that the Nuremberg agglomeration is Europe's leading energy region in terms of employment, firm number and market share). Nanotechnology and ceramics are considered under 'new materials'. The rather important regional medical technology industry forms one value-added chain with health and biotech. Column 3 of Table 1.7 contains the rough outlines of all clusters' singularities.

Figure 1.9: Functional affiliations of establishments by share of employees



Notes: Establishments weighted by number of employees, option of choosing more than one industry; in dark grey: value-added chains not considered for the eight clusters; N = 888.
Abbreviations: ICT = information and communication technology, manuf. = manufacturing, pharma. = pharmaceutical, techn. = technology.

Source: Nuremberg region establishment survey.

Table 1.7: Cluster categories and singularities of the Nuremberg region's clusters

Cluster	Cluster categories	Singularities
AUT Automotive	1st tier supply for automotive components 1st tier supply for plastic parts 1st tier supply for electronic parts 1st tier supply for metal parts 2nd tier supply for plastic parts 2nd tier supply for electronic parts Other 2nd tier supply Downstream supply Supply machinery & equipment Supporting institutions & service provision	No car producer, but several world-renowned first tier suppliers for automotive components (also with headquarters and R&D) Important and traditional field of regional economy, very diversified Management of Bavarian automotive cluster in Nuremberg
EL Electronics	Electronics Sensor technology Power electronics Electrical engineering Electro-mechanical parts Supply of parts and systems service provision R&D, education, training & supporting institutions	Nuremberg 'strongest energy region in Europe'[27] in the field of power electronics, full value-added chain from materials to systems
ETE Environmental Technology & Energy	Power engineering Utility provision Environmental technology Renewable energy Supply of machinery & equipment Engineering, other services, downstream suppliers R&D, education, training & supporting institutions	Very strong competencies in energy production and power systems, many institutions Links between power engineering and power electronics, many manufacturers of machinery for production of (renewable) energy Power station construction
I&C Information Technology & Communication Services	Software development Data systems technology, communication, networks Internet services Media, print & publishing Trade fairs & exhibition stand construction Call centre Market research & marketing Supporting inst. & IT-savvy firms	Unusually broad cluster: Headquarters of leading company in data systems Headquarters of leading company in market research Traditional and strong location for international trade fairs – many relevant suppliers
L&T Logistics & Transport Technology	Traffic engineering Logistics services (transport, cargo handling) Logistics consulting & other services Logistics systems Construction of packaging & containers Supporting institutions, suppliers & logistics-savvy firms	Region traditionally specialised in transport systems (e.g. first commercial railway in Germany), market leader in urban transport

27 Dögl/März (2004).

Table 1.7 continued

Cluster	Cluster categories	Singularities
MED Medical Technology & Health	Medical technology Out-patient healthcare In-patient healthcare Pharmaceuticals Biotechnology Research & development Services, supply of machinery & equipment Supporting institutions	Location of a market leader in medical technology and healthcare Strong links to regional healthcare institutions, ~half the application used in the region R&D, many research institutions (public & private)
PLA Plastics Industry & New Materials	Plastics – production & processing New materials Supply – tool manufacturing & mould construction Supply – machinery & equipment Other inputs & service provision R&D, education, training & supporting institutions	Focus on new materials with R&D facilities after structural change Concentrated in the rural areas around Ansbach
SPA Specialised Automation	Automation technology Machine tools Plant engineering Supply of components, systems & power electronics Other inputs & services R&D, education, training & supporting institutions	'Automation Valley' in Northern Bavaria, regional applications
Others	Manufacturing, service provision, building sector, institutions	

Source: CORIS data, expert interviews, author's own illustration.

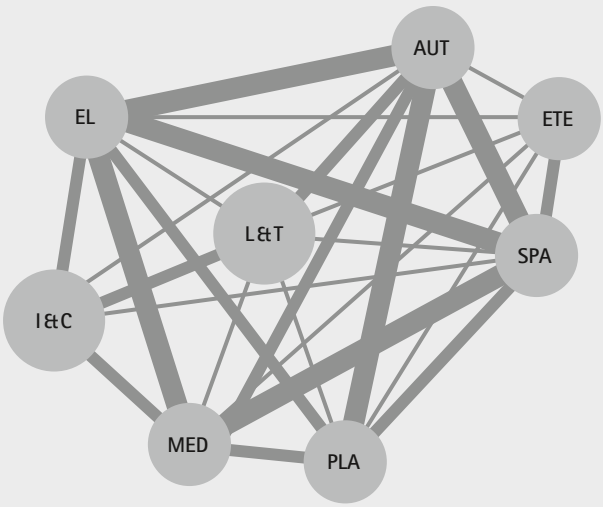
Table 1.8: Numbers and average frequency of multiple cluster affiliations

Cluster	AUT	EL	ETE	I&C	L&T	MED	PLA	SPA	Average frequency
AUT	**92**								2.207
EL	47	**145**							1.855
ETE	12	22	**80**						1.486
I&C	13	45	8	**226**					0.801
L&T	23	18	12	25	**113**				1.240
MED	26	37	11	31	18	**125**			1.576
PLA	38	26	13	4	13	29	**91**		1.736
SPA	43	64	28	32	19	38	32	**144**	1.826

Notes: N = 888, number affiliations = 1,016.
Abbreviations: see Table 1.8.

Table 1.8 provides the cross-cluster affiliations as the number of establishments in one chosen cluster that are also affiliated to the respective other cluster via products or services offered or co-operation activities. The factors taken together are visualised in an approximate manner in Figure 1.10.[28]

Figure 1.10: Interlinkages between the eight clusters in the Nuremberg region



Abbreviations: see Table 1.8.

Our data show that the interlinkages between the clusters Specialised automation [SPA] and Medical technology & health [MED], for instance, are strong, as they are between SPA and Electronics [EL] and Automotive [AUT] respectively. In the Nuremberg region MAC as producers of capital goods are specialised in these fields, as a number of joint research and development projects shows. However, the links between SPA and I&C (Information technology & communication services) are not as strong as might be expected, considering 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-added chains. At the core of the European Metropolitan Region the links to I&C are stronger than expected. The reason for this might lie in Nuremberg's specialisation in transport technology, such as the development and implementation of the driverless underground train with a high share of software and sensors, for example.

28 This paragraph is largely based on Eigenhüller et al. (2010).

The average frequency in Table 1.8 indicates an aggregated cluster's multiple affiliation to other regional clusters. It is interesting to note that in the Nuremberg region the clusters which are usually strongly interlinked with others, namely I&C and LOG, are the ones with the lowest values of multiple affiliation. This is down to the unusual shape of the two value-added chains in this economic space explained above.

After this introduction of the database and explanation of how it was built, the remaining chapters of this doctoral thesis present the research outcomes based on this fundamental work, which still continues.

Appendix Chapter 1: Cluster criteria in Eastern Bavaria

This Appendix consists of three connected tables:[29]

Table 1.9 Overview main products, services and leading companies in ten clusters

Table 1.10 Overview supporting institutions and evidence of co-operation in clusters

Table 1.11 Comments on labour market pooling and framework data for ten clusters

Table 1.9: Appendix 1.A: Overview main products, services and leading companies in ten clusters

Cluster	Main products and services	Leading companies
AUT	Cars Components and intermediary products	BMW Regensburg in the centre of the region, more than 40 first tier suppliers close-by BMW Dingolfing and Landshut (close-by: Audi Ingolstadt) 1st tier suppliers with headquarters functions and R&D: Beinbauer Automotive, Harman/Becker, Hör Technologie, Magna, Müller Präzision, SiemensVDO Automotive (today: Continental), Webasto, Die Wethje Kunststofftechnik, ZF Passau
BIO	Red biotechnology Life sciences Medical technology Renewable energies	Amgen Research, Antisense Pharma, Bionorica, Geneart, Schmack Biogas, Tyco Healthcare, Wilden (today: Gerresheimer)
EE	Semiconductors Power engineering (world-market leaders) Broad range of intermediate products for automotive, communication, household appliances, industrial electronics, environmental technology etc. Some final goods (keyboards, audio systems) Electromagnetic compliance	Alstom Sachsenwerk (today: Schneider), Cherry (today: ZF), Continental Automotive, emz Elektromanufaktur Zangenstein, F.EE, Harman/Becker, Infineon Technologies, MR Maschinenfabrik Reinhausen, Mühlbauer High Tech International, Osram Opto Semiconductors, Siemens, SiemensVDO Automotive (today: Continental), SGB Starkstrom-Gerätebau, Toshiba Europe, Zollner

29 Based on the project's final report (Endbericht 2001). For individual in-depth information see http://ostbayern.coris.eu.

Table 1.9 continued

Cluster	Main products and services	Leading companies
G	Flat glass for architecture, solar technology, pharmaceuticals, electronics, trains and cars (concentrated in the north and east of the region) Hollow glass handmade and industrially produced, crystal and leaded crystal (concentrated in Bavarian Forest south-east of the region) Machinery, ovens, tools Glass art	*Technical glass:* Flabeg, Flachglas Wernberg, Irlbacher, Pilkington Deutschland, Rodenstock (today: Linos), Schott Mitterteich *Hollow glass:* Eisch, Joska Crystal, Nachtmann Crystal, Poschinger, Schott Zwiesel (today: Zwiesel Kristallglas), Theresienthal, Weinfurtner *Machinery:* Horn Glass, Kinle, Linn High Therm
IT	E-commerce users (e.g. traditional firms in specialised trade) Intelligent logistics IT security	AVL Software & Functions, Bizteam Systemhaus, CipSoft, F.EE, Heitec, Samhammer, SWS, Witt Weiden
LOG	Specialised trade Logistics systems Construction of packaging	*Specialised trade:* A.T.U Auto-Teile-Unger, Conrad Electronics, Fritz Berger, Ingram Macrotron, Witt Weiden *Logistics systems:* Witron Logistik + Informatik *Packaging:* Gebhardt
MAC	Technologically advanced machinery (developed in many respects since the 1950s for the needs of regional industry) Customer-specific applications	Andritz Fiedler, BHS Corrugated, Deprag Schulz, F.EE, IMA, Krones, Mühlbauer High-Tech International, Netzsch, Rohde & Schwarz, Witron Logistik + Informatik, Zippel
P&C	World-market leaders in high-quality porcelain (home, professional: hotel, catering, hospitals) High-quality processed raw materials for p&c production Technical ceramics Services: décor, processing, laboratories Machines	*Porcelain:* Arzberg, BHS tabletop (brands: Bauscher, Hutschenreuther) Dibbern, Rosenthal, Seltmann *Ceramics:* CeramTec, Stelco *Raw materials:* AKW Kick, Dorfner *Machines:* Netzsch
PLA	Complex products for different markets Mostly suppliers of intermediate products and systems	Birner, Hueck Folien, Inotech, Peguform, Rehau, Wilden (today: Gerresheimer)
SE	Sensors for many applications, focus on automotive and automation	Continental, Krones, Dallmeier electronic, Infineon, Maschinenfabrik Reinhausen, Micro-Epsilon, OSRAM Opto Semiconductors, Siemens

Table 1.10: Appendix 1.B: Overview supporting institutions and evidence of co-operation in clusters

Cluster	Supporting institutions	Co-operation and networking
AUT	AARU Audi Accident Research Unit Innovation Park Wackersdorf LLK Competence Center for Lightweight Design (FH Landshut)	Automotive Forum Safety, Software, Systems (since 2006) SappZ – Sensors Application Centre Outsourcing of production to suppliers: strong customer-supplier relations Many bi- and trilateral joint R&D projects Joint systems production in Wackersdorf Supra-regionally embedded in the South-German automotive industry
BIO	BioCampus Straubing-Sand BioPark Regensburg BioRegio Regensburg Cluster Bayonik – Bavarian Bionik Network (since 2010) Competence Centre for Renewable Energies Straubing ICT International Center for Telemedicine Fraunhofer UMSICHT-ATZ JCC José-Carreras-Centre for Somatic Cell Therapy (since 2008) KFB Center of Excellence for Fluorescent Bioanalytics Mechatronics Research Unit (FH Regensburg) Zentrum für rationelle Energieanwendung und Umwelt (ZREU) GmbH	OTPD – Network Optical Technologies in Photodynamics IA Interdisziplinäre Anwendungsfelder: joint R&D with regional companies from other industries (MAC, PLA) (since 2006) RCBE Regensburg Center of Biomedical Engineering (since 2012) RCI Regensburg Center for Interventional Immunology (since 2010) Tumorzentrum Regensburg e.V. Many start-ups/spin-offs from the universities Technology centres
EE	Competence Network Mechatronics Cham Bavarian Cluster Sensor Technology (since 2006) Bavarian Cluster Mechatronics & Automation (since 2006) Bavarian Cluster Power Electronics (since 2006) Mechatronics Research Unit (FH Regensburg)	Many university-industry co-operation projects Endowed chairs Trainee Programme Mittelstand (with MAC, PLA) Development of joint products (e.g. with PLA) Co-operation of three large power engineering companies: e.g. exchange of measurement technique, marketing
G	Vocational schools for all relevant professions Glasstraße (tourism) Gläserner Winkel (marketing) OTTI East Bavarian Technology Transfer Institute	WOPAG: basic research on surfaces and processing Joint marketing 'laid table' (also with porcelain) Joint R&D with electronics & plastics industry
IT	IT-Speicher technology centre IKT Akademie IT-Security cluster (since 2006) Bavarian cluster IKT (since 2006) Cluster Bayonik – Bavarian Bionik Network (since 2010) NIL Network Innovative Logistics	BiSP Regensburg – Biometric and Sensor Technology Research Center CC-SE Competence Centre Software Engineering Management IT-Speicher – networking events Em_PDA Research Association SPIKE – co-operation Secure Process-oriented Integrative Service Infrastructure for Networked Enterprises Many university-industry links

Table 1.10 continued

Cluster	Supporting institutions	Co-operation and networking
LOG	Endowed chair for Integrated Logistics systems (FH Amberg-Weiden) GVZ Güterverkehrszentrum Regensburg Harbours in Regensburg, Straubing, Passau NIL – Network for Innovative Logistics (since 2009)	FGR Fördervereinigung Güterverkehrslogistik Regensburg RegLog® City-Logistik (until 2012) Customer-specific packaging: Intense and long-running customer-supplier relations, involvement in product development
MAC	Bavarian Cluster Mechatronics & Automation (since 2006) Competence Network Mechatronics Cham ÜBZO Überbetriebliches Bildungszentrum in Ostbayern	Joint international marketing as competition only in submarkets Trainee Programme Mittelstand (with EE, PLA) Joint projects with regional engineers and design offices Many university-industry links Often machine development jointly with customer's product/process development – exchange of engineers Often machine development jointly with customer's product/process development – exchange of engineers
P&C	Vocational schools for all relevant professions Verband der Keramischen Industrie (syndicate) National museums Porzellanstraße (tourism)	Research project FORKERAM (on new applications and china surfaces) High-tech initiative of north-east Bavarian china industry (focus on processing) Joint marketing 'laid table' (also with glass)
PLA	Cluster Bayonik – Bavarian Bionik Network (since 2010) LLK Competence Center for Lightweight Design (FH Landshut)	Development of new composite materials with glass, ceramics and metals Intense and long-running customer-supplier relations, involvement in product development Trainee Programme Mittelstand (with EE, MAC)
SE	Bavarian cluster Sensor Technology (based in Regensburg, since 2006) Bavarian Cluster Mechatronics & Automation (since 2006) Cluster Microsystems (FH Landshut) Competence Network Mechatronics Cham Endowed chair Sensor Technology (FH Regensburg) Endowed chair Industrial Sensors (FH Deggendorf)	BiSP Regensburg – Biometric and Sensor Technology Research Center SappZ – Sensors Application Centre Many university-industry links

Abbreviations: FH = university of applied sciences, R&D = research and development

Table 1.11: Appendix 1.C: Comments on labour market pooling and framework data for ten clusters (effective December 2010)

Cluster	Labour market pooling	N	Number of employees
AUT	Many companies now 1st and 2nd tier suppliers were founded in the region before BMW opened Regensburg plant, the region is well-endowed with the diverse range of relevant professions (vocational schools)	estab. = 263 inst. = 89 co-op. = 38	min. = 1 max. = 18,760 mean = 316.21
BIO	Faculties at the University of Regensburg and the FH Deggendorf & Regensburg – biology, chemistry, microsystems	estab. = 78 inst. = 76 co-op. = 27	min. = 1 max. = 982 mean = 101
EE	Large knowledge base/specialisation in power engineering Leading companies attract highly qualified employees Mechatronic competencies Faculties at FHs	estab. = 262 inst. = 95 co-op. = 52	min. = 1 max. = 5,900 mean = 188.53
G	Bavarian Forest as major centre for glass for centuries Rich accumulated knowledge of production and raw materials Highly specialised knowledge in machinery/ovens and toolmaking Longstanding working culture	estab. = 100 inst. = 76 co-op. = 31	min. = 1 max. = 1,411 mean = 98.01
IT	IKT-Akademie for extended vocational training (joint offer of public and private educational providers) Expertise in IT security High fluctuation, knowledge exchange	estab. = 239 inst. = 112 co-op. = 41	min. = 1 max. = 1,895 mean = 47.43
LOG	Faculties at FHs (logistics systems) Traditional specialised trade companies – accumulated knowledge Embeddedness less via regional sales, but via employees	estab. = 118 inst. = 79 co-op. = 27	min. = 1 max. = 1,895 mean = 118,47
MAC	Specialised workforce, e.g. for food processing technology and pick&place robots for minute parts – professional education Specialised workforce glass & porcelain production (ref.) High professional level for customer-specific machine parts & parts as per drawings	estab. = 224 inst. = 90 co-op. = 42	min. = 1 max. = 5,384 mean = 179.92
P&C	Since the 19th century north-east Bavaria as major centre for porcelain & ceramics ('porcelain towns' Selb & Weiden) Rich accumulated knowledge of production and raw materials Highly specialised knowledge in machinery (processing of very viscose and abrasive materials) Longstanding industrial working culture	estab. = 95 inst. = 55 co-op. = 30	min. = 1 max. = 598 mean = 95,15
PLA	Specialised workforce – deep knowledge of 2k- and 3k-products and 3D-moulding in many firms	estab. = 154 inst. = 74 co-op. = 29	min. = 1 max. = 2,030 mean = 150.02
SE	Faculties at FHs, endowed chairs Many traditional firms with deep knowledge base	estab. = 163 inst. = 46 co-op. = 32	min. = 1 max. = 18,760 mean = 398.35

Abbreviations: co-op. = co-operation projects, estab. = establishment, FH = university of applied sciences, inst. = institutions, max. = maximum size, min. = minimum size.

2 Industrial clusters and economic integration – theoretic concepts and an application to the European Metropolitan Region Nuremberg

Joint with Joachim Möller

Abstract

Economic integration typically goes along with disintegration of production through outsourcing and offshoring. As horizontal and vertical links between firms become more and more pronounced, value systems within regions are increasingly organised by production and innovation clusters. On the basis of a literature overview, we argue that in a world of economic integration clusters can be expected to play a prominent role. Therefore clusters can also be seen as a key element in the European metropolitan region concept. Within such an economic space, localisation economies according to the 'Marshallian trinity' can be realised.

The chapter builds on a comprehensive establishment survey for the core of the European Metropolitan Region Nuremberg that includes customer-supplier relationships and various forms of co-operation. As indicated by numerous empirical studies, the characteristics of clusters differ substantially. In order to overcome the fuzziness of the concept we suggest a bottom-up methodology of cluster identification using a set of qualitative and quantitative indicators.

Given that many kinds of barriers to interregional and international trade are becoming less and less important and transport cost are falling, modern production clusters tend to have a higher geographical extension than traditional ones. We therefore raise the question of whether clustering is relevant for economic integration on the regional, national and supra-national level.

JEL classification: R11, R12, R38, R58, O18

Keywords: Economic Integration, Industrial Clusters, Outsourcing, Offshoring, Border Regions, Cluster Identification, Proximity, Concept of European Metropolitan Region, Border Situation, Co-operation

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2.1 Introduction

Economic integration typically goes along with disintegration of production through outsourcing and offshoring (Feenstra 1998). As horizontal and vertical links between companies become more and more pronounced, companies' value-added chains within regions and regional value systems are increasingly organized by production and innovation clusters, that is 'geographically proximate group[s] of interconnected companies, suppliers, service providers and associated institutions in a particular field, linked by externalities of various types' (Porter 2003: 562). Firm clusters are a widespread empirical phenomenon and cluster promotion has become a cornerstone of regional economic policy. Clusters are strongly linked to the realisation of localisation economies according to the 'Marshallian trinity', that is knowledge spillovers, input sharing and labour market pooling (Marshall 2009 [1890], Rosenthal/Strange 2004). Also in New Economic Geography industrial clustering is an important issue (Fujita et al. 1999, ch. 16). Moreover, cluster policies might play a key role in the concept of the European metropolitan region.

It can be assumed that production clusters today tend to have a higher geographical extension than clusters in former times that were often based on raw material and resource availability or infrastructure, for example. Given favourable transport facilities and a situation of declining border impediments, production clusters might increasingly cross borders. Such supra-national forms for the division of labour can be seen as a specific form of how economic integration is proceeding.

In this chapter we argue that in a world of economic integration, clusters can be expected to play a prominent role. A higher division of labour, the ample use of outsourcing and offshoring possibilities and declining vertical integration as expressed by Krugman's (1995) famous 'slicing the value chain' requires more active horizontal and vertical interlinkages between firms. In addition, diagonal links for example to research institutions and service partners gain importance for successful innovation. Along with this comes a growing need for getting in touch with more and new business partners. We consider clusters and the analysis of their internal structures to be helpful for a better understanding of regional structures and potentials and to support their exploitation. In order to

put the concept on a firmer footing we try to find objective criteria for cluster identification and measurement.

The chapter is structured as follows. Section 2.2 provides an overview. We then give a critical appraisal of the cluster concept in Section 2.3. Section 2.4 provides a case study using European Metropolitan Region Nuremberg as an example for a highly integrated economic space. We raise the question of whether clustering is relevant for economic integration on the regional, national and supra-national level. Section 2.5 concludes.

2.2 Economic integration, agglomeration and clustering

2.2.1 Background

International economic integration 'is a process and a means by which a group of countries strives to increase its level of welfare.'[1] Although in recent times there has been growing scepticism among economists *vis-à-vis* the implications of pure neoclassical trade theory, this process of economic integration in general is expected to generate a win-win situation with positive influences on the development of all participating countries – at least in the long run, as costs in the short term can be quite high.[2]

Economic integration can remove market distortions and eases the exploitation of economies of scale, creates new incentives for product and process innovations, allows better factor allocation and leads to enhanced competition and thus to efficiency gains. The effects become more pronounced with the entering of different stages or overlapping types of integration: from lower tariffs for partners in a preferential trading area to a partial customs union to a free trade area with the abolition of all internal tariffs and quotas. Advanced stages of integration are a customs union, a common market introducing free mobility of factors, an economic and monetary union boosting financial integration and finally the complete economic integration including a supranational government.

Baldwin (2008: 7) paints a picture of the developments of the European Union (EU) from the devastations of World War II – leading to 'very uneven attitudes towards the supranationality that is at the heart of the uniqueness of European integration' – to the Treaty of Rome (1957). It already went far beyond a customs union, aiming at a full economic union and establishing the European Commission

1 Jovanović (1998: 9), being today's use of the notion. In the introductory chapter (p. 5 ff.) he gives an overview of the development of definitions: 'Integration means different things in different coun¬tries and at different times' (p. 8), with the term arising in the 1940s.

2 For the discussion of costs, benefits and compensations see Jovanović (1998: 100 ff., 113 f.).

to supervise its implementation independently: 'the idea of using economics as a Trojan horse for political integration worked like a charm' (*ibid.:* 12). The positive sides of the Internal Market exert a strong attraction to outside countries. As the last accession rounds show, many – but not all – European countries accept the rules of supra-nationality. Baldwin (2008) states that this far-reaching interference makes it hard for other regions to learn from the European process.

However, different stages of economic integration are brought forward on a worldwide scale. The establishment of the Free Trade Agreement between the USA and Canada in 1988, the creation of the North American Free Trade Agreement (NAFTA) six years later with the elimination of all tariff barriers between the three nations in 2008, for example, made trade triple between 1993 and 2007. In the European context a major step towards fully integrated markets was made in 1992. The *Single Market Programme* abolished non-tariff trade barriers between the member states. The *Internal Market* with its integrated goods markets, service markets, labour markets and capital markets led to dynamic positive developments in the participating countries.

2.2.2 Integration of markets and disintegration of production

One consequence of the integration of markets is the increasing international division of labour. Companies widely use the opportunities offered to exploit advantages of re-organising their internal production processes and to concentrate on their core competencies. Some specialise in certain activities in the value-added chain that turns fragmented or sliced (Krugman 1995). As for the country level, economic activity becomes less and less vertically integrated, but vertically specialised. The focus is on the products and processes in which they have a comparative advantage. As Feenstra (1998: 41) puts it: 'By a variety of measures, the increased use of imported inputs, and narrowing of production activities within each country, is a characteristic feature of many OECD countries over the past two decades.' Hummels et al. (2001) try to quantify these developments. They shed some light on one feature of vertical specialisation: the sequential production within an international value-added chain. For ten OECD countries the share of imported goods that are used to produce export goods is 0.2; for the smaller countries it mounts to 0.4. Between 1970 and 1990 this share increased by about 30 per cent for ten OECD and four emerging market countries. Along with vertical specialisation comes a higher variety of both preliminary and intermediate goods, leading to lower costs and better matching in the production process (Jabbour 2007a, Feenstra 1998, Ethier 1982).

Another aspect of vertical specialisation is vertical foreign direct investment (FDI),[3] growing at a much higher rate than international GDP. Coeurdacier et al. (2009) analyse the development of the most important share in FDI, being cross-border mergers and acquisitions. Their results indicate that such activities in manufacturing were boosted by the European Internal Market and the European Monetary Union, whereas mergers and acquisitions in services have no significant effect. Neary (2009) sheds light on the conflict between the theoretical predictions that falling trade costs should hamper FDI and the empirical observations of the boom of vertical, horizontal and export platform FDI as well as mergers and acquisitions. He observes that a clear distinction of these forms of cross-border activities is not very useful, as most companies pursue complex operations that mix different approaches.

Behrens et al. (2011) employ a new trade theory framework with exports and FDI between technologically heterogeneous countries. The model distinguishes peripheral and central locations and includes heterogeneous firms as well as multi-nationals. The study shows that an 'increasing liberalization of FDI yields larger gains than increasing trade liberalization' (*ibid.:* 4). As for the effects of trade liberalisation on companies and countries the authors draw the general conclusion that it raises productivity and welfare of them all, but it attracts resources to more productive firms, to countries with a larger market, a more central and accessible location and better technological possibilities as well as to countries with lower costs. Concerning the introduction of bilateral trade agreements, Behrens et al. (2011) show that in all of their model settings insiders gain and outsiders lose.

In the context of this chapter, two other aspects of vertical specialisation are of paramount importance: outsourcing and offshoring. Blinder (2007: 1) distinguishes the two phenomena as follows: 'a job is *outsourced* when it is contracted *out of the company* – presumably to another company. The *country* in which the job is now being done is irrelevant. [...] *Offshoring,* by contrast, means moving jobs *out of the country*, whether or not they leave the company' (original italics).

Outsourcing is possible with both tradable and non-tradable goods and services. By their very nature the latter are not subject to offshoring. Typically they require face-to-face contact. In his paper offering reflections about the changing scope of international division of labour, Blinder (2005) uses the label 'personal services' for the corresponding tasks. Over time, the weight of personal services in total production is not invariant. Considering the developments in information and

3 FDI is a major factor in development because of the inflow of capital, but also of knowledge coming into the target country through the channels of management and production processes.

communication technologies, more and more services are becoming tradable and thus turn into 'impersonal services' that are possible to provide abroad. The author especially emphasizes the necessary change in looking at skill levels. The traditional idea is that highly qualified workers are providing personal services and are winners of proceeding globalisation, whereas less qualified workers are associated with impersonal services and are therefore considered losers. However, the exposure of jobs to offshoring is not necessarily linked to the skill level. For instance, software development can be classified as impersonal services that can be transferred abroad, whereas hairdressing is a personal service that has to stay local.

Blinder (2005) sees the offshoring activities that are just starting as the early stages of a *Third* Industrial Revolution[4], the *Information Age*. In order to allay the related fears he writes (*ibid.:* 9):

> 'Just as with the first two industrial revolutions, massive offshoring will not produce massive unemployment. Nor should we view it as a long-run threat to our standard of living. The world gained enormously from the first two industrial revolutions, and we are likely to do so from the third as well'.

But this will be accompanied by social and economic frictions. A heavy burden of adjustment lies on the educational system. Just to provide more education might turn out not to be sufficient. The question is also for which professions or tasks workers should be prepared. Blinder concludes that maybe the job alienation as a frequently observed outcome of the First Industrial Revolution might well be a fading phenomenon.

The requirements for the international and interregional division of labour in the Information Age might have further consequences. On the basis of a trade model that treats the cost-reducing effect of offshoring like technological progress, Robert-Nicoud (2008: 518) discovers that 'offshoring triggers a specialisation by function rather than by sector.' Grossman/Rossi-Hansberg (2006) also find effects of trading and offshoring on the character of tasks needed to produce final goods. In their view, 'international trade is less today a matter of countries' specialization in particular industries and more about their specialization in particular occupations and tasks.' Grossman/Rossi-Hansberg (2008: 1). The authors develop a model that breaks down the wage effects of new developments in information and communication technologies into three parts: a productivity effect, a relative-price effect and a labour-supply effect. They show that the productivity effect of transferring tasks abroad – that can be seen as factor-augmenting technological

4 Blinder (2005), p. 7, with the First Industrial Revolution being the shift from farm to factory (mainly taking place in the 19th century) and the Second Industrial Revolution the shift from manufacturing to services (20th century and still ongoing).

progress – can dominate the other two effects. This possibly entails an *increase* in domestic demand of the type of workers whose jobs are exposed to offshoring. Therefore, their wages might rise as well.

Jabbour (2007b) takes into account the transaction costs involved in internationalisation and analyses the effects on the productivity of companies. She finds positive effects of both outsourcing and offshoring on productivity. But taking a closer look at the latter reveals that only offshoring to other companies leads to significant profits, whereas intra-company offshoring even reduces profits, especially when high-tech inputs are imported. The author also compares different theoretical models explaining offshoring and tests the hypotheses again with French data (Jabbour 2007a). She checks which internationalisation strategy is followed by companies and finds 'that most productive and large firms engage in partnerships, low productive and low scale ones vertically integrate while firms with intermediate levels of productivity and scale outsource from independent suppliers' (*ibid.:* 38 f.).

2.2.3 Economic integration and highly asymmetric border regions

The European Union included some of the Central and Eastern European countries in its *Generalised System of Preferences* (GSP) as early as the fall of the Iron Curtain in 1989. One reason was to extend the positive micro-economic effects and dynamics of economic integration. For former 'border countries' this meant a deep change in economic relationships. Eight of the ten new member states of the 2004 enlargement are Central and Eastern European post-socialist countries. With regard to Germany, for instance, two of them are direct neighbours and all of the eight countries have Germany as a geographically proximate 'old' member state. After May 2004 this led to dynamic developments of foreign trade that markedly exceeded the growth rates of exchange with former trading partners inside and outside the EU.[5]

For studies in general, special attention has to be devoted to border regions: 'Borders affect economic activity in border regions since they generate barriers that raise the costs of cross-border interaction and reduce the transfer of information and knowledge' (Niebuhr/Stiller 2006: 60). As far-reaching economic integration not only abolishes trade barriers but also reduces the impact of national borders, the effect on border regions can be expected to be even larger than on the rest of the country, especially in interfaces with high discrepancy in GDP per capita.

5 Untiedt et al. (2007) give a broad, coherent analysis and description of the effects of EU enlargement on Germany. In several aspects, the country seems to have benefited more than expected from the new situation.

Krätke (2001) provides empirical evidence that the German-Polish border region hardly profits of the possibilities of economic integration. The author speaks of a 'leapfrogging effect', that is cross-border activities like offshoring and FDI mainly happen transnationally between economically strong regions in both countries – consequently the border region suffers of increasing traffic, but has no welfare gains. From a theoretical point of view, Forslid (2011) demonstrates with a New Economic Geography footloose model – it includes three regions differing in size – that in certain parameter constellations economic integration without accompanying regional policies leads to a total deindustrialisation of the peripheral region. However, welfare is growing in all three types of region.

In the context of NAFTA, the impacts of trade along the US-Mexican border are investigated by Feenstra/Hanson (1997). The authors develop a theoretical model with trade of intermediate goods. They find that US firms are outsourcing activities with – by American standards – relatively low skill requirements, but need relatively highly skilled workers from a Mexican perspective. As a consequence of the relative labour demand shifts due to integration, the skill premium increases on both sides of the border.

Enright et al. (1997) study the relationship between Hong Kong and the Chinese Mainlands. They also argue for positive economic effects on both sides when exchange is started in a borderland situation with extraordinary wage differentials. Not only do wages and employment in the low-wage region increase but the high-wage region also gains. 'In Hong Kong's case, decentralization of the vast majority of its manufacturing has resulted in an eight to tenfold increase in production controlled by Hong Kong firms in the last two decades' (Enright 2003: 110).[6]

As the EU enlargement process transforms some former peripheral external borders of the EU into centrally located internal borders, the integration effects should be even stronger than in other regions, especially on the goods and the labour markets. Due to geographical proximity, outsourcing of different economic activities is possible with comparatively low transaction costs and enhanced possibilities for offshoring emerge.

For labour market integration, Niebuhr/Stiller (2006) give an overview of theories that touch the topic of effects specific to border regions: traditional location theory, New Economic Geography, trade theory and migration theory. The empirical analysis of spatial structures and their cross-border interdependencies in internal border regions versus external and non-border regions reveals that the 'spatial dependence between neighbouring labour markets in Europe is relatively low along national borders' (*ibid.:* 71) – concerning not only the new internal

6 Referring to Enright et al. (1997).

borders of the 27 EU member states after enlargement, but the borders of the 15 already highly integrated 'old' member states.

Moritz/Gröger (2007) focus on the labour market situation along the border between the Czech districts of Western Bohemia and the German districts of Eastern Bavaria. This border region was characterised by one of the world's largest spatial wage differentials. Analysing the development from 1980 to 2001, they capture the labour market effects of the fall of the Iron Curtain in 1989 that had already changed the pre-accession border situation massively. They expect structural shifts in the labour market due to extensive offshoring possibilities. However, changes in the skill structure in Eastern Bavaria follow the same pattern as in comparable rural regions and in the entire federal state of Bavaria – a trend towards higher qualifications and a convergence towards the national average. As for wage differentials, they also find a catching-up effect of wages for skilled and highly-skilled workers and a non-significant change for low-skilled workers. There is no evidence for either a significant positive or negative special effects for the Bavarian-Bohemian border region after the fall of the Iron Curtain.

For Germany as a whole, Geishecker/Görg (2008) trace the impact of the international division of labour on individual workers' real wages using German micro-level data for 1991 to 2000. For Germany, this decade was characterised by quite stable relative wages of low skilled workers and strongly increasing international outsourcing. Against this background they single out the short-run effects of international outsourcing and conclude that in this process low skilled workers lose and highly skilled workers gain.

Marin (2011, 2004) addresses fears in Austria and Germany concerning possible job transfer due to Eastern Enlargement. She uses a survey data set that covers all of the German and 80 per cent of the Austrian direct investment projects from 1990 to 2001 in the (future) new member states with the two countries being the most important investors. Her results show that outsourcing activities both in manufacturing and services are considerable, but that the job losses are much lower than expected. Marin gives two explanations for this. First, the horizontal foreign direct investment dominates which often serves as a strategy of market entry. Second, in the case of vertical foreign direct investment there is no net substitution of jobs in the source country to the target country. As a consequence, 'German and Austrian firms increase their production and employment demand in Germany and Austria when workers in their affiliates in the CEE countries become less costly' (Marin 2011: 309). This is due to the general increase in profitability when companies use the advantages of international division of labour. Companies with advantageous cost structure can survive easier in a competitive world. In contrast to other results like e.g. of Geishecker/Görg (2008) and Feenstra/Hanson

(1997) the author also finds that – down to the good endowment of skills in the accession countries and the low percentage of skilled workforce at home – both Austria and Germany transfer high-skill and R&D activities on unexpected large scale to their Eastern affiliates (Marin 2011).[7]

2.2.4 Functional specialisation

Outsourcing and offshoring can occur simultaneously. As for outsourcing, Rossi-Hansberg et al. (2009) develop a theory concerning firms that can split up their internal production processes into headquarters and production plants. Both can locate either in the centre of a city or on its edge. Their work is based on the empirical observation that the internal structure of cities in the US has changed hugely over the last few decades. Data of the 50 largest Metropolitan Statistical Areas in the USA between 1980 and 1990 (and partially available data extensions for 1970 to 2000) reveal that population in the cities grew considerably, both in the centre counties and the edge counties. This was coupled with employment growth and an increasing number of establishments, whereas the size of plants and establishments declined in all city areas. Relatively speaking, the shares of population and employment on the edge of the cities increased.

Rossi-Hansberg et al. (2009) observe that this movement in economic activity to the periphery is mainly down to non-management and not to management occupations. However, they find no evidence that this shift is driven by any specific industry or sector. 'One interpretation of the theory we present, and the empirical evidence more broadly, is that with firms sending their larger and more routine operations to the periphery, city centres are steadily becoming management or administrative hubs.' (*ibid.*: 145). Their theory helps explain these transformations in urban structure by showing that population growth is the driving force behind changes in firms' internal organisational structure. They shift from integrated operations to a structure with headquarters and management in the centres and production plants on the outskirts.

Duranton/Puga (2005: 345) observe similar developments in the division of labour between cities of different sizes:

> 'By 1980 differences across cities had increased substantially and a clear ranking by size had emerged: larger cities had become specialised in management functions whereas smaller cities had become specialised in production. This pattern became even more marked over the following decade.'

7 Lorentowicz et al. (2005) in their study on the international division of labour ascertain the same pattern for Austria and Poland – high-skilled jobs go to the low-wage country, low-skilled jobs stay in the high-wage country.

They call this the shift from 'sectoral specialisation' to 'functional specialisation' – that is to production of final and intermediate goods versus headquarters and business services. The integration decision of firms in the model of Duranton/Puga (2005) is determined by the trade-off between the benefits of having production and management facilities located in their specialised environments and the benefits of having a single location, respectively. The cost advantage of the latter declined rapidly in the decades under consideration thanks to technological progress in management methods and communication technologies.

2.2.5 Market integration and industrial clusters

The integration of markets lowers transaction costs for companies to locate in favourable business environments – worldwide. Companies can more easily exploit the advantages of vertical integration, offshoring and outsourcing. For regions this results in fierce competition over companies and highly skilled or creative workers. It is no longer predominantly the traditional factors like infrastructure, resource endowment and geographical location that attract investment, but dynamic factors like availability of personnel with the necessary qualifications and the existence of universities and research institutions – in other words an environment favourable for innovation and knowledge spillovers. Companies locate where they find this advantageous atmosphere. It can be observed 'that even as competition and economic activity globalize, [...] competitive advantage can be localized' (Enright 2003: 100). Porter (1990) calls this the 'location paradox'. To make their economic strengths, advantages and distinctive features visible, regions strongly focus on promoting regional clusters.

2.2.6 Agglomeration economies and industrial clusters

The correlation between economic growth and agglomeration is well known. Looking at traditional explanations, regional economics differentiates between two major types of agglomeration advantages: *localisation economies* as the benefits resulting from concentration of companies in a specific industry on a given location[8], and *urbanisation economies* as positive external effects between spatially concentrated different industries. Both benefits are typically restricted to companies and individuals in the same economic space.

8 Marshall (2009 [1890]) describes localisation economies as externalities of knowledge spillovers, input sharing and labour market pooling (see also Rosenthal/Strange 2004).

The interaction of these factors leads to agglomeration advantages that can also be measured empirically: Ciccone/Hall (1996) estimate a productivity growth of four to six per cent for the USA with the doubling of population density; for Europe a similar effect is shown (Baptista 2003, Ciccone/Cingano 2003, Möller/Haas 2003)[9]. And Lehmer/Möller (2010) – controlling for urban-rural skill bias, individual characteristics, regional industries and firm-size effects[10] – find an urban wage premium of 8.6 per cent in Germany.

In addition, a range of dynamic local externalities contribute to the growth and success of regional clusters, requiring an analysis in a framework of both time and space. An important milestone in New Economic Geography – which discusses models based on monopolistic competition (Ethier 1982, Dixit/Stiglitz 1977) in a world with transport costs in the widest sense, scale economies and externalities of market size (e.g. Head/Mayer 2003, Fujita/Thisse 2002, Fujita et al. 1999, Ottaviano/Puga 1998, Krugman 1991) – is Krugman's core-periphery model that has been extended and modified several times (e.g. Forslid/Ottaviano 2003, Puga 1999, Helpman 1998, Krugman/Venables 1995). The interplay of production, consumption and localisation decisions in certain constellations can develop centripetal forces that lead to a centralisation of production. Evolutionary Economic Geography emphasizes the role of institutions, knowledge spillovers and variety for the emergence and development of cities, regions and clusters and also adds information e.g. on history (Boschma 2009, Jovanović 2009).

The characteristic feature of value-added chains or supply chains is vertical integration with its forward and backward linkages, externalities that affect a company because of changes in either suppliers' or customers' actions (Hirschman 1958). These local interactions of companies and consumers are one prerequisite for clustering. The analysis of horizontal links between companies – including mutual learning effects and therefore fostering innovation – provides another approach to looking at clusters. The three factors Feldman/Audretsch (1999) stress to make the step towards successful innovation clusters refer to these horizontal interconnections. First, complementary activities should be diverse to a certain extent and, if possible, share a thematic platform. This recurs concerning empirical results for example by Glaeser et al. (1992) and Jacobs (1969), showing that diversity proves to be more conducive to innovation than specialisation. Second, they conclude that the endowment with technological potential in the past only partly explains the development of innovation clusters. For successful progress it

9 Agglomeration also has disadvantages, for example congestion, higher costs of living and bad environmental conditions like pollution.

10 The 'raw' premium is about 15.5 per cent.

seems to be far more important to efficiently organise the existing structures and business contacts: 'The underlying economic and institutional structure matters, as do the microeconomic linkages across agents and firms' (Audretsch 2003: 19). Third, they state that competition spurs innovation more than a monopoly (Audretsch/Feldman 1996, Glaeser et al. 1992). It is not just the fact of competition stimulating technological developments, but also the co-operation among competitors. For this constellation, Brandenburger/Nalebuff (1996) coined the notion 'co-opetition'. According to Jonas (2005), from the sociological point of view competition and confrontation play crucial roles in clusters, but this interplay is hardly included in the analysis.

Along with co-operation and the efforts of establishing contacts and staying in touch – be it between horizontally or vertically interlinked companies or diagonally linked research institutions – comes the exchange of information and knowledge, as already observed by Marshall 2009 [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' (Cooke 2007, footnote 3). Information can also be termed 'explicit knowledge', in contrast to 'tacit knowledge' introduced by Polanyi's seminal work (1966). The latter is hard or even impossible to codify, it is bound to individuals and therefore to locations and regions which causes its character to be 'sticky'.[11] Both specifications of knowledge are mutual complements (Nonaka 1991, Polanyi 1966).

Local knowledge spillovers, also termed 'spatially bound knowledge externalities' or 'non-market based knowledge flows', are strongly connected to sticky or tacit knowledge. They can be considered a local pool of knowledge that is nurtured through social interaction that typically happens more frequently in geographical 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 tacit knowledge is conceptually unclear and has not been sufficiently modelled or measured – according to Breschi/Lissoni (2001) it is still a black box.[12] Consequently Howells (2002: 876) argues that 'most of the metrics imply the imparting of knowledge, but do not actually measure it.'

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

11 Von Hippel (1994) introduces the notion 'sticky', Audretsch (2003) adapts it to 'sticky knowledge'.

12 See Breschi/Lissoni (2001) for a critical assessment of the concept of localised knowledge spillovers, the abuse of the notion and implications for further research.

citations.[13] They find that spillovers not only occur in technologically close fields, but that important knowledge externalities also come from other industries. Ten years earlier Scherer (1982) had already used this methodology to point out the importance of inter-industrial spillovers on a company's productivity growth. Also the pioneer work of Jacobs (1969) stresses the positive influence of diversity on knowledge externalities and therefore on innovation.

Almeida/Kogut (1997) show evidence of clear localisation effects in the US semiconductor industry also by looking on citations in new patents as an indication of knowledge flows. According to Bottazzi/Peri (2003), knowledge externalities can be measured by observing the effects of spending in research and development in one region on R&D productivity in neighbouring regions. Estimating the effects of doubling R&D expenditures, they find an 80 to 90 per cent increase in innovation in the region of origin, two to three per cent in a 300 km radius and no effect further away. 50 per cent of new patents in the EU-15 countries as well as 50 per cent of R&D spending are allotted in five out of 86 regions. However, Scherngell/Barber (2009) show that in cross-region formalised R&D collaboration networks established under the 5th European Union Framework Programme the geographical dimension is an important factor, but less so that the technological distance between the partners. Several authors[14] introduce spatial aspects in the knowledge production function. Using this method, Audretsch/Feldman (1996) show that the innovative output of all companies in a region increases with the overall R&D inputs.

However, Breschi/Lissoni (2009) divide localised knowledge flows into pure externalities being non-market based social interactions and market-based knowledge exchange pinned down in formal co-operation. In the framework of the patent citation method by Jaffe et al. (1993), the latter is observed with a geographical analysis of inventors' mobility across companies in selected industries in the US. To employ a mobile inventor and thus to profit of the knowledge (tacit and explicit) he gathered in former contracts is connected with a price. Thus, the authors include social network analysis and also look at co-invention networks with short social chains. Their results reveal that a high share of localised knowledge flows are down to the market transactions of mobile inventors, and as they rarely move out of their co-invention network the geographical aspect is strong. They conclude that informal interactions are by far overrated for the explanation of the diffusion of tacit knowledge.

13 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.'

14 Audretsch/Feldman (1996), Feldman (1994) and Jaffe (1989), see Audretsch (2003: 17).

A further important feature of clusters are diagonal interlinkages between companies and research institutions. They become important particularly in regard of innovation. As for the local knowledge spillovers from universities, Varga (2000, 1998) and Jaffe (1989) show positive effects of university research on the number of new patents of local companies, Anselin et al. (1997) on high-tech innovations. And Acs et al. (2002) carry on the approach to show their positive impact on local employment in high-tech industries.

Literature distinguishes three forms of knowledge externalities: both Marshall-Arrow-Romer (MAR) and Porter externalities see localisation economies as a source for local knowledge spillovers and regional growth, but they differ in their view on the role of competition. MAR puts emphasis on the 'threatening' character of knowledge spillovers as through espionage and poaching. They argue that local monopolies allow firms to get the maximum return out of their investments in research and development and human capital. Porter however stresses the quality of local competition to spur innovation and diffuse knowledge.[15] Jacobs (1969) follows his view on competition, but Jacobs externalities emphasize the role of diversity and inter-industry spillovers, that is urbanisation economies.

In addition, sociological literature also challenges the 'automatism' that regular personal contact and direct interaction create trust and reciprocity within clusters (Shrum/Wuthnow 1988). Questions that arise are, for instance, which formal and informal rules enable the cohesion of clusters, whether 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 (Abraham 2001, Blumberg 2001, Uzzi 1997, Hakanson/Johanson 1993). Network analysis can contribute to the discussion with statements on cohesion, the density of relation and connectivity or the degree of centralisation, e.g. whether certain clusters are dominated by one agent or 'leading company' (Jansen 2002, 1999).[16] Sociological aspects help explain, beyond economic reasons, why companies co-operate with others, which framework they prefer, what their expectations are or how strong the cluster awareness within a region is. The common scenario of 'self-fulfilling harmony' in regional clusters will gain some additional twists.

15 However, there is mixed evidence. In their study of the determinants of spatial concentration in German high-tech industry, Alecke et al. (2006) do measure the localisation economies introduced by Marshall (2009 [1890]) – being input sharing, labour market pooling and knowledge spillovers. They regress the Ellison/Glaeser index of geographic concentration on different industry characteristics and find only weak effects for labour market pooling, for input sharing strong effects on agglomeration. Their results show no evidence for knowledge spillovers between high-tech companies and conclude that for the geographic range used, knowledge spillovers do not contribute to agglomeration.

16 Examples of applied network analysis in the cluster context can be found in Cantner/Graf (2006) and Wrobel (2004).

Pervading all these aspects is the notion of proximity, but not only the geographical aspects. Boschma (2005) demarcates four additional dimensions, namely cognitive, organisational, social and institutional proximity, and characterises their respective roles and their interplay in the knowledge creation process. Also their balance has to be considered – neither too much nor too little proximity is conducive to innovation. Against this background, but focusing on the spatial dimension, Torre (2008a) questions the need for co-location and the frequency of face-to-face contact necessary for knowledge spillovers and innovation. He does not go as far as Cairncross (1997) to proclaim the 'death of distance' due to new information and communication technologies. Neither does he follow the literature on epistemic communities (like the network of Linux developers) and communities of practice to the end, claiming that geographical proximity is not at all necessary and all knowledge transfer can happen entirely in cyberspace. Based on empirical observations, e.g. that even in epistemic communities project leaders have to meet personally, that (professional) mobility concerning both distance and time away from home increases and that new developments in information and communication technologies leads to 'actor's ubiquity' (Torre 2008a: 876), he states that temporary geographical proximity with meetings in certain stages of an innovation project is adequate for knowledge exchange.[17]

The possible negative effects of being located close to suppliers, customers and co-operation partners are scarcely noted. Torre (2008b: 37) lists three major sources of possible problems. First, he states that the local diffusion of knowledge cannot only spur innovation, but can also mean 'knowledge leaks, industrial espionage, and poaching of specialist employees'. This happens especially in clusters in which activities of different economic actors are technologically closely linked and with participating innovation and technology leaders. Second, Torre (*ibid.*) names the negative aspects of lock-in, such as the possibility that a cluster is 'plagued by excessive specialization or trapped in mono-activity' or in exclusivity. His last point is the nature of communication between cluster members: it is possible that in a comfortable situation of co-location interactions are reduced to routines, but that exchange does not lead to any new impulse.

And Simmie (2004) stresses – after analysing the activity range of innovative companies in the UK – that most of the proximity effects on innovation discussed in connection with clusters can already be explained by traditional agglomeration theory.

17 However, permanent geographical proximity is especially sought after by SMEs, as big companies can more easily send their employees on longer business trips abroad.

2.2.7 The concept of European metropolitan regions

By nature, the cores of metropolitan regions are densely populated urban areas. The correlation between economic growth and agglomeration in Europe can already be observed during the Industrial Revolution. High economic growth goes along with urbanisation, the emergence of industrial regions and deepening regional disparities (for instance Duranton 1999, Martin/Ottaviano 2001). Consequently Fujita/Thisse (2002) argue that agglomeration can be seen as the spatial counterpart of industrial growth.

An ambitious central objective of the Lisbon Strategy for the European Union – as discussed at the EU Summit 2000 – is the creation of 'the most competitive and dynamic knowledge-based economy in the world, capable of sustained economic growth providing more and better jobs and greater social cohesion' by 2010 (Lisbon European Council 2000). One means to achieve this aim is the creation of European metropolitan regions, considered to be 'the motors of societal, economic, social and cultural development. They are taken for spatial and functional locations whose outstanding functions on an international scale also radiate across the national borders' (Adam et al. 2005: 417).[18] Thus, European Metropolitan Regions are designed to put agglomerations on an international stage.

And in the European Spatial Development Perspective 1999 it is pinned down that a polycentric approach should improve spatial balance in Europe:

> 'The creation of several dynamic zones of global economic integration, well distributed throughout the EU territory and comprising a network of internationally accessible metropolitan regions and their linked hinterland (towns, cities and rural areas of varying sizes), will play a key role' (European Commission 1999: 20).

That is, being based on the idea of Functional Urban Areas in the EU, they comprise not only an urban agglomeration, but also extensive surrounding rural areas – the concept takes into account the space influenced by a city. This radius does not necessarily coincide with political or administrative boundaries, but is characterised by commuter flows, for example, indicating a common labour market.

Within the economic space of a European metropolitan region, economic development typically varies considerably. In a long-term study, Bade (2007) shows that from 1960 to 2006 employment in the West German metropolitan core cities fell by roughly ten per cent, whereas it increased in the surrounding urbanised districts by nearly 60 per cent. Interestingly, it is not the core cities but

18 Translation by the authors.

the peripheral regions which are the winners in structural change. This is true not only for changes in employment but also for GDP growth. Moreover, Bade (2007) presents some evidence that the phenomenon cannot be explained by the well-known suburbanisation process alone. Hence the concept of strengthening metropolitan regions is questionable if it is meant as a highly dynamic core giving momentum to the periphery. It is reasonable only if the whole economic space is considered in order to re-vitalise its interlinkages in a comprehensive and symmetric manner.

Despite the sceptical view of past development as expressed by Bade (2007), metropolitan regions can be seen as focal points in an upcoming knowledge and information society. A wide range of studies shows that the share of research and development as well as the share of highly skilled workers is substantially higher in densely populated regions than in rural areas. Glaeser/Saiz (2004) argue for the causality of high urban productivity and high urban growth rates leading to high skill levels both in cities and metropolitan statistical areas.[19] This triggers a dynamic process since skilled people attract more skilled people. Berry/Glaeser (2005) and Moretti (2004) report an increasing divergence in skill levels for US cities – in their findings 'smart' cities experience a far higher growth in the share of highly skilled workers than agglomerations with a lower initial level of education. According to Südekum (2008), for West Germany these concentration forces are less strong. In contrast to results from the US, he even shows a convergence of skill levels across regions as well as within industries. However, the data from 1977 to 2002 also indicate that regions with a higher initial level of education experience a higher increase of total employment.

Against this economic background stands the creation of European metropolitan regions with their objective to 'maintain the productive capacity and competitiveness of Germany and Europe and help accelerate European integration' (COMMIN). Taking a look at some features of European metropolitan regions, some analogies to the cluster concept are eye-catching.

2.3 The analysis of industrial clusters

2.3.1 Pros and cons of clustering

An extensive debate about the critical aspects of the cluster concept has been sparked by the publications of Porter, and especially by his diamond model of

19 They show that double the number of colleges per capita in 1940 leads to four per cent higher urban growth in the decades between 1970 and 2000.

competitiveness (1990 and ensuing papers, reviving the importance of localisation economies in times of proceeding globalisation). This focus is mainly down to the popularity of the policy-oriented part of his work that has served as the basis for the implementation of regional cluster policies worldwide, from industrialised to developing countries. 'Porter's work met with even greater response than Krugman's, since its implications are not confined to economics. Rather they directly apply to the work of policy makers at the local as well as at the national level' (Torre 2008b: 32). This is also observed by Martin/Sunley (2003) – their critical appraisal of Porter's diamond model of competitiveness found many recipients. They state that a major reason for the success of the concept is the creation of a brand called 'cluster'. It is picking up various ideas of economic geography approaches like industrial districts, innovative milieux, learning regions, regional innovation systems and networks,[20] but applies strongly to practitioners with the aim of enhancing competitiveness and a well-written business strategy.

Martin/Sunley (2003) give a critical survey of the theoretical and analytical base of the cluster concept, the empirical grounds it rests on and the way it is implemented on the practical side. An argument for the popularity of Porter's work is the flexibility of the construct which makes it feasible for a wide spectrum of applications. The authors warn against careless use, as 'the mere popularity of a construct is by no means a guarantee of its profundity' (Martin/Sunley 2003: 7). However, the 'successive refashioning of an already soft concept furthermore allows it to keep up with changing trends and thereby remain 'marketable'' (Torre 2008b: 34).

In this critical context Feser (2008: 196) remarks 'that devising recipes for building clusters according to ideal-types [...] has become a multi-million dollar consulting business.'[21] The confinement to the ideal-type of clusters – 'leading export-oriented industries in selected industrialized countries' (Feser 2008: 196) and the neglect of declining or dying industries – is one aspect in his critical appraisal. And (Feldman/Braunerhjelm 2006: 1 f.) observe: 'Lists of attributes of successful clusters tell us little about how these clusters get started and what differentiates successful clusters from places where investments yield no significant benefits for the local economy'.

Not much is known yet about the evolution of clusters. Their life cycle cannot be compared with the developments of the industry they are associated with (Menzel/Fornahl 2007) and especially their first step and emergence is distinct

20 See for instance Barjak/Meyer (2004) for a detailed discussion about the differences of these concepts.

21 For the scope of Porter's work see also the websites of the 'Institute for Strategy and Competitiveness' (www.isc.hbs.edu) and 'TCI – The Competitiveness Institute' (www.competitiveness.org), on the website described as 'the global practitioners network for competitiveness, clusters and innovation'.

and often only visible in hindsight. (Feldman/Braunerhjelm 2006: 2) argue that 'while mature clusters may look similar, what really matters is the process by which clusters come into existence' and 'some triggering events coupled with an entrepreneurial spark seem necessary in order for industry clusters to emerge and enter a sustainable growth trajectory' (*ibid.:* 3).

(Feser 2008: 198) therefore suggests that not 'building clusters' should be the policy focus but 'leveraging synergies': 'innovation policies should aim to nurture and exploit innovative synergies between interdependent firms and institutions, regardless of whether a discrete spatial cluster emerges as a result'. The point is not to create clusters for the sake of it, but to try and prepare rich soil for cluster prerequisites to grow.

Duranton (2011) argues in the same direction. He asks whether the aim of Porter's diamond – to create and enhance regional competitiveness – is enough motivation for the implementation of an often quite costly policy.[22] His look at the mechanics of clusters unearths major inefficiencies and leads him to conclude that the proposed policies can hardly deal with 'solving a very difficult co-ordination problem and correcting for a number of market failures, which we know very little about' (*ibid.:* 40). Looking at a catalogue of expected benefits of clusters and their methods of estimation shows that even the 'very modest' effects are probably overrated. Both Duranton (2011) and Martin/Sunley (2003) point out that the question of causality between regional growth and geographic concentration has not really been answered yet.

An additional critical aspect concerns the long-run development of regional specialisation. As empirical studies show, the specialisation of regions tends to decline (Kim (1995) for USA, Haas/Südekum (2005) and Möller/Tassinopoulos (2000) for Germany). The measurement concept in these studies is based on conventional industry classifications. However, looking at specialisation not only along intra- but also along intersectoral regional value-added chains the picture may change. In an automotive cluster, for instance, there are producers from the metal, plastics and electronics industries, among others. Standing for many examples, Porter (1998b) identifies a medical technology cluster in Massachusetts (USA) with over 400 companies that was hidden in the statistics due to their highly diverse industry affiliation.[23]

22 Duranton (2011) gives an overview of the complexity of the model, the difficulties resulting from this specification, inefficiencies arising and what is missing.

23 See Möller/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. Included are horizontal, vertical and diagonal interlinkages.

Sölvell (2008: 91) defends Porter's diamond cluster concept and brings to mind the evolution of his groundbreaking publication as being 'offered as tool for scholarly analysis, it became much more used as a tool by policymakers. And policymakers have in many cases, while referring to Professor Porter, used the tool for many other purposes than what was originally thought.' He also clearly distinguishes between the proposed 'evolutionary view of the world' and the widely criticised 'constructive view of the world'. The latter really is prevalent in practical implementation, as a survey of cluster and network managers in Germany underpins (Wrobel/Kiese 2009).

Despite all the critical aspects, it is a matter of fact that cluster development has become a cornerstone of regional economic policy in the last two decades. Empirical studies present overwhelming evidence for the existence of clusters. The practical relevance of the phenomenon cannot be denied. Clusters are dealt with in a wide spectrum ranging from highly formalised models of regional economic theory to practical training units for business development institutions.

One reason for the popularity of clusters might lie in the fuzziness[24] of the concept. Porter's definition given in the introduction leaves open how to exactly interpret 'geographical proximity', 'particular field' or 'various types of externalities'. One could imagine a black box with no sharp outlines, unknown size and unspecific complexity. And this blurry picture is what many definitions have in common.

There is another important caveat with respect to the definition problem. Several authors emphasise the considerable differences between the structures of clusters, be it the variety between countries, regions, technological fields or hierarchical structures (Steinle/Schiele 2002, Guinet 1999). As (Enright 2003: 101) puts it: 'Similar terminology is used for clusters with widely different characteristics. 'Cluster' terminology seems so embedded that one despairs of redefining or sharply defining the term.' This variety should not be neglected in data collection and analysis and hampers the operationalisation of clustering as a workable empirical concept. It seems that a *passepartout* is illusionary.

Sound empirical analysis of the concept therefore requires a proper identification strategy. On taking a closer look, the definitions offer a range of possible topics and approaches. Kiese (2008b) denotes clusters as eclectic concept, combining parts of theories with different perspectives from economics, economic geography, sociology and political science. However, the practical developments worldwide – with cluster policies implemented by cities, counties, districts, regions, nations – are far ahead of their analytical pervasion.

24 Also noted by Martin/Sunley (2003).

2.3.2 Cluster identification methods

An approach for identifying clusters can be based on a characteristic ingredient of the concept, the regional concentration of certain economic activities. In the vast literature on the exploration of the distribution of economic activity in space[25], certain measurement concepts get close to the nature of clusters, both from a top-down and a bottom-up point of view.

As an important example of a top-down approach, the index of geographical concentration as developed by Ellison/Glaeser (1997) must be mentioned. Based on a dartboard method, ibn which companies choose their locations randomly, the authors differentiate between various forms of geographical concentration of employment and control for firm sizes. Geographical concentration may result from single companies running big plants that dominate the regional industry structure, or the (co-)location decision of different companies. The Ellison/Glaeser index allows one to 'compare with more confidence, for example, the concentration of American and European industries, the concentration of high- and low-tech industries, and the changes in levels of concentration over time' (Ellison/Glaeser 1997: 890 f.).[26]

Alecke et al. (2006) apply the Ellison/Glaeser index to German high-tech manufacturing industries in order to examine 'the existence and strength of *localization* economies as opposed to *urbanization* economies which occur *across* industries' (*ibid.*: 22). In this context, they use the notion of 'clusters' for agglomeration patterns of a three-digit industry.

Another top-down method is suggested by Sternberg/Litzenberger (2006) – the 'cluster index'. It avoids problems of arbitrariness coming with the bottom-up approaches and also allows comparability between regions and industries focused on in different studies. The authors combine measures of spatial concentration and spatial specialisation that can be calculated with easily available regional data. When a region exhibits above-average concentration and specialisation in a certain industry, this is not, in their eyes, a sufficient indicator for the existence of a regional cluster. The authors therefore also control for firm size. However, they conclude that the 'cluster index' can capture what is defined as a 'regional cluster' by the European Commission, being the first hierarchical step in cluster identification. To include the linkages between companies and between

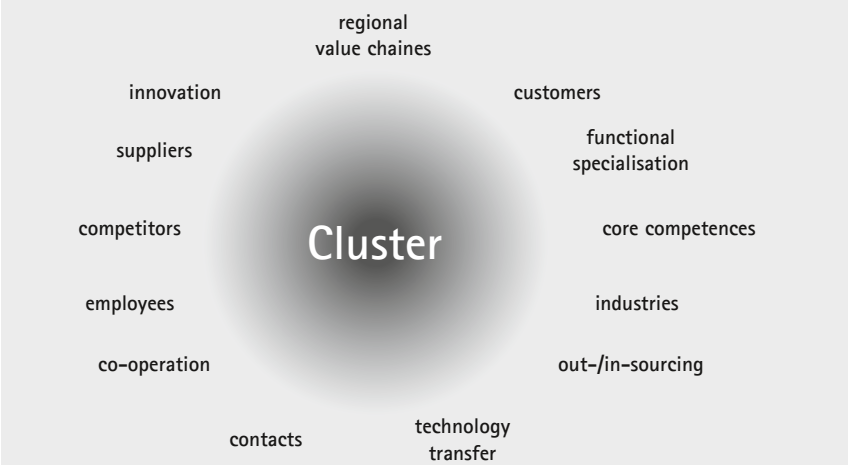
25 Combes/Overman (2004: 2857 ff.) provide a range of criteria for identifying good measures for spatial location of economic activities.

26 An even more general concept for measuring spatial concentration has been developed by Duranton/Overman (2002). Since the data requirement for calculation of the proposed index is high, the concept has rarely been applied in practice yet.

companies and institutions and therefore identify 'regional innovation systems' or 'regional innovation networks'[27], the index has to be complemented with bottom-up methods also focusing on cross-industry structures of value-added chains.

Because of these characteristics, Enright (2003) develops a different approach. He suggests a range of criteria (termed 'cluster dimensions') to provide a useful and applicable classification for various types of clusters. These dimensions cover aspects like geographic scope, density, breadth, depth and stage of development of the clusters. Moreover, characteristics of firms forming the clusters like geographic span of sales, technological activity and innovative capacity as well as ownership structure play a role for classification. The data he uses stem from a survey carried out with cluster experts worldwide, generating 160 detailed descriptions of working clusters. It turns out that they vary widely with respect to all of the dimensions. Nevertheless Enright (2003: 102) argues that the characterisation 'along these dimensions allows one to understand their potentials and problems in ways that can inform policy and strategy.'

Figure 2.1: The complexity of cluster-related aspects



Source: Authors' own illustration.

Unfortunately, most of Enright's cluster dimensions remain fuzzy as well (Möller/ Litzel 2008). The underlying problem is that economic space is the result of a process of formation of business, growth and decline. It reflects economic and political history, regional circumstances like accessibility and market potential, availability of natural resources, artisan traditions, impacts of economic policy etc. Additionally,

27 The authors use the definition by the European Commission.

value-added chains, in which regions are typically specialised, are extremely different in their complexity, and their requirements of technology, skills and logistics. As a result, the structure of every economic space as a conglomerate of all these forces is as idiosyncratic as any organic structure. Figure 2.1 tries to capture the most important aspects of clustering. Again, it becomes clear that the concept with its different approaches is blurry and encircles company-oriented questions.

2.3.3 A methodology for cluster identification

To identify a region's clusters and to encompass different approaches offered by the literature, we developed a methodology[28] to register the value-chain-oriented structures and functional specialisation systematically in an economic space. Cluster-relevant individual firm data were collected and backed by geographical information.

The survey was conducted along the core competencies of individual companies and institutions and their interactions that can be observed on the micro-level. The methodology involves several interconnected elements. To gain a first insight into the economic structures and to identify the leading companies in the region, in-depth interviews with experts from different institutions were conducted. In the following, members of the managing boards of the leading companies were 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 was developed.[29] After this stage, a rough outline of the region's economic system became visible, including first indications about the segments covered by regional competencies as well as about relevant companies and institutions. The extent of cluster-specific geographical space also became clearer. Typically it turns out that cluster regions do not correspond to the areas drawn by administrative borders. If possible, they should therefore be defined by functional considerations.[30]

The interviews give initial information about potential regional clusters, main vertical and horizontal links between companies and diagonal links between firms

28 This section is based largely on Möller/Litzel (2008, 8.3.1). See also Section 1.2.2 of this doctoral thesis.

29 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 2.1. 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.

30 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.

and institutions as well as some strengths and weaknesses of the location. On this basis we conducted a survey of manufacturing and service companies. The questionnaire aims at deepening the cluster-specific information. It contains sections inquiring about customer-supplier relationships and co-operations with partners from within or outside the region, for instance joint projects in human resource development or research and development. Additionally we asked for products and services offered, core competencies, important innovations, firm size, company structure etc.

For the identification of cluster potential in a region we used a set of five criteria in order to check whether fields of functional specialisation can be considered working clusters or, alternatively, 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) and the presence of supporting institutions and network activities.[31]

2.4 Clusters in a European Metropolitan Region: the case of Nuremberg

Our case study builds on a comprehensive enterprise survey for the initial core of the European Metropolitan Region Nuremberg. In this section we first introduce our area of investigation and its geographical position in Central Europe. Second, we describe the database used for analysis. Section 2.4.3 presents some evidence on economic integration in the Nuremberg region. It is indicated by findings on the strength of backward and forward linkages as well as on co-operation behaviour of regional companies within and outside clusters. We then raise the question of whether clustering within a European metropolitan region is relevant for economic integration on the regional, national and supra-national level.

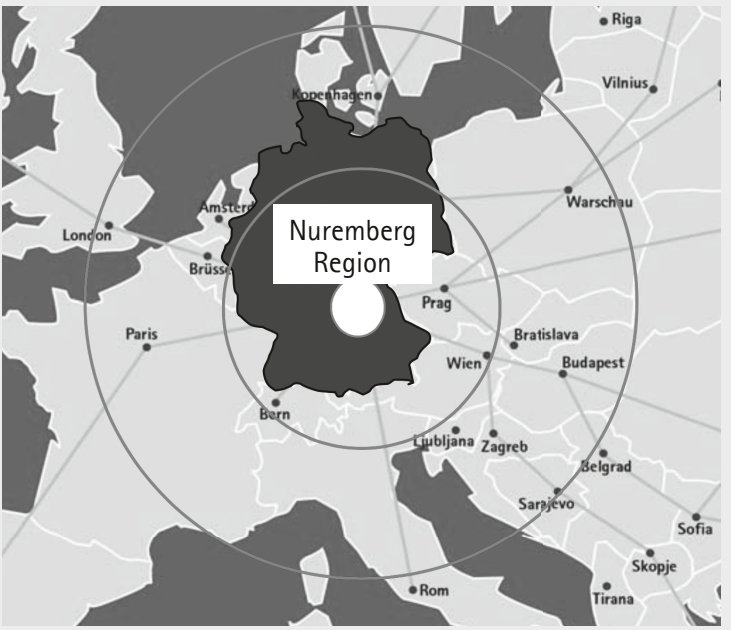
2.4.1 The European Metropolitan Region Nuremberg

In the European Spatial Development Perspective (ESDP), the European Commission puts focus on the relevance of 'gateway cities' for regional development. The concept encompasses regions 'which provide access to the territory of the EU (large sea ports, intercontinental airports, trade fair and exhibition cities, cultural centres)' (European Commission 1999: 22). As for Nuremberg, three

31 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 2.4.2).

Trans-European Networks intersect, two Pan-European Corridors start[32] and the region provides several infrastructure facilities like an international airport, a cargo transport centre and one of the world's 15 largest exhibition centres[33]. In addition, the concept applies to 'metropolitan regions located on the periphery, which can use specific advantages, such as low labour costs or special links with economic centres outside Europe or neighbouring non-Member States' (European Commission 1999: 22). The Nuremberg region is about 100 kilometres away from the border to the Czech Republic and has strong historic links especially to its capital Prague. Against this background, Nuremberg was designated as 'Gateway to Eastern Europe' by the European Union in 1997.[34] Figure 2.2 depicts the geographic position of the Nuremberg region in Central Europe.

Figure 2.2: Geographic position of the Nuremberg region in Europe



Source: IHK (2007: 41).

32 Railway axis TEN 1, inland water axis TEN 18, railway axis TEN 22, corridors IV and VII (see e.g. IHK 2007).

33 See http://www.nuernbergmesse.de/en/company/.

34 The second German 'Gateway to Eastern Europe' is Dresden. In 2007 a workgroup of the German Federal Ministry of Transport, Building and Urban Affairs proposed a new guideline for further development of the Czech-German border region. The underlying idea is that the existing Euregiones in the sparsely populated border region are of too small scale to initiate efficient cross-border co-operation. Thus they introduce the so-called 'Central European Crystal', a planning region spanning between the European Metropolitan Regions Prague (CZ), Munich (D), Nuremberg (D), Saxon Triangle (D) and Wrozław (PL).

For the Nuremberg region, this proved to be an important step in becoming a European metropolitan region. In the 1990s a joint regional steering committee[35] developed a long-term strategic concept in a discursive and mutual collective learning process. The aim was to shape the national and international profile of the agglomeration explicitly – being one of 30 top economic regions in Europe and among the ten strongest technology regions in Germany[36] – in the competition between economic locations.

For two decades a massive structural change took place in and around Nuremberg. Traditional industries like metal and electrical industry switched importance with services. 'The proportion of industrial employees fell from 61 per cent to 39 per cent, whilst the proportion of service employees rose from 38 per cent to 61 per cent' (Heidenreich 2005: 746).[37] In a certain sense the economic space of Nuremberg had to reinvent itself after deindustrialisation with tertiarisation. According to Glaeser/Saiz (2004), adjusting the skill level is an important factor for regions that experienced negative external shocks. To face the challenges of structural change, to support the regional labour market and to strengthen existing potentials with global growth potential the joint strategy referring to cluster concepts was implemented.

A central feature in the development of a strategic concept is the Master Concept of Development (*Entwicklungsleitbild*) that was first passed in 1998 and then updated in 2005.[38] Taking into account existing network partners and interested companies it identified regional so-called 'fields of competence', that is clusters. These were to be organised in 'competence initiatives' – different kinds of organisations managing cluster activities to an individual extent.[39] The strategies pinned down in the Master Concept of Development are designed for the long run and are thoroughly implemented. In addition, it helped to focus the region's governance structure and also to set up a joint regional marketing association.

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35 Partners on the long run are the regional Chamber of Commerce and Industry, the regional Chamber of Crafts, unions, universities and universities of applied sciences, the district government of Central Franconia, and all cities and counties in Central Franconia plus adjacent counties. Financial support for projects in this framework is provided by the Federal State of Bavaria, the Federal Republic of Germany and the European Union.

36 See for instance IHK (2007), where a benchmark of all eleven European metropolitan regions (EMRs) and 16 agglomerations in Germany is provided. Egeln et al. (2006) compare the potential for endogenous growth of 15 European metropolitan regions. The choice of EMRs to benchmark the EMR Rhine-Neckar represents poly- and monocentric regions in Germany and other member states and includes EMR Nuremberg.

37 Also see IHK (2005a) and Stadt Nürnberg (2003) (both in German language).

38 The Master Concept was developed under the lead of the Nuremberg Chamber of Commerce and Industry and the City of Nuremberg with scientific co-operation by Prognos AG.

39 See Neumann (1996); Stadt Nürnberg (2003); Entwicklungsleitbild (2005) for information on the development and implementation of the process (in German language).

To start with, cluster management activities were implemented in five fields of competence.[40] Consequently, the performance of the region in international rankings climbed several positions and resulted in its admission as a European metropolitan region in 2005 – the eleventh in Germany. Figure 2.3 indicates the both the area under investigation as the 'core' of the European Metropolitan Region Nuremberg and its size in 2008. It was geographically extending ever since.

Nuremberg is the dominant city, where roughly one quarter of the population is living, but where 37 per cent of employees subject to social security are working and where about 37 per cent of the region's GDP is generated. In addition, 37 per cent of the unemployed are registered in the city of Nuremberg.[41] Concerning skill structure, the region under consideration roughly follows the West German pattern, e.g. the national share of highly skilled graduated employees is 8.7 per cent, compared to 9 per cent in the core of the European Metropolitan Region Nuremberg. Outstanding is the city of Erlangen with 25 per cent of employees holding a degree. The reason for this lies in the concentration of employers like the University Erlangen-Nuremberg[42], 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 per cent) is also considerably higher than in the national average (12.9 per cent).

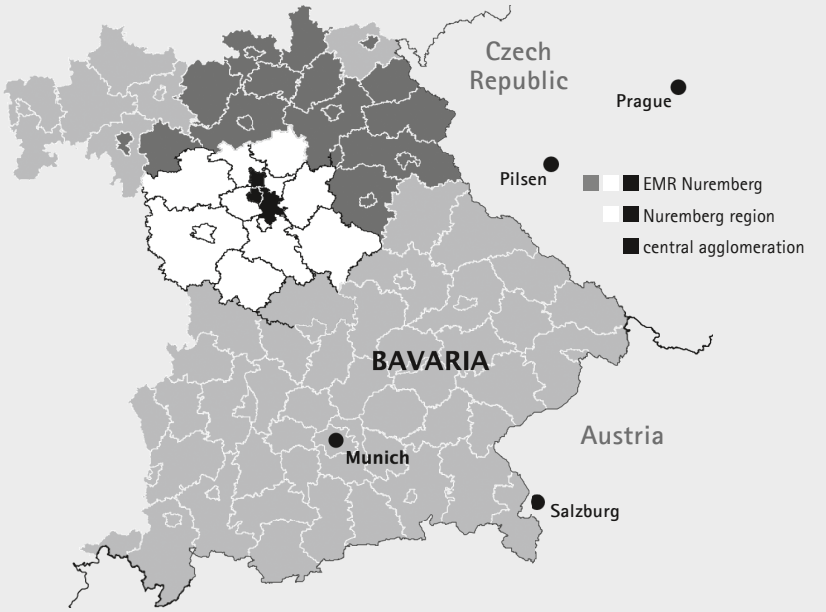
Within the Nuremberg Metropolitan Region the cultural interconnections and economic integration are strong, as can be seen, for example, by the intra- and interregional commuting patterns focused on the agglomeration, by the double-location of the University Erlangen-Nuremberg and the distribution of headquarters in the cities and related production sites in the outskirts. Some of the biggest industrial employers with headquarters in the Nuremberg Region have more employees outside than in the region, indicating a strong international economic integration.

40 These five fields of competence are Transport and Logistics, Information and Communication, Medicine and Health, Energy and Environment and New Materials. In 2005, the sixth field, Automation and Production Technology, was started. A range of subclusters focuses, on certain aspects of the individual competence initiatives. To take account of the dominant production-related service industry with national and international importance the field of Innovative Services was also named as a regional core competence with strong potential for future growth.

41 Data source for this section: Bavarian State Office for Statistics and Data Processing and the statistical information offered by the Federal Employment Agency (BA).

42 The University Erlangen-Nuremberg in 2008/2009 has around 26,000 students and 12,000 employees (45 per cent of which are affiliated with the clinical centre) (www.uni-erlangen.de).

Figure 2.3: The Federal State of Bavaria and the Nuremberg region



Notes: The graph depicts the Federal State of Bavaria (light grey), the entire European Metropolitan Region (EMR) Nuremberg in 2008 (dark grey, white and black – 21 counties, 12 cities, roughly 3.5 million inhabitants) and the area in the focus of the study, the Nuremberg region coloured in white and black. This corresponds to the former 'core of the EMR Nuremberg' as the Bavarian district of Central Franconia and the two adjacent counties Forchheim (in Upper Franconia) and Neumarkt (part of Upper Palatinate). After 2005 the EMR is growing as additional nearby counties join. The region with its nearly two million inhabitants is characterised by the triangle of the cities Nuremberg-Fürth-Erlangen (coloured black). This agglomeration is surrounded by counties with high population and industry density, the counties further away are rural areas.

As for the impact of European integration on the Nuremberg Metropolitan Region, Heidenreich (2005: 743), referring to the massive deindustrialisation and tertiarisation process after 1970, states:

> 'The economic difficulties of the Nuremberg region, however, were the result of the economic liberalisation in Europe after the creation of the Common Market and the economic integration of eastern and western Europe. Many of the traditional electro-technical and mechanical engineering companies of the region either closed down or outsourced a considerable part of their production tasks abroad.'

However, according to a survey of export-oriented companies in Central Franconia[43], in 2005 10 per cent plan investment or production in the new member states, roughly 40 per cent have intense contact and only 13 per cent

43 The quoted survey was conducted by the Nuremberg Chamber of Commerce and Industry (IHK 2005b), the feedback was 204 questionnaires.

of them feared negative effects of the 2004 EU-enlargement. It seems that after the process of deep structural change, the Nuremberg region has found its new position in the highly integrated economic space in Central Europe. This might be due to favourable conditions of the location including human resources and soft factors, combined with a coherent regional cluster strategy.

To analyse whether clustering is relevant for economic integration on the regional, national and supra-national level, we refer to a detailed regional establishment survey.

2.4.2 Database

In the following we use data collected in the research project at the Institute for Employment Research (IAB) 'Clusters and Inter-Firm Networks in the Nuremberg Region'. In late 2005 and early 2006 in-depth expert interviews have been conducted with experts of regional economic structures and with company representatives. The information obtained formed the basis for an establishment survey in the second half of 2006 and a follow-up survey in early 2007. See Figure 2.3 for a depiction of the area under investigation – the district of Central Franconia plus the two adjacent counties. The detailed questionnaire covered the range of topics illustrated in Figure 2.1 and thus the survey contains detailed information not only about the companies and institutions forming the clusters and their products, services, size, age etc., but also about customer-supplier-relationships and co-operations.[44]

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 per cent). The sample represents roughly 88,000 employees, or again a little more than 10 per cent of all dependent workers.[45]

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44 Information was also collected to build the web-based cluster-oriented regional information system CORIS, available under http://www.coris.eu (in German language).

45 We apply the data described above to a set of five criteria. It is used to check whether fields of specialisation can be considered working clusters or, alternatively, value systems 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 (see Möller/Litzel (2008, Section 8.3.1) for a description of the application of the methodology to data from Eastern Bavaria.)
For the Nuremberg region, the eight value chains we identified as clusters operate in medical technology & health, automotive, logistics & transport technology, information technology & communication services, plastics industry, specialised automation, electronics and environmental technology & energy. Clearly 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.

2.4.3 Evidence on the Nuremberg region's economic integration

One central aim of the creation of Metropolitan Regions is to foster intra-regional integration to strengthen its economic performance – but this does not imply that a Metropolitan Region's economy is encapsulating itself. The same accounts for regional clusters where outside linkages and contacts are of vital importance. In this context, we take a closer look on the backward and forward linkages as well as on co-operation behaviour of regional companies within and outside clusters.

For the background it is important to be informed about the companies' awareness of being part of a cluster.[46] In our survey, 14.9 per cent state to be active members of at least one cluster in the Nuremberg region and 8.6 per cent of a supra-regional cluster. In addition, 24.1 per cent of the companies classify themselves as potential members of a regional and 20.2 per cent of a supra-regional cluster. In the following, we add the active and potential members to form the group of 'cluster affiliates' and contrast them with non-cluster companies.

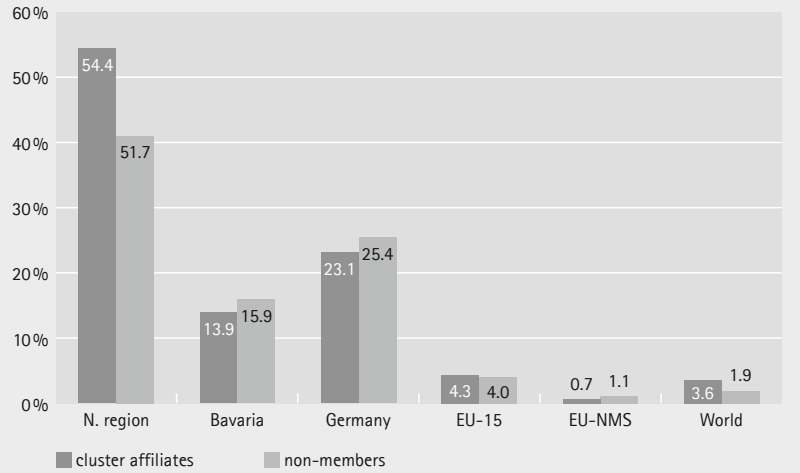
As for the forward linkages, we asked the companies in the survey where their three most important customers are located (Figure 2.4). With 54.4 per cent for cluster affiliated companies and 51.7 per cent for non-members stating to have their three most important customers located here, both groups indicate that for them the Nuremberg region is a major market.[47] By contrast, the rest of Bavaria appears less important with 13.9 and 15.9 per cent respectively and the share of companies where the most important customers are located outside Germany is around 4 per cent. Interestingly, the respective share of the new EU member states is more or less negligible. Taken together, the strongest forward linkages are found within the Nuremberg region in more than 50 per cent of the cases, in nearly 70 per cent within Bavaria (excluding the region under consideration) and in more than 90 per cent within Germany (excluding Bavaria).

Figure 2.5 gives an impression of the strength of the backward linkages. It turns out that the geographical scope of the most important suppliers is a little higher than that of the most important customers. Nevertheless, nearly 50 per cent of the cluster affiliates state that the most important suppliers are located within the Nuremberg region, whereas this is the case for 43 per cent of the non-cluster members only. For both groups, Germany (excluding Bavaria) is on the second

46 In the questionnaire we gave a brief definition of a cluster as a localised network of companies and supporting institutions in a specialised field of production or services, possibly spreading to several industries.

47 Not depicted here are the results for the most important customer only, the result being 63.6 per cent for cluster members and 57.3 for non-members.

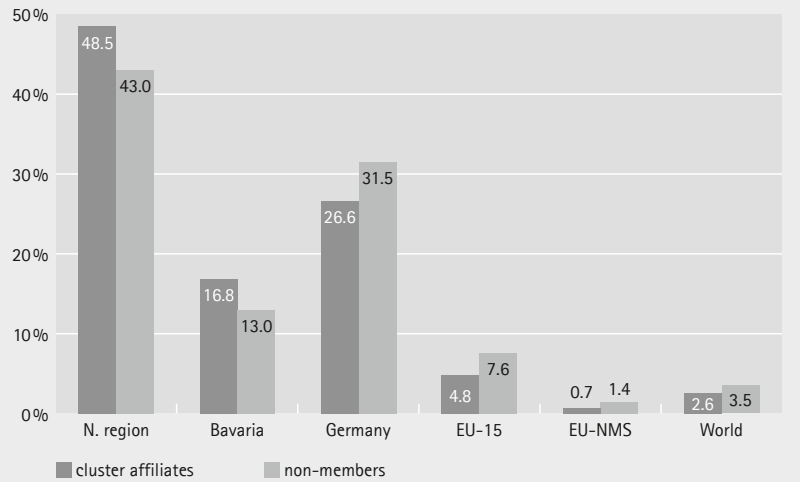
Figure 2.4: Location of three most important customers



Cumulated answers to the question: 'Please name the location of your three most important customers' by affiliation with regional clusters.
Notes: Results for the most important, second and third most important customers were added.
N (cluster affiliates) = 886, N (non-members) = 1,177. The differences between cluster affiliates and non-members are significant at the 10 per cent level according to a χ^2-test.

Source: Establishment survey 2006/2007, Nuremberg region.

Figure 2.5: Location of three most important suppliers



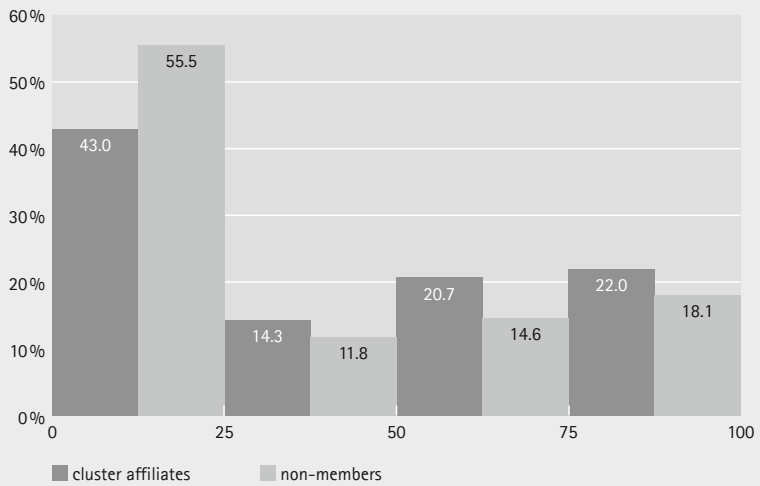
Cumulated answers to the question: 'Please name the location of your three most important suppliers' by affiliation with regional clusters.
Notes: Results for the most important, second and third most important suppliers were added.
N (cluster affiliates) = 730, N (non-members) = 993. The differences between cluster affiliates and non-members are significant at the 1 per cent level according to a χ^2-test.

Source: Establishment survey 2006/2007, Nuremberg region.

most important position. Again there is no evidence that cross-border linkages to the new EU member states are of paramount importance. The importance of local suppliers and customers is remarkable. Checking for the quantitative side of forward and backward linkages, we first look at the total share of inputs from the local market and second on the share of turnover respectively.

The histogram in Figure 2.6 shows that cluster affiliates are more regionally oriented than non-members. 22 per cent of all regional cluster affiliates buy between 75 and 100 per cent of their inputs in the Nuremberg region, whereas roughly 18 per cent of non-members are sourcing regionally. In the lowest quartile, indicating a share of less than a quarter of all inputs, the difference is more striking: for 55.5 per cent of non-members of regional clusters the local market is of minor importance, the corresponding value-added for cluster affiliates is 43 per cent.[48]

Figure 2.6: Shares of inputs from the Nuremberg region



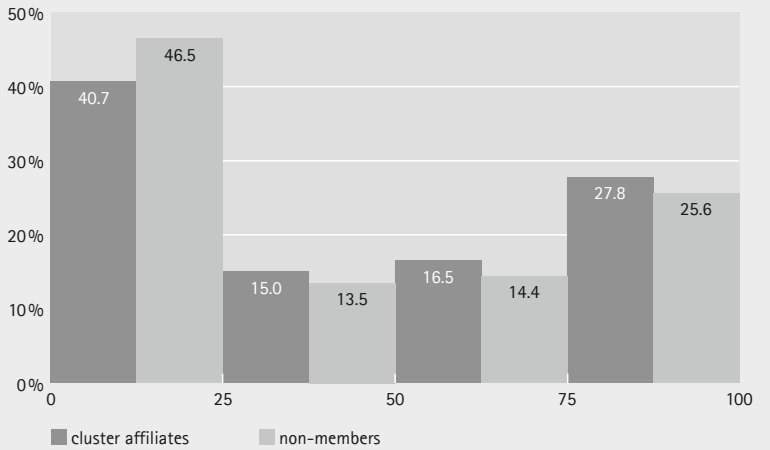
Distribution of shares of inputs from the Nuremberg region by cluster affiliation.
Notes: N (cluster affiliates) = 314, N (non-members) = 431.
Means of cluster affiliates and non-members are equal (significant at the 1 per cent level according to a two-sample t-test allowing for unequal variances).

Source: Establishment survey 2006/2007, Nuremberg region.

48 As for the number of firms weighted with the number of employees the picture changes markedly. 12.5 per cent of all cluster affiliates and 8.4 per cent of non-members get their inputs mainly from the Nuremberg region (4th quartile), still indicating a stronger local focus of cluster affiliates, but both values are smaller than in the unweighted case. However, the weighted share of companies that use less than 25 per cent of regional inputs is 68 and 66.8 per cent respectively. These differences make visible the sourcing strategies of big companies versus small and medium-sized firms. For the latter, international supply is less important.

Figure 2.7 shows again that cluster affiliates are more regionally oriented than non-members, now referring to the demand side. However, turnover shares are more evenly distributed than inputs. 27.8 per cent of cluster affiliates generate more than three quarters of their turnover in the Nuremberg region and 40.7 per cent less than a quarter. For non-members the corresponding shares are 25.6 and 46.5 per cent.[49]

Figure 2.7: Turnover generated in the Nuremberg region



Distribution of shares of turnover generated in the Nuremberg region by cluster affiliation.
Notes: N (cluster affiliates) = 334, N (non-members) = 473.
Means of cluster affiliates and non-members are equal (significant at the 10 per cent level according to a two-sample t-test allowing for unequal variances).

Source: Establishment survey 2006/2007, Nuremberg region.

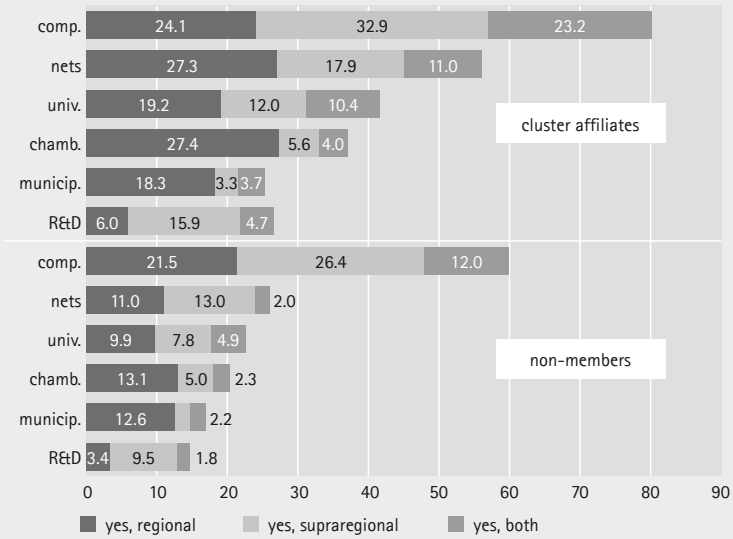
Together with backward and forward linkages, co-operation activities are another vital aspect of regional economic integration. As is to be expected, the co-operation behaviour of cluster affiliates is more developed than in other companies. This is clearly visible in Figure 2.8 – contacts to all different groups of co-operation partners are more developed for cluster affiliates.

The literature suggests that in cluster regions companies co-operate more frequently on the regional level than with partners from outside the region. Our data shows that for co-operation with other companies 24.1 per cent of cluster affiliates rely on regional partners only, whereas 32.9 per cent choose partners from outside the region. 23.2 per cent co-operate both intra- and inter-regionally.

49 The weighted results are again different: 13.2 per cent of cluster affiliates and 9.7 per cent of non-members have more than three quarters of their sales in the Nuremberg region (4th quartile). As for the weighted share of companies that generate less than 25 per cent of their turnover regionally is 77.2 and 69 per cent respectively. Also for the demand side the sales strategies of big companies indicate a much stronger supra-regional focus.

Also non-members have a stronger focus on co-operation partners from outside. For cluster affiliates, just 6 per cent find their research and development partners within the Nuremberg region only, the share of firms with only outside co-operations is 2.5 times as high. However, taking a look at co-operation with universities renders a different picture: local bonds are dominant here.

Figure 2.8: Co-operation with different partners



Answers to the question: 'Has your establishment already co-operated with the following partners?'

Notes: The differences between cluster affiliates and non-members are significant at the 1 per cent level for all items, apart from item 'municipalities' that is significant at the 10 per cent level according to a χ^2-test.

Source: Establishment survey 2006/2007, Nuremberg region.

Concerning joint activities with locally oriented partners like chambers of commerce and industry, chambers of crafts and municipalities, the regional shares are certainly higher than the supra-regional one. Only few address both regional and supra-regional institutions.

To summarise our empirical results we find that both backward and forward linkages within the selected region are remarkably strong. In general this holds for all firms irrespective whether they classify themselves as affiliated to a cluster or not. However, cluster affiliates rely even more on partner firms located within the Nuremberg Region. The difference is statistically highly significant for suppliers, but less so for customers.

A striking fact is the important role that regional co-operation activities play for the firms in our sample. This holds not only for inter-company relationships, but also for various forms of exchange with other partner like universities, research

institutes or other business supporting institutions. Again, the extent to which firms interact is significantly more developed for those who report a high degree of cluster awareness.

2.5 Résumé and perspectives

Our survey highlights the fact that economic integration should not be restricted to the aspect of cross-border integration but should also consider the higher intensity of intra-regional relationship between business partners as well as between firms and supporting institutions. In so far, developing regional and local ties can be seen as a means to increase economic fitness of local firms. Industrial clusters play an important role in this context.

Our case study covers the Nuremberg region, the core of the European Metropolitan Region Nuremberg. The concept of metropolitan regions is intended to foster intra-regional co-operation of various forms by introducing suitable governance structures. In addition, investment in the local transport infrastructure extends the relevant local economic area. At the same time the awareness of a common economic space can be developed.

Despite the strong ties to regional partners, cluster activities should not be understood as encapsulation of the economic space. Typically intra-regional co-operation is complemented with business relations and contacts to external partners. Being strongly involved in regional activities does by no means exclude intensive contacts to outside partners. In so far as clustering strengthens the affiliated firms, they can be expected to be better prepared for inter-regional competition. Although our example region is neighboured by low-wage areas, it seems that fears concerning possible job transfers are groundless. In our survey the trading partners in the new EU member states do not play a major role neither for sales nor for supply. Geographical proximity, fruitful co-operation and knowledge spillovers might outweigh possible cost savings through offshoring.

Our general conclusion is that localisation as a form of intra-regional integration does not contradict a more intensive supra-regional or international integration. To the contrary, both can be seen as being complementary to each other.

3 Who with whom – co-operation activities in a cluster region

Joint with Lutz Eigenhüller and Stefan Fuchs

Abstract

This study examines the effect of establishment and cluster characteristics on different co-operation partners in one particular region. Based on a survey in the Nuremberg region in Germany, we estimate a multivariate probit model and confirm other studies, in particular regarding co-operation with R&D institutions. Establishments in the service sector are especially likely to co-operate with local initiatives and networks, a type of co-operation that functional cluster affiliation has no effect on. Co-operation with local authorities is of interest only if establishments are affiliated with a cluster that is of importance to regional policy. Establishments that consider themselves cluster members are particularly likely to co-operate.

JEL classification: R12, R38, R58, O18

Keywords: Regional clustering, cluster identification, co-operation

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3.1 Introduction

Co-operation is essential in firms' economic behaviour (Fritsch 2003, Richardson 1972). It is also indispensable in the formation and performance of regional clusters. Most co-operation-related studies focus on the extent and effects of research and development (R&D) co-operation, mainly with regard to innovation as a specific outcome (Broekel 2012, Chun/Mun 2012, Belderbos et al. 2004, Beaudry/Breschi 2003, Tether 2002; see also the results of the European Regional Innovation Survey ERIS: Fritsch 2003, Sternberg/Arndt 2001). Often the emphasis is on the study of the evolution, nature and ends of firms' co-operation behaviour in general but with disregard for regional aspects (Fontana et al. 2006, Tether 2002, Bayona et al. 2001). Some research on regional clusters encompasses co-operation, being one central cluster feature. These studies address, for instance, the question of the extent to which co-operation of cluster firms takes place within or outside the cluster region (Torre 2008a, Bell 2005, Fritsch 2001), or their focus is on co-operation activities in clusters in the same industry in different regions with the aim of analysing the importance of regional specifics for co-operation (Hendry/Brown 2006, Giuliani 2005, van den Berg et al. 2001). These questions are also often the focus of studies that deal with co-operation in the context of other concepts of regional development like regional innovation systems or networks (Fritsch/Graf 2011, Àlvarez et al. 2009, Gallié 2008). Surprisingly little is known, however, about what factors at the establishment level affect one form of co-operation rather than another, and how different types of co-operation are influenced by cluster affiliation and filtered through specific regional contexts.

Against this background, the contribution of this paper is twofold. First, we examine the effect of establishment *and* cluster characteristics on *different* co-operation partners. We believe that in order to gain a better understanding of firms' regional co-operation activities it is important to move beyond the general discussion of determinants of co-operation and to examine in detail how establishment and cluster characteristics are associated with different types of co-operation. In line with the mainstream of regional cluster and network studies, in this paper we analyse co-operation between establishments as well as between establishments and universities and other R&D institutions. We extend the view on co-operation by also examining establishments' co-operation with regional institutions, initiatives and networks involved in regional co-operation.[1] This is of particular importance for cluster policy because it is based on the implicit

1 Based on evidence from interviews with experts prior to the survey, we decided to treat 'initiatives' and 'networks' jointly in our analysis.

assumption that clustering per se leads to more co-operation (Feser et al. 2008, Brenner/Mühlig 2007; Boschma 2005 for a critical discussion).

Second, we examine co-operation in *one particular region* and build on a unique and comprehensive establishment survey in the Nuremberg region in the south of Germany. This allows us to frame the effects of establishment and cluster characteristics on different co-operation activities in their regional context. In the early 1990s, for example, Nuremberg was one of the first regions in Germany to apply regional cluster policy in the aftermath of massive structural change (Kiese 2012, Sternberg et al. 2010, Heidenreich 2005). Thus, establishments' co-operation activities can be expected to be embedded in developed institutional structures that in turn may have an effect on the different types of co-operation examined in this study.

We show that functional cluster affiliation of an establishment based on industry affiliation, products and core competencies has no significant influence on the overall propensity to co-operate. For different types of co-operation, however, cluster affiliation makes a difference. Being affiliated with the cluster 'Medical Technology & Health', for example, increases the propensity of establishments to co-operate with both universities and research institutes. This cluster is also a traditional economic feature of the city of Erlangen in the Nuremberg region that is headed by a large German company and a university that has specialised in the field. Being affiliated with either 'Information Technology & Communication Services' or 'Logistics & Transport Technology' has a positive effect on co-operation with other establishments. We also find that establishments that are 'cluster aware', i.e. that see themselves as cluster members, are particularly likely to co-operate. This should be of concern above all to regional economic policy where there is an interest in cluster creation. It lends support to the notion that for a successful policy to encourage co-operation, it is conducive to raise or strengthen cluster awareness.

The remainder of the paper is organised as follows. In Section 3.2 we review the relevant literature on the determinants of co-operation. Section 3.3 describes the Nuremberg region as the economic space under analysis and our method of cluster identification. In Chapter 3.4 we introduce variables and the estimation method. Section 3.5 contains the models on co-operation and a discussion of the results. Section 3.6 concludes.

3.2 Determinants of co-operation

To understand the drivers of co-operation is of paramount importance to regional science and economic policy – and to cluster policy in particular. Research shows that considerable rewards are to be earned from successful co-operation, for

example in the form of shared resources and knowledge spillovers that trigger economic and employment growth (Schröder 2013, Malecki 2010, Oerlemans et al. 2001) and have become more important in the last three decades (Gordon/McCann 2005, Cantner/Graf 2004, Rosenthal/Strange 2004, Rosenfeld 1996, Freeman 1994). At the same time, following the seminal work of Porter (1990), who defined clusters as 'geographic concentrations of interconnected companies, specialized suppliers, service providers, companies in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also co-operate' (Porter 2000: 15), regional policy has increasingly focused on co-operation in the evolution and strategic management of regional clusters.[2]

In the following, we discuss determinants of different types of regional co-operation at the establishment and cluster level. Rather than drawing on co-operation in general, and on the theory and evidence that supports it, we organise this chapter with regard to three specific co-operation channels: (a) other establishments, (b) universities and other research institutions and (c) regional institutions, i.e. the administration of municipalities, regional initiatives/networks, chambers of crafts and chambers of industry and commerce.

3.2.1 Co-operation between firms

Linkages between establishments in a region are numerous and manifold. Among the factors influencing the extent of co-operation are size and age, industry or sector and cluster affiliation.[3]

Firm Size

Larger companies *per se* are more active economically than smaller ones so they also have a higher propensity to co-operate (Belderbos et al. 2004, Hauschild/Wallacher 2004, Miotti/Sachwald 2003, Tether 2002, Fritsch 2003, 2001, Bayona et al. 2001, Fritsch/Lukas 2001). Co-operation activities require financial resources, personnel and time – factors small companies might be short of (Fontana et al. 2006, Bathelt et al. 2004, Rosenfeld 1996; Veugelers/Cassiman 2005 for R&D partners), but for smaller companies joint projects and co-operation can provide good opportunities

2 Cluster policy has been criticised for the naïve transfer of the concept into practice and for the lack of serious empirical testing as to its success (Maier/Trippl 2012, Kiese/Wrobel 2011, Taylor 2010, Benneworth/Henry 2004, Simmie 2004, Martin/Sunley 2003, Malmberg/Maskell 2002). For an overview of how competitive and successful different cluster implementations are, see Porter's Cluster Mapping Project (http://www.clustermapping.us). The INNOVA Cluster Mapping Project collects framework data for European regions and organisations (http://www.clusterobservatory.eu).

3 We limit our discussion to establishment characteristics that we consider of importance to different types of co-operation. Other factors are part of the cluster identification strategy and are discussed in Subsection 3.3.2.

for knowledge generation and cost sharing, to expand resources and production capacities, generate access to new markets and reduce risk in innovation (Chun/Mun 2012, Kingsley/Malecki 2004, Miotti/Sachwald 2003, Tether 2002, Camagni/Capello 2000, Sakakibara 1997). We expect the propensity to co-operate to increase with establishment size.

Firm Age

Regarding the effects of company age on co-operation activity, the literature provides mixed results. Some studies find positive effects (Hendry/Brown 2006, Zimmermann 2004), while other studies find no significant influence (Sacchetti 2009, Boschma/ter Wal 2007, Fritsch/Lukas (2001) for local and international co-operation) or observe an inverted U-shape concerning the relation between age and co-operation (e.g. Oliver (2001) for the first eleven years of biotech companies). In theory, older companies should be more established, have a better reputation and more knowledge about potential partners than newly founded ones. Like small enterprises, young or new companies can have trouble in finding a co-operation partner because of a lack of reputation. However, younger companies might also co-operate intensively to build reputation, strengthen their market position and deal with more complex orders. Younger firms may be mainly orientted towards local partners while older ones are more often part of larger entities and therefore more externally oriented (Hendry/Brown 2006). In our model, we check which position is confirmed by our data.

Industry Affiliation

A considerable share of the literature deals with industry affiliation as a potential factor for co-operation. Some studies focus on one industry in one or in several regions (Matuschewski 2006, Grotz/Braun 1997). Other studies look at different industries (Veugelers/Cassiman 2005) or industry subgroups (Sacchetti 2009, Fontana et al. 2006, Miotti/Sachwald 2003, Fritsch 2001, Fritsch/Lukas 2001). For co-operation with other companies some studies suggest that the propensity to co-operate might be higher for service providers (Belderbos et al. 2004). However, in the Cambridge region Keeble et al. (1999) reveal a higher share of innovative small and medium-sized manufacturing enterprises co-operating with other companies than with high-tech service providers. Matuschewski's (2006) findings are limited to the IT sector, where she describes a high share of co-operation. Hauschild/Wallacher (2004) show that a broader range of business-related service companies are by far the most co-operative ones, followed by producers in manufacturing. Based on this evidence we can expect different results for the different co-operation partners. Overall we assume that establishments in manufacturing co-operate less frequently than service providers. When establishments are affiliated both with services and

manufacturing, they can be expected to 'insource' the business services they need and find it less attractive to co-operate with other companies.

Cluster Affiliation

Cluster affiliation should increase the propensity of firms to co-operate in general. Following Bathelt et al. (2004), this could happen on a local level through the 'buzz' within clusters that generates a common basis for co-operation. Beyond the local level, firms' access to 'global pipelines' via clusters is another channel to create new knowledge via co-operation. Cluster affiliation should also capture the effect of technological relatedness on the choice of co-operation partners (Cantner/Meder 2007) regarding firms' resources, products and the qualifications and occupations of their employees.

A significant difference may emerge between establishments that are aware of existing cluster structures in their region and those that are not. The former are seen to be more open for co-operation: they are expected to be better informed about the potential rewards of co-operation, therefore are more interested in exchanging knowledge with other actors (both acquiring and disclosing), so they invest more resources in finding out about opportunities for co-operation. Establishments that are cluster aware are expected to be more interested in co-operation.

Differences between clusters may also influence both the likelihood and intensity of co-operation. Some firms and industries have more tendency to cluster than others (Steinle/Schiele 2002). By default we expect establishments that are members of clusters anchored in the service sector, e.g. in logistics or IT, to be more likely to co-operate than establishments of production-oriented clusters. Since services with relevance for clusters are often customer-specific and business-related, they require more coordination with partners. This should be conducive to co-operation, as the services are tailored to the needs of manufacturing. These needs can be brought forth through knowledge spillovers from informal co-operation.

3.2.2 Co-operation with universities and research institutes

Co-operation with universities and non-university research institutes is important for both the success of companies and regional growth (Fontana et al. 2006, Hall et al. 2003). Academics and research institutions are a major source of knowledge and a prominent location factor (Abel/Deitz 2012, Anselin et al. 1997, Jaffe 1989; Goldstein 2009 for an overview). They contribute to the clustering of innovative industry activities where knowledge spillovers are important (Ponds et al. 2010, Brenner/Mühlig 2007).

The extent and effects of R&D co-operation, mainly with regard to innovation as a specific outcome, are well documented (Chun/Mun 2012, Tether 2002). To be able to use this knowledge coming from external sources in the best possible way for the company, its absorptive capacity has to be considered (Cohen/Levinthal 1990; Lane et al. 2006 for an overview). One precondition is intra-firm R&D activity: Miotti/Sachwald (2003) discover positive effects of continuous R&D on co-operation with research institutions. Belderbos et al. (2004) show a positive effect of R&D intensity on co-operation. This effect is strong for vertical and institutional co-operation and weaker for horizontal co-operation. Companies with an R&D department were found to be more active in formal co-operation activities with customers and suppliers than in informal ones (Bönte/Keilbach 2005). Given the results of existing studies (Saito/Gopinath 2010, Fontana et al. 2006, Veugelers/Cassiman 2005, Fritsch/Lukas 2001) we expect a positive effect of absorptive capacity on co-operation with universities and research institutes.

Being a firm in a high-tech cluster has also been found to have a positive effect on its propensity to co-operate with universities and research institutions (Sacchetti 2009, Miotti/Sachwald 2003, Hagedoorn 2002). The same holds true for high-tech industries where one particular co-operation outcome is the local start-up rate (Feser et al. 2008). Thus, we expect a higher propensity of establishments in these clusters and industries to co-operate with research institutes and universities.

3.2.3 Co-operation with regional institutions

Local networks and initiatives

The presence of local institutions that provide 'bridging as well as bonding ties' drives regional networking, co-operation and innovation (Maenning/Ölschläger 2011: 444) and mirrors an environment with established structures of co-operation between firms and regional institutions. The focus of local networks and initiatives is the management of relations and the distribution of information through networking. Initiatives of this kind are often voluntary associations that publish newsletters, organise meetings and workshops for their members or represent them at business fairs. We expect a positive effect of these associations on co-operation for establishments in the respective industries, especially with members of these associations. The propensity of establishments to co-operate with initiatives/networks could also be boosted by cluster affiliation if they specifically address firms from a cluster.

Chambers of crafts and chambers of industry and commerce

Chambers of crafts and chambers of industry and commerce are national associations with regional divisions. Membership is compulsory for all firms. Chambers represent the interests of all firms in a particular region and provide their members with a variety of services, also as intermediaries in regional R&D co-operation (Cantner et al. 2011). Chambers of industry and commerce gather all firms involved in trade, services and the production of goods, chambers of crafts all firms concerned with the craft business. Both are also responsible for vocational education, qualification and training in the occupations assigned to them.

Given that membership is compulsory, we expect few differences regarding the effect of establishment characteristics on co-operation. However, co-operation with chambers should be more interesting for those establishments that provide vocational apprenticeships. Hypothesising for clusters, we expect establishments of service-oriented and high-tech clusters to have a lower propensity for co-operation with chambers than others because they have a high share of employees that are high-skilled, i.e. hold a university degree rather than a vocational qualification. Since chambers are a vital part of the regional economy in Germany and offer a wide range of services to their members, we expect a positive effect on co-operation for those firms that are cluster members or cluster aware as they might be generally open to regional networking, including chambers.

Municipalities

Municipalities are the smallest administrative unit in Germany. They are responsible for many administrative, legal and infrastructure issues regarding the establishments at their location, for example, the provision of building plots. To firms, municipalities offer information services and networking, give advice regarding start-ups or funding opportunities, and organise regional marketing and trade fairs. Competition to attract investment is intense among German regions so many municipalities offer services tailored to establishments' needs, often in a 'one-stop' fashion (Mäding 2012, Stiller/Bräuninger 2006). To firms looking for a fruitful environment with potential co-operation partners, specialised suppliers, a pool of qualified labour, urbanisation and localisation economies (Rosenthal/Strange 2004, Marshall 2009 [1890]) municipalities can be important co-operation partners. However, once settled in a municipality the initial incentive to co-operate might diminish. In addition, we expect establishments to address municipalities for co-operation only occasionally, i.e. when there is a business-related issue of interest. The mix of services municipalities offer to firms beyond those that are compulsory might also compete with the work of other local institutions and at the same time be less specific than offers from a specialised network or cluster

initiative. Thus, we expect a low propensity of establishments co-operating with municipalities. Some clusters, however, might be of more strategic or political importance to municipalities than others. Being affiliated with a cluster of such a type should have a positive effect on co-operation with municipalities.

3.2.4 Regional context

In addition to examining the effect of the economic structure we also examine how the regional context influences co-operation activities. By regional context we mainly refer to the critique of approaches in agglomeration economies where advantages from geographic proximity often 'entail some very simplistic assumptions on a homogeneous capacity to co-operate, to exploit knowledge, and to learn across space' that tend to neglect 'non-material elements such as attitudes towards co-operation, level of trust or a sense of belonging' (Capello 2009: 156). If we observe that the social and institutional relations between economic actors of a region are formalised, indicated, for example, by numerous cluster management or network activities, we would also expect established co-operation channels between different actors of the region. If firms consider themselves being a part of and sharing such activities, we can also expect these firms to be more open towards potential co-operation partners.

To better understand the specific regional context of our analysis of the co-operation behaviour of firms, the following chapter describes the region under study in more detail. Particular attention is paid to how the local conditions are shaped by institutional and political responses to past shocks to the economic structure of the region, most notably the rise of cluster and network activities.

3.3 Cluster identification in the Nuremberg region

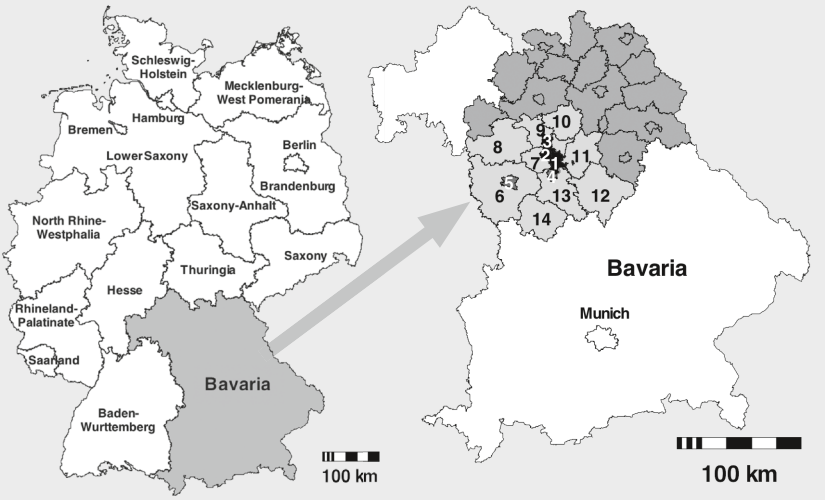
3.3.1 The Nuremberg region

Our study focuses on the Nuremberg region in the northern part of the Federal State of Bavaria in Germany (see Figure 3.1). The region's economic centre is the tri-city area Nuremberg-Fürth-Erlangen with more than one third of the population and over 50 per cent of the region's employees.

Economic integration within the Nuremberg region is strong judged by the dense commuting patterns, the extent of the public transportation system, the presence of companies with both headquarters and production sites in the region and the double-location of the University of Erlangen-Nuremberg. Furthermore, in a joint effort, the Nuremberg region applied successfully for the title 'European

Metropolitan Region' (EMR)[4] in 2005.[5] The agglomeration is one of two economic hubs in Bavaria and one of the ten strongest technology regions in Germany (Egeln et al. 2006).

Figure 3.1: The Nuremberg region



Notes: On the left the Federal State of Bavaria in the Federal Republic of Germany; on the right the Nuremberg region in Bavaria (black: tri-city area: Nuremberg (1), Fürth (2), Erlangen (3); dark grey: the cities of Schwabach (4), Ansbach (5); light grey: rural areas in the Bavarian district of Central Franconia: Ansbach (6), Fürth (7), Neustadt/Aisch-Bad Windsheim (8), Erlangen-Höchstadt (9), Nürnberger Land (11), Roth (13), Weißenburg-Gunzenhausen (14) and two adjacent counties Forchheim (10, district Upper Franconia) and Neumarkt (12, district Upper Palatinate); medium grey: rest of the EMR Nuremberg.

Source: Authors' own illustration.

The Nuremberg region (as the core of the EMR) is particularly interesting for cluster studies since coordinated network activities developed as early as the 1990s. Case studies by Kiese (2012), Sternberg et al. (2010) and Heidenreich (2005) deal with the organisation of the cluster policy in Nuremberg and compare it to other regions. The region is described as a pioneer and the centre of regional cluster policy in Bavaria following two decades of difficult structural change from the manufacturing to the service sector. High unemployment among workers accompanied this change since the 'proportion of industrial employees fell from 61 percent to 39 percent, whilst the proportion of service

4 Blotevogel/Schmitt (2006) describe the EMR as the top level in the hierarchy of the German system of spatial planning: They are defined as 'high performance locations whose outstanding functions transcend the national boundaries to have impacts on the international scale' (*ibid.*: 60). To become an EMR a region has to apply to the 'Standing Conference of Ministries Responsible for Spatial Planning'.

5 To date, the EMR is larger than at its start in 2005 as many neighbouring districts and cities have taken the political decision to join. Our paper concentrates on the core of the EMR, the 'Nuremberg region'.

employees rose from 38 percent to 61 percent' (Heidenreich 2005: 746).[6] In recent years the region recovered and in 2006 the unemployment rate for the Nuremberg region was lower than the German average. The manufacturing industry, however, remains a cornerstone of the region's economy and the employment share of the sector is still higher than the German average.[7] One of Germany's largest corporate groups in manufacturing is the region's biggest employer, based in the cities Nuremberg and Erlangen with their headquarters in the business fields health care, energy technology, automation and transportation systems. Other big employers are found in mechanical engineering and the automotive industry.

Against this background, and to face future challenges, local authorities started a strategy based on cluster concepts to strengthen the potential of local industries and the regional labour market (Kiese 2012, Heidenreich 2005, Küpper/Röllinghoff 2005). A central feature was the preparation of the 'Regional Development Model' (RDM; *Entwicklungsleitbild*) by the cities and counties of the region, the government of Central Franconia, the unions, the chamber of crafts, the regional universities and universities of applied sciences under the lead of the Nuremberg Chamber of Commerce and Industry. Cluster policy in the region is an example of a bottom-up approach supported by the regional government, unions and economy in contrast to top-down approaches, where regional cluster policy is executed by the state or management consultants (Kiese 2012). The RDM was first passed in 1998, updated due to the nomination as EMR in 2005 and again in 2010. Taking into account existing networks and interested companies, the RDM identified regional 'fields of competence', i.e. clusters. Heidenreich (2005) describes the selection as a negotiation process between actors who wanted to focus on the remaining 'traditional' industries (e.g. Transportation and Logistics) and those who wanted to support the 'new' industries (e.g. Information and Communication). In general, the fields of competence should represent important regional value-added chains with their establishments and institutions that are connected via production, technology, specific services and R&D (Entwicklungsleitbild 2005).

In 2005, prior to our survey, the region's economic profile was characterised by six fields of competence: Transport/Logistics; Information/Communication; Medicine/Health; Energy/Environment; New Materials; Automation/Production Engineering (Entwicklungsleitbild 2005).[8] All were supported by cluster

6 Heidenreich's figures refer to Central Franconia. The trend for the Nuremberg region (two more counties) is the same.

7 See Appendix 3.A.

8 Automation/Production Engineering was added in 2005.

management activities, organised in so-called 'competence initiatives', to develop and support networks and co-operation, generate technology transfer between establishments and universities or research institutes, back up start-ups and do marketing and lobby work for the fields of competence. However, Kiese (2012) criticises the fact that the fields of competence are too broad to capture the region's cluster structure and that no elaborate analytical instruments or tools like input-output or value-added chain analysis were applied for identification. Heidenreich (2005) also suggests that R&D co-operation between universities and companies is still expendable. This is surprising as there is considerable technological expertise, not least for the fields of competence: the University of Erlangen-Nuremberg, for example, is home to a medical faculty and an institute for polymer technology, the University of Applied Sciences Nuremberg teaches logistics and supply chain management, the University of Applied Sciences Ansbach has a focus on plastic technology, and the business fields of the Fraunhofer Institute for Integrated Circuits include audio and multimedia, positioning and navigation, imaging systems and medical technology. In sum, Heidenreich (2005: 754) argues that the RDM process was successful because it directed attention to 'the real strengths and potentials' of the region and introduced the supporting role of the competence initiatives for the development of regional networks and start-ups so that 'the regional cluster policy could contribute to the transformation of a traditional industrial region into one of the most innovative German technology regions' (*ibid.*).

3.3.2 Cluster identification

Our identification of cluster structures in the Nuremberg region is based on regional value-added chains and functional specialisation. It builds on a method mix.[9] After document analysis and extracting information from the RDM, we added data through expert interviews and an establishment survey. In the first step of the cluster identification process, basic information on the development and structure of the region's economic foci and fields of competence was collected in 2005 and 2006 and discussed in 50 semi-structured interviews with regional

9 Although top-down approaches can yield valuable insights into cluster structures (Broekel 2012, Brachert et al. 2011, Brenner 2006, Sternberg/Litzenberger 2006), bottom-up methods are useful if cross-industry linkages of regional value chains, vertical clustering, spatial particularities (Feser et al. 2001) and differences in the nature of specific clusters (Guinet 2003) are taken into account. As Atherton/Johnston (2008: 93) state: if clusters are to be analysed, 'the approach taken (…) has tended to be top-down in analytical and planning terms [but] does not reflect the dynamics of clusters formation as a function of increasing collaboration between firms'.

experts.[10] Half of these interviews were with representatives of local institutions involved in regional policy (e.g. departments of economic development of cities and counties, competence initiatives, technology transfer offices, universities and research institutes), and half with representatives from establishments that were identified as important actors of the regional economy and/or rooted in the region. In the process of selecting experts we used the results of our document analysis and added further names provided by the interviewees, who were asked to indicate other actors who were, in their opinion, important for the regional economy or fields of competence. All interviews were recorded, transcribed, coded and analysed comparatively to measure the economic structure and value-added chains of the region under study.

Regarding the foci of economic activity and regional clusters, the majority of interviewees agreed that the fields of competence identified for the RDM represented the important value-added chains of the Nuremberg region. Some added that other value-added chains shared the potential for more clustering, e.g. the plastics industry, that is concentrated in the more rural western part of the Nuremberg region. Familiarity with the cluster concept and the regional policy derived from it differed notably among establishment representatives. Some interviewees saw their establishment as part of a field of competence and emphasised that they played an active role in local initiatives. Others reported that regional fields of competence had no relevance for them even if, for example, their business segment fits a field of competence defined in the RDM and they had business relations with other actors from this field of competence in the region.

The written establishment survey was developed to gain insight into the structure of regional value-added chains/clusters and co-operation activities between economic actors. The questionnaire contained sections on basic establishment data like age, the number and qualification of employees, or turnover. We also asked for the establishments' industry affiliation, products and services, core competencies, the importance of regional customers and suppliers and the regional value-added chains they associated themselves with. The 26 regional value-added chains listed in the questionnaire were derived from the initial document and interview analysis and included the fields of competence

10 All interviewees were asked about the regional labour market, infrastructures, significance of R&D co-operation and technology transfer for the region. The interview guide for representatives of local institutions focused on the development of the economic centres and fields of competence of the region, implementation of the competence initiatives, structures of regional value chains, the interviewee's role in regional economic policy and management of the fields of competence. The main topics with representatives of establishments were information about the establishment, its relations with other economic actors, significance of science, technology and technology transfer in the region and their view of the RDM and the region's fields of competence.

from the RDM as well as other value-added chains named by experts. Information on co-operation activities were gathered in detail and with regard to different co-operation partners. Finally we asked the establishments whether they saw themselves as members of a cluster.[11]

To build a sample of establishments to be surveyed, a comprehensive dataset was created including information on all establishments in the Nuremberg region with at least one employee subject to social security from administrative data (address, number of employees and code of the German industry classification WZ03).[12] We excluded establishments irrelevant to the purposes of the study, for instance petrol stations, institutions of primary education and private households that employed individuals.[13] In other industries small and micro-enterprises were also dropped from the data, for example trade and repair businesses with fewer than five employees, based on the assumption that these businesses fulfilled local needs but most likely not in business fields important to clusters. In contrast, all IT businesses and all laboratories were surveyed irrespective of their size.[14] The questionnaire was then sent to 8,693 establishments.[15] The survey was entitled 'Industrial Clusters and Company Networks in the Nuremberg Region' and we received completed questionnaires from 888 establishments (10.2 per cent) by early 2007.[16]

Information from the various data sources was then used to detail fields of functional specialisation that can be considered working clusters or, alternatively, value-added chains with a high potential for clustering. For this purpose a set of criteria were applied to the data gathered and combined with the regional value-added chains listed prominently in the establishment survey: concentration of industries in space, labour market pooling, presence of technology or market leaders, existence of support institutions and network activities (see Appendix 3.B).

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11 Most of the questions were standardised. Some were open-ended, e.g. questions on products and core competencies. The questionnaire is available upon request (in German).

12 WZ03: Classification of Economic Activities, Edition 2003 of the Federal Statistic Office Germany, based on the NACE.

13 Several correction procedures were applied: if an establishment was included twice with an identical record, for example, it received only one questionnaire. Exclusion of establishments was handled restrictively based on the information from the interviews, document and data analyses.

14 This selection process refers to Porter's (2003) distinction between local, resource-based and traded industries. What is of importance here is the assumption that traded industry clusters contribute especially to the competitiveness of a region, although he also notes that clustering can appear in local industries (Porter 2000).

15 Establishment representatives who participated in the expert interviews also received a questionnaire.

16 The response rate of 10.2 per cent is low but not unusual for this kind of survey (see, for example, Schröder 2013, Oerlemans et al. 2001). We carefully checked the distribution of establishments that participated against those in the sample. As for industry codes the distribution of our data follows the sample quite closely; as for size, establishments with 250 employees or more are oversampled. To account for the differences we used weights for our estimations.

Thus, eight clusters were identified: Automotive [AUT], Electronics [EL], Environmental Technology & Energy [ETE], Information Technology & Communication Services [I&C], Logistics & Transport Technology [L&T], Medical Technology & Health [MED], Plastics Industry & New Materials [PLA] and Specialised Automation [SPA]. The category 'others' comprises all establishments that participated in the survey but could not be affiliated with one of the eight clusters. However, they form the largest group and are also important for the local economy. Establishments in this category are from the construction sector and the toy industry, but also include consultant agencies, accountants, lawyers, temporary employment agencies, training companies, caterers and the like (see Table 3.1 and Appendix 3.C). As was to be expected, the clusters derived from the analysis match the regional fields of competence of the RDM. However, based on the data from the establishment survey, e.g. on products and core competencies, the main outlines of the identified clusters differ to a certain extent from the fields of competence.[17] Furthermore, two more clusters were identified from our data (AUT and EL).

From the answers of the establishments we assigned each establishment to the clusters identified. This was done based on the information about industry affiliation, products and services, core competencies and self-reported affiliation to a regional value-added chain.[18] In this regard, the survey data provide a major advantage compared with the use of administrative data because they allow a more realistic assignment of establishments to clusters. For instance, an establishment from the metal industry is affiliated with the cluster Automotive if its core competence is the production of valves for vehicles and/or if the establishment considers itself part of the regional value-added chain 'vehicle manufacturing', whereas in the administrative data the same establishment would count as part of the metal industry.

In the following we describe our strategy to empirically test our hypotheses on the determinants of different types of co-operation regarding establishment and cluster characteristics. We begin with a description of the explanatory and dependent variables (Section 3.4.1) and then explain our estimation strategy (3.4.2).

17 One example is the PLA cluster. In the RDM this field includes 'New Materials' only. In our survey and from expert interviews the plastics industry was named as rather important, especially for the future development of the region.

18 Technological relatedness increases the probability of co-operation between establishments (e.g. Cantner/Meder 2007). It is also a pillar of our cluster identification strategy. However, we can only indirectly capture its effect on co-operation (via cluster affiliation).

Table 3.1: The eight individual clusters in the Nuremberg region – more details in Appendix 3.C

Cluster	N	Cluster awareness	Number of employees	Establischment age in years	Manufacturing (MF) & services (S)	Location in a city	Share highly qualified/ total number of empl.	R&D department
AUT: Automotive	92	yes = 52.81 %	min. = 1 max. = 1,142 mean = 128.28	min. = 1 max. = 201 mean = 34.78	MF only = 43.48 % S only = 29.35 % both = 27.17 %	yes = 46.74 %	9.2 %	yes = 54.35 %
EL: Electronics	145	yes = 45.71 %	min. = 1 max. = 1,809 mean = 89.52	min. = 1 max. = 180 mean = 31.63	MF only = 30.34 % S only = 37.93 % both = 31.72 %	yes = 55.86 %	25.7 %	yes = 51.03 %
ETE: Environmental Technology & Energy	80	yes = 53.95 %	min. = 1 max. = 2,848 mean = 149.46	min. = 1 max. = 144 mean = 34.66	MF only = 20.00 % S only = 60.00 % both = 20.00 %	yes = 42.50 %	19.97 %	yes = 37.50 %
I&C: Information Technology & Communication Services	226	yes = 55.14 %	min. = 1 max. = 5,413 mean = 85.12	min. = 1 max. = 348 mean = 23.45	MF only = 8.41 % S only = 76.99 % both = 14.60 %	yes = 60.62 %	34.41 %	yes = 40.27 %
L&T: Logistics & Transport Technology	113	yes = 42.20 %	min. = 1 max. = 2,400 mean = 115.74	min. = 1 max. = 427 mean = 42.38	MF only = 9.73 % S only = 66.37 % both = 23.89 %	yes = 55.29 %	13.43 %	yes = 28.32 %
MED: Medical Technology & Health	125	yes = 51.24 %	min. = 1 max. = 1,800 mean = 98.14	min. = 1 max. = 244 mean = 34.50	MF only = 25.60 % S only = 47.20 % both = 27.20 %	yes = 57.60 %	24.14 %	yes = 43.20 %
PLA: Plastics Industry & New Materials	91	yes = 62.79 %	min. = 1 max. = 2,000 mean = 139.47	min. = 1 max. = 201 mean = 40.54	MF only = 53.85 % S only = 12.09 % both = 34.07 %	yes = 35.16 %	9.09 %	yes = 53.85 %
SPA: Specialised Automation	144	yes = 51.82 %	min. = 1 max. = 1,809 mean = 91.26	min. = 1 max. = 223 mean = 29.95	MF only = 30.56 % S only = 35.42 % both = 34.03 %	yes = 53.47 %	21.47 %	yes = 53.47 %
others	306	yes = 39.24 %	min. = 1 max. = 2,600 mean = 52.46	min. = 1 max. = 877 mean = 42.55	MF only = 15.36 % S only = 72.88 % both = 11.76 %	yes = 49.35 %	5.74 %	yes = 12.75 %

Notes: N > 888, as establishments can be affiliated with more than one cluster. max.: maximum, min.: minimum; columns: MF & S: establishments' industry affiliation; location in city: dummy if location in Ansbach, Erlangen, Fürth, Nuremberg or Schwabach; highly qual. empl.: employees with an academic degree.

Source: Establishment survey 2006/2007.

3.4 Methods

The focus of our research is on the determinants of co-operation between establishments as well as between establishments and other economic actors and institutions. In addition, we take into account establishments' cluster membership and their affinity to regional clustering to compare co-operation patterns of different clusters.

3.4.1 Variables

Co-operation, the dependent variable in our analysis, is built from answers to the question: 'Has your establishment already co-operated with the following partners?'. In the survey questionnaire, co-operation is defined as any relation with another partner that goes beyond a mere business transaction like the selling or buying of goods or services. Thus, it comprises both formal and informal co-operation with potential partners. For clustering, both intraregional and interregional co-operation is vital. The former is a constituting element for clusters, while the latter is important for avoiding lock-in, mono-activity or exclusivity (Lejpras/Stephan 2011, Hassink 2005, Bathelt et al. 2004, Simmie 2004), so in the survey we asked establishments to differentiate between intra- and interregional co-operation (see Table 3.2 for shares and total numbers).

Table 3.2: Share of intra- and interregional co-operations per cluster

	AUT	EL	ETE	I&C	L&T	MED	PLA	SPA	Others
Intraregional	43.7	41.6	44.0	38.0	41.6	36.8	37.4	41.0	54.2
Interregional	34.5	35.7	29.7	37.8	37.3	39.7	39.6	35.1	32.5
Both	21.8	22.7	26.4	24.2	21.1	23.5	23.0	23.9	13.3
Total no. of co-op.	197	286	182	466	209	272	187	268	548

Notes: Only co-operating establishments (N = 666); for cluster abbreviations see Table 3.1; co-op. = co-operation.

Source: Establishment survey 2006/2007.

Across clusters, Table 3.2 shows that in most clusters establishments that co-operated only intraregionally have the highest share and between one fifth and one quarter of establishments use both channels of co-operation. So all clusters are well-rooted in the region but are also connected to extraregional partners. Regarding those establishments that participated in the survey but could not be affiliated with one of the clusters ('others'), we find confirmation for the assumption that for them, ties to the local economy are of particular importance. However, we

do not differentiate between the location of the co-operation partners for the estimations as we focus on the effect of clusters on co-operation in general.

A comparison of establishments that list at least one co-operation partner to establishments that have none shows that the majority of establishments are co-operating (78.4 per cent; 666 establishments).[19] However, at 27.6 per cent, a significant share of establishments reported no such activity in the past (184 establishments).[20]

The explanatory variables[21] are derived from the discussion in Section 3.2. As for establishment characteristics, size is measured by number of employees (in logarithm) and age in logarithm in years since foundation. Absorptive capacity representing the channels to access external knowledge is accounted for with two variables, the existence of an in-house R&D department and the share of highly qualified employees, i.e. employees with a degree from a university or a university of applied sciences. Dummy variables are included to control for the location of an establishment in a city[22] and for its industry affiliation, indicating if the establishment is part of the manufacturing industry, the service industry or both.

To control for the effect of cluster affiliation of establishments on co-operation we included nine dummy variables, one for each cluster including 'others'.[23] We also added our measure of establishments' cluster awareness to the analysis. In the survey, clusters were defined as 'a regional network of companies and supporting institutions in a specialised field of production or services that can also extend to other sectors'. The variable was coded one if establishments considered themselves a member of a cluster, and zero if not.

3.4.2 Estimation strategy

We estimate the influence of the explanatory variables on establishments' propensity to co-operate in two steps. In model A we examine which establishments co-operate at all. We estimate a logit model with a dependent variable that takes the value one if the establishment has co-operated at all in the past with

19 The 38 establishments that did not answer this question were dropped from the analysis.

20 Compared to other studies, this is a high share of co-operation (Fontana et al. 2006, Hauschild/Wallacher 2004, Simmie 2004, Miotti/Sachwald 2003, Fritsch (2003, 2001), Fritsch/Lukas 2001). One explanation might be that our question on co-operation activities did not refer to a particular point in time or to a specific co-operation activity like R&D. In addition, a list of six potential partners was provided in the survey, so respondents could have been more aware of the different co-operation possibilities than in studies that only ask about co-operation activities in general. Another possible explanation is response bias, i.e. that establishments engaged in co-operation activities are more interested in our survey and thus responded more often than those not interested in the issue.

21 The details to all variables are given in Table 3.3.

22 See Figure 3.1, black and dark grey areas.

23 We use 'others' as a reference category to examine differences in the co-operation behaviour of clusters.

one of the listed partners and the value zero if not. In model B we differentiate between different types of co-operation. The dependent variable indicates if an establishment has co-operated with one of the partners and we consider only those that co-operate with at least one partner.

We choose a multivariate probit model to account for systematic correlations between the six dichotomous dependent variables via the error terms of the equations (Greene 2008, Cappellari/Jenkins 2003; for the equation see Appendix 3D). In the case of correlations between the dependent variables, the multivariate probit model delivers more efficient results than, for instance, separate logit or probit estimates for each potential co-operation partner. It is most likely that the decision to co-operate with one partner is related to the decision to co-operate with another partner (Belderbos et al. 2004, Fritsch 2003, Fritsch/Lukas 2001).

For the estimates we use STATA 10 and the ado-file 'mvprobit' by Cappellari/Jenkins (2003). It applies the Geweke-Hajivassiliou-Keane simulator to the maximum likelihood estimation of the multivariate probit regression.[24] Since our sample is not a random sample data are weighted by industry affiliation and size for each establishment.[25]

3.5 Results

3.5.1 Model A: Co-operation

Model A sheds light on the determinants of co-operation with any partner. It contrasts the establishments that co-operated in the past with the ones that did not co-operate. Table 3.3 displays the statistics.

The significant positive coefficients (Table 3.4) met most of our expectations. Co-operation is driven by the general amount of economic activity, indicated by the number of employees, and absorptive capacity, reflected by a high share of highly qualified employees and the presence of an in-house R&D department. In addition, being part of the service sector makes co-operation more likely. The exact geographic location within the economic space – be it rural or urban –

24 The multivariate probit estimation is based on 50 draws. We follow Cappellari/Jenkins (2003), who suggest that the number of draws be at least as high as the square root of N.

25 The weights are a combination of six classes of firm size and an aggregation of the WZ03 codes in seven classes. We also estimated unweighted regressions. The results are consistent with those presented in the paper and are available upon request.

does not matter. Being 'cluster aware' enhances the propensity to co-operate[26], whereas functional cluster affiliation, indicated by the cluster dummy variables, is not related to establishments' propensity to co-operate. The picture only changes when co-operation partners are examined individually (model B).

Table 3.3: The independent variables for model A (N = 768)

Establishment characteristics		Minimum	Maximum	Mean	S.d.
Establishment size		1	2,400	72.56	221.13
(ln) size		0	7.78	3.00	1.53
Establishment age		1	877	36.41	54.38
(ln) age		0	6.78	2.94	1.20
ac: share highly qualified employees		0	100	20.12	28.00
	yes (N)	*yes (%)*			
ac: in-house R&D department	243	31.46			
Location in a city	407	52.99			
ia: manufacturing industry (reference)	147	19.14			
ia: service industry	471	61.33			
ia: service & manufacturing industry	150	19.53			
Cluster-related variables					
Cluster awareness	348	45.31			
Cluster affiliation with …					
AUT	79	10.29			
EL	130	16.93			
ETE	70	9.11			
I&C	201	26.17			
L&T	95	12.37			
MED	114	14.48			
PLA	73	9.51			
SPA	125	16.28			
Others (reference)	263	34.24			

Notes: Establishments that reported only missing values for all different co-operation partners are excluded, as are those that reported a missing value for one of the independent variables; *ac:* absorptive capacity; *ia:* industry affiliation; *s.d.:* standard deviation; for cluster abbreviations see Table 3.1.

Source: Establishment survey 2006/2007.

26 The reverse relationship is also possible. Establishments might not be cluster aware *per se*. Good experiences with co-operation in the past can lead to an interest in future co-operation. To this end, openness for co-operation is essential and cluster awareness reflects this openness.

Table 3.4: Binary logistic regression: Co-operation with any other partner

Establishment characteristics	Coefficient	S.e.
(ln) establishment size	0.311***	(0.08)
(ln) establishment age	-0.112	(0.10)
Industry affiliation – manufacturing industry (reference)		
Service industry	0.681**	(0.30)
Service & manufacturing industry	0.516	(0.32)
Location in a city	-0.209	(0.21)
ac: share highly qualified employees	0.013***	(0.00)
ac: in-house R&D department	0.675***	(0.25)
Cluster-related variables		
Cluster awareness	1.029***	(0.22)
Cluster affiliation – others (reference)		
AUT	0.552	(0.47)
EL	-0.041	(0.31)
ETE	-0.089	(0.40)
I&C	0.248	(0.26)
L&T	-0.209	(0.29)
MED	-0.031	(0.29)
PLA	-0.169	(0.43)
SPA	-0.493	(0.31)
Constant	-0.422	(0.44)
N	768	
McFadden's R^2	0.1197	
Log pseudolikelihood	-3640.058	
Prob > chi2	0.0000	

Notes: Robust standard errors in parentheses (s.e.); * $p<0.10$, ** $p<0.05$, *** $p<0.01$; ac: absorptive capacity; for cluster abbreviations see Table 3.1.

Source: Establishment survey 2006/2007.

3.5.2 Model B: Co-operation with specific partners

In a second step, using a multivariate probit model, we only consider the 600 establishments that show co-operation activity. We distinguish six different co-operation partners and use the same weights as in model A. The results for the correlation coefficients between the error terms in the multivariate model underline that co-operation with one partner is not independent of co-operation with another partner. Eleven of fifteen combinations show significant correlations between the dependent variables, nine positive and two negative (see Appendix 3.E). Tables 3.5 and 3.6 contain the statistics for model B.

Table 3.5: The dependent variables for model B (N = 600)

Co-operation with ...	yes (N)	yes (%)
Establishment	525	87.5
University	216	36.0
Research institution	134	22.33
Municipality	141	23.5
Initiative/network	273	45.5
Chamber	193	32.17

Source: Establishment survey 2006/2007.

Table 3.6: The independent variables for model B (N = 600)

Establishment characteristics		Minimum	Maximum	Mean	S.d.
Establishment size		1	2,400	83.35	246.5
(ln) size		0	7.78	3.00	1.56
Establishment age		1	877	35.83	56.85
(ln) age		0	6.78	3.00	1.21
ac: share highly qualified employees		0	100	22.7	28.82
	yes (N)	*yes (%)*			
ac: in-house R&D department	212	35.33			
Location in a city	322	53.67			
ia: manufacturing industry (reference)	102	17.00			
ia: service industry	380	63.33			
ia: service & manufacturing industry	118	19.67			
Cluster-related variables					
Cluster awareness	306	51			
Cluster affiliation with ...					
AUT	65	10.83			
EL	102	17.00			
ETE	61	10.17			
I&C	172	28.67			
L&T	73	12.17			
MED	90	15.00			
PLA	57	9.50			
SPA	97	16.17			
Others (reference)	201	33.50			

Notes: Establishments that reported only missing values for all different co-operation partners are excluded, as are those that reported a missing value for one of the independent variables; *ac:* absorptive capacity; *ia:* industry affiliation; for cluster abbreviations see Table 3.1.

Source: Establishment survey 2006/2007.

Table 3.7: Multivariate probit: Co-operation with different partners

	Establishment	University	Research institute	Municipality	Initiative/ network	Chamber
Establishment characteristics						
(ln) establishment size	-0.050 (0.05)	0.198*** (0.05)	0.148*** (0.05)	0.073 (0.05)	0.150*** (0.05)	-0.024 (0.04)
(ln) establishment age	-0.038 (0.06)	0.098* (0.06)	0.035 (0.06)	0.180*** (0.07)	-0.079 (0.06)	0.080 (0.06)
industry affiliation – manufacturing industry (reference)						
Service industry	0.210 (0.23)	-0.098 (0.19)	-0.330* (0.19)	0.121 (0.22)	0.793*** (0.19)	0.075 (0.19)
Service & manufacturing	0.201 (0.23)	-0.012 (0.18)	-0.186 (0.16)	0.120 (0.22)	0.387** (0.20)	0.126 (0.19)
location in a city	0.078 (0.15)	0.143 (0.13)	0.016 (0.14)	-0.226* (0.13)	-0.086 (0.12)	-0.003 (0.12)
ac: share of HQ empl.	-0.004 (0.00)	0.010*** (0.00)	0.003 (0.00)	0.001 (0.00)	-0.002 (0.00)	-0.003 (0.00)
ac: in-house R&D	0.277 (0.18)	0.395*** (0.14)	0.285** (0.13)	-0.359** (0.15)	-0.027 (0.14)	-0.047 (0.13)
cluster-related variables						
cluster awareness	0.287** (0.15)	0.330*** (0.12)	0.175 (0.13)	0.227* (0.12)	0.800*** (0.12)	0.420*** (0.12)
cluster affiliation – others (reference)						
AUT	-0.197 (0.29)	0.144 (0.23)	0.447* (0.23)	-0.301 (0.27)	0.062 (0.22)	-0.435** (0.21)
EL	0.076 (0.22)	0.392** (0.17)	0.078 (0.17)	-0.221 (0.20)	-0.278 (0.18)	0.127 (0.17)
ETE	0.222 (0.24)	0.288 (0.18)	0.037 (0.23)	0.366* (0.19)	-0.289 (0.20)	-0.148 (0.20)
I&C	0.477** (0.20)	-0.165 (0.16)	-0.161 (0.16)	-0.211 (0.16)	0.129 (0.14)	-0.416*** (0.15)
L&T	0.869*** (0.26)	-0.066 (0.23)	0.052 (0.21)	-0.098 (0.20)	-0.175 (0.19)	-0.081 (0.19)
MED	0.265 (0.22)	0.357** (0.18)	0.425** (0.17)	-0.044 (0.19)	0.102 (0.16)	0.082 (0.17)
PLA	0.105 (0.27)	-0.025 (0.23)	-0.094 (0.24)	-0.505* (0.28)	0.130 (0.21)	-0.100 (0.22)
SPA	-0.194 (0.21)	-0.168 (0.18)	-0.076 (0.18)	-0.134 (0.18)	-0.241 (0.17)	0.032 (0.18)
Constant	0.88*** (0.31)	-1.947*** (0.28)	-1.497*** (0.30)	-1.328*** (0.33)	-1.168*** (0.27)	-0.708 (0.28)
N	600	600	600	600	600	600

Notes: Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; *ac:* absorptive capacity; HQ: highly qualified; for cluster abbreviations see Table 3.1.

Source: Establishment survey 2006/2007.

Table 3.7 displays the determinants for establishments' co-operation activities for different co-operation partners (model B). It shows, first, that establishment characteristics are not significantly related to co-operation with other companies. Since 88 per cent of the establishments in the sample have already co-operated with other companies, linkages between establishments are the norm rather than the exception regardless of their characteristics.

Second, the results lend support to the notion that establishment size and absorptive capacity are good predictors of co-operation in matters of R&D. Establishments with more highly qualified employees have a higher propensity to co-operate with universities, while those with more employees and an in-house R&D department are more likely to co-operate with universities and research institutes. Establishment size is also positively associated with co-operation with initiatives/networks. However, the existence of an in-house R&D department exerts a negative influence on co-operation between establishments and municipalities. One explanation for this finding is that for establishments that have a focus on product development and R&D, municipalities are, by their range of activities, not very interesting co-operation partners. Another possible explanation is that, because of the expected bureaucratic nature of many dealings with municipalities, R&D-intensive actors tend to consider municipalities an impediment to their business rather than a facilitator, e.g. in terms of infrastructure or incentives to attract much needed personnel.

Third, with increasing age we find a significant positive association with the propensity of establishments to co-operate with universities and municipalities. Although being very different partners, the mechanism behind this finding might reflect reputation-building over time, including the formation of contacts. It is likely that long-established firms will be better known in their environment, be addressed more frequently by authorities to take over patronages, act as spokespersons or lend support to local concerns via donations, for instance. This conclusion goes hand in hand with the result that being located in one of the Nuremberg region's cities has a negative influence on co-operation with municipalities. In cities the embeddedness of single companies and smaller establishments might be weaker than in rural districts and smaller communities. In addition, in peripheral regions the efforts to keep companies in their location might be both more visible and more appreciated. While establishments in cities might experience the municipality and its bureaucratic proceedings as being detached and enigmatic, establishments in rural districts might feel the opposite, since municipalities there are able to offer solutions suitable for each establishment in a 'one-stop-shop' fashion. For co-operation with other partners it does not matter whether establishments are located in urban or rural areas. We conclude that for joint projects central to their

business interests, like co-operation with other companies or research partners, the exact location of co-operation partners within an integrated economic space is of little concern.

Fourth, establishments from the service sector show a significantly higher propensity to co-operate with initiatives/networks than manufacturing establishments. Business-related services often require close coordination with partners and initiatives/networks facilitate access to potential business partners. The negative effect of service establishments on co-operation with research institutes points at the aim of R&D co-operation, the development of new products in particular, where manufacturing rather than service has vested interests.

Fifth, turning to the cluster variables, the results show that cluster awareness is significantly positively associated with co-operation with all partners, with the exception of research institutions. We conclude that if establishments are aware of their cluster and know about the potential of clusters, their openness towards co-operation in all directions is greatly enhanced.

In contrast to model A, model B delivers significant results with regard to the impact of functional cluster affiliation, albeit with differences regarding the impact of individual clusters. We find that co-operation with other companies is positively influenced by affiliation to the clusters I&C or L&T, in contrast to being affiliated with no particular cluster ('others'). Both clusters are characterised by business-related services that are also important for operations in other value-added chains and firms. Affiliation with cluster EL or MED increases the propensity to co-operate with universities. Both clusters are oriented towards high-tech and are thus in need of input from basic research. This is especially true in the field of medical technology, in which the local University of Erlangen-Nuremberg specialises. It is a centre of basic and applied research, also acting as a node for research-oriented business contacts and generating a large number of start-ups. For the EL cluster there is also a concentration of cutting-edge departments at the local universities amenable to establishments in search of co-operation partners. Table 3.7 shows that establishments from the AUT or MED clusters are also more likely to co-operate with research institutions than establishments with no particular cluster affiliation, probably because of the resources concentrated in applied research in the Nuremberg region, for example in the institutes of the Fraunhofer-Gesellschaft.[27]

Regarding co-operation with municipalities, our results show a significant and positive impact of the ETE cluster. Environmental technology is a relatively new

27 Of course co-operation with universities or research institutions is not restricted to the Nuremberg region. Nonetheless the probability of co-operation with such partners could increase when local scientific institutions are specialised in the same field as cluster establishments.

field of specialisation and has a high priority for local authorities, e.g. concerning decentralised energy supply and its respective infrastructure, water management, renewable energy, recycling and waste management. Therefore, co-operation with the local decision makers is vital for establishments active in this field.[28] The weakly significant negative effect of affiliation with PLA on co-operation with municipalities cannot be explained. All possible arguments would also apply to the other six clusters, for instance that they address municipalities for co-operation only occasionally.[29]

AUT and I&C exert a significant negative effect on co-operation with chambers of industry and commerce/chambers of crafts. Typically, chambers are rooted firmly in the region and offer broad services to their members. For establishments affiliated with I&C, chambers' services and offers might not meet the specific needs of project-oriented suppliers of business services. As for AUT, the production portfolio in the Nuremberg region lacks a genuine car factory. While the chambers' work has its emphasis on the regional level, the first-tier and second-tier suppliers that dominate the regional cluster might look outside the region for co-operation.

Although there are numerous industry networks and coordinated network activities in the Nuremberg region, Table 3.7 shows non-significant results for co-operation activities with cluster establishments throughout. We can only speculate about the reasons here. For example, the longstanding history of clustering and networking in the Nuremberg region could lead establishments to take these for granted like 'regular' institutions and suppress the co-operation efforts that have been necessary to establish and sustain them. It is also plausible that establishments will tend not to define their ties to initiatives/networks in terms of 'co-operation'. Most likely, they will tend to perceive them in terms of 'association' or 'membership' rather than co-operation. Indeed, regional initiatives/networks are rarely business partners of establishments, even if membership fees are paid or company money is spent on joint regional marketing, for instance. Against this background, offers from initiatives/networks would be considered non-binding and 'nice to have', for example in the form of lectures and get-togethers. Of course, significant co-operation activities originate from these workings and establishments regularly acknowledge the contributions of initiatives/networks in this regard. However, from the establishments' point of view their business is to promote co-operation rather than to be a co-operation partner.

28 For instance, Fürth has participated in the national 'Solar City' competition since 2001 and therefore has a distinct interest in projects concerning renewable energy.

29 All others are not significant, but the trend is also negative.

3.6 Conclusions

Co-operation is essential in establishments' economic behaviour and indispensable in the formation and performance of clusters. We commenced from the observation that although co-operation is important, empirical evidence on the influence of cluster affiliation on the co-operation of establishments with other actors is scarce. Using the example of the Nuremberg region we applied a comprehensive methodical approach to identify regional clusters on the basis of expert interviews and an establishment survey. Compared to other studies this allows us to find out more about the relation between clusters and co-operation. We analysed the determinants of co-operation and especially the effect of cluster affiliation on the co-operation of establishments with different economic and institutional actors.

We documented that the majority of establishments are involved in co-operations (78.4 per cent). This co-operation is mainly driven by establishment characteristics. Large size and affiliation with the service sector, a high share of highly qualified employees and the presence of an in-house R&D department, reflecting absorptive capacity, increase the propensity to co-operate significantly. We also find that establishments that see themselves as cluster members are particularly likely to co-operate. However, cluster affiliation based on functional criteria like products and core competencies has no influence on the propensity of establishments to co-operate.

Regarding different co-operation partners, we were able to confirm results from other studies, particularly for R&D co-operation. Older and larger establishments, establishments in manufacturing and those with highly qualified employees and R&D departments tend to co-operate with universities and other research institutions. We also shed light on a lack of co-operation with regional municipalities and conclude that, for the establishments in the survey, co-operation with local authorities is – at best – of little interest. However, they play an important role in co-operative activities of establishments located in more rural counties.

As mentioned above, the functional cluster affiliation is of no importance to establishments' general inclination to co-operate. A closer look shows that establishments in the service sector co-operate significantly more often with regional initiatives/networks than establishments from the manufacturing sector. Establishments associated with high-tech clusters such as MED or EL are especially likely to co-operate with universities and research institutions. This indicates one direction of future regional economic policy as there is still potential for enhancing both networking and R&D co-operation, e.g. for using best practice examples from the clusters located nearby. The establishments affiliated with a cluster that is important to local authorities, like ETE, are much more likely to co-operate with

municipalities. We also find that establishments that consider themselves aware of cluster activities in the region are particularly likely to co-operate.

Establishments that are not affiliated with a particular cluster ('others') warrant more attention in future analyses. Although we could not assign these establishments directly to a cluster, they appear to be well-rooted regionally. For a better understanding of their role in regional co-operation activities, for example regarding the possibility that they fill the 'holes' between cluster establishments (see Burt 2004, 1992, for example), in-depth or case studies and/or network analyses would seem appropriate.

One further avenue for future research will be to shed more light on the effects of spatial differences in the co-operation activities of clusters (Torre 2008a, Giuliani 2005, Simmie et al. 2002, Keeble et al. 1999). Another is to examine in more detail the ends of establishments' co-operation with different partners locally, nationally and on an international scale (Lejpras/Stephan 2011, Simmie 2004). This would also help to avoid overestimating the importance and growth effects of local or regional co-operation and thus the possible impact of regional cluster policies.

What is of particular interest is the fact that we find no positive impact of affiliation with any particular cluster on co-operation with initiatives/networks. Although we can only speculate about the reasons here, the definition of 'co-operation' might play an important role (Smith et al. 1995). For example, establishments in the sample might still define co-operation in business terms although we asked about all activities that transcend 'mere business transactions'. Future research could take up on this result and first ask what co-operation means to establishments as well as initiatives/networks. Second, different definitions of co-operation could be systematically varied in surveys.

The transferability of results from the economic space analysed should also be tested by further research. The Nuremberg region developed and institutionalised cluster and cluster management early by German standards. So the challenge of this successful cluster and network heritage of the Nuremberg region could be to preserve the high level of co-operation and networking and keep it alive.

From our analysis, an establishment's functional cluster affiliation and the cluster structures derived from it do not necessarily increase the propensity to co-operate. This should be of concern particularly to regional economic policy involving cluster creation. That 'cluster awareness' has a significant positive impact on co-operation lends support to the notion that for a successful policy to encourage co-operation, it is conducive to raise or strengthen this awareness. This can be done, for instance, by providing access to new customers and business-relevant information, making regional opportunities for co-operation more transparent and promoting best practice leading to regional added value through co-operation.

Appendix Chapter 3

Table 3.8: Appendix 3.A: A comparison between Germany, Bavaria and the Nuremberg region

Region	Germany	Bavaria	Nuremberg region
Pop. (31.12.)	82,314,906	12,492,658	1,954,548
Pop. density (pop./km²) (31.12.)	230	177	212
Number of empl. (30.06.)	26,354,336	4,319,703	694,329
Unemployment rate, annual average	10.8 %	6.8 %	7.8 %
Share empl. in manufacturing (30.06.)	25.0 %	30.0 %	30.2 %
Share highly qualified empl. (30.06.)	9.7 %	9.6 %	9.8 %
Share of empl. in firms >250 empl.	31.5 %	33.7 %	36.1 %

Notes: All figures from 2006; empl.: employees; pop.: population.

Source: Statistics of the German Federal Employment Agency, authors' own calculations.

Table 3.9: Appendix 3.B: Cluster identification criteria[30]

Criterion	Description	Data used
Concentration of industries in space	a. Calculation of the location coefficient (employment) and analysis for all industries. b. Collection of basic information about the structure of the region's economic fields of competence. After the first stage of interviews (see Section 3.2), together with the results of the location coefficient analysis, we establish a rough outline of the region's main value-added chains and functional specialisation, including fields and technologies covered by regional competencies.	a. Administrative data, IAB Establishment History Panel (establishment-level data on employment and industries) b. Document analysis (e.g. RDM), interviews, establishment survey
Labour market pooling	Check for existence of a specialised workforce and whether employers are aware of matching and poaching incidents.	Interviews, administrative data

30 See also Eigenhüller et al. (2010) and Chapter 8.3.1 in Möller/Litzel (2008).

Table 3.9 continued

Criterion	Description	Data used
Presence of technology or market leaders	Check if there are pole companies in the industries under consideration. *Definition:* 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/icon).	Interviews, document analysis, media
Existence of support institutions and assessment of their sectoral importance	Check for universities and universities of applied sciences (with cluster-relevant faculties and fields of research), research institutes, technical and vocational schools, technology transfer institutions, regional development agencies, working committees and network management. (see Appendix 3.C for more details)	Document analysis, interviews, establishment survey
Existence of network activities	Check for local networks, competence initiatives and the like, evidence of formal and informal co-operation between establishments and between establishments and institutions. Of some importance are also joint actions in the sense of *co-opetition* as the co-operation between competitors. (see Appendix 3.C for more details)	Document analysis (e.g. RDM), interviews

Table 3.10: Appendix 3.C: The eight clusters in the Nuremberg region

Cluster	Cluster categories	Institutions/R&D/networks/ initiatives (examples)
AUT Automotive	1st tier supply for automotive components 1st tier supply for plastic parts 1st tier supply for electronic parts 1st tier supply for metal parts 2nd tier supply for plastic parts 2nd tier supply for electronic parts Other 2nd tier supply Downstream supply Supply machinery & equipment Supporting institutions & service provision	Bayern Innovativ – Management Cluster Automotive (c.p.) Fraunhofer Institute for Integrated Systems and Device Technology – Centre for Automotive Power Electronics and Mechatronics ZKLM
EL Electronics	Electronics Sensor technology Power electronics Electric engineering Electro-mechanical parts Supply of parts and systems service provision R&D, education, training & supporting institutions	ECPE European Centre for Power Electronics e.V. Fraunhofer Institute for Integrated Systems and Device Technology Fraunhofer Institute for Integrated Circuits
ETE Environmental Technology & Energy	Power engineering Utility provision Environmental technology Renewable energy Supply of machinery & equipment Engineering, other services, downstream suppliers R&D, education, training & supporting institutions	EnergieRegion Nürnberg e.V. (c.p.) Bayern Innovativ – Management Cluster Energy Technology (c.p.) Energy Agency Central Franconia e.V. etz Centre for Energy Technology Nürnberg
I&C Information Technology & Communication Services	Software development Data systems technology, communication, networks Internet services Media, print & publishing Trade fairs & exhibition stand construction Call centre Market research & marketing Supporting institutions & IT-savvy firms	NIK Nuremberg Initiative for Communication Business e.V. (c.p.)
L&T Logistics & Transport Technology	Logistics services (transport, cargo handling) Logistics consulting & other services Traffic engineering Logistics systems Construction of packaging & containers Supporting institutions, suppliers & logistics-savvy firms	CNA Centre for Transportation & Logistics Neuer Adler e.V. (c.p.) Bayern Innovativ – Management Cluster Logistics (c.p.) Fraunhofer Institute for Integrated Circuits – Centre for Applied Research on Supply Chain Services SCS

Table 3.10 continued

Cluster	Cluster categories	Institutions/R&D/networks/ initiatives (examples)
MED Medical Technology & Health	Medical technology Out-patient healthcare In-patient healthcare Pharmaceuticals Biotechnology Research & development Services, supply of machinery & equipment Supporting institutions	KIMPG Competence Initiative Medicine-Pharma-Health (c.p.) Forum MedTech Pharma e.V. Fraunhofer Institute for Integrated Circuits – Development Centre for X-ray Technology (EZRT) IZMP – The Innovation Centre for Medical Technology and Pharmaceuticals
PLA Plastics Industry & New Materials	Plastics – production & processing New materials Supply – tool manufacturing & mould construction Supply – machinery & equipment Other inputs & service provision R&D, education, training & supporting institutions	Bayern Innovativ – Management Cluster New Materials (c.p.) KINEMA Competence Initiative New Materials Region Nürnberg ZWL – The Centre for Material Analysis Institute of Advanced Materials & Processes of the University Erlangen-Nuremberg (ZMP)
SPA Specialised Automation	Automation technology Machine tools Plant engineering Supply of components, systems & power electronics Other inputs & services R&D, education, training & supporting institutions	ECPE European Centre for Power Electronics e.V. (c.p.) Automation Valley Northern Bavaria FAPS – Institute for Factory Automation and Production Systems (FAU)
Others	Manufacturing Service provision Building sector Institutions	

Notes: c.p.: cluster platform.

Source: Authors' own illustration.

Appendix 3.D Formalisation of a multivariate probit model

Following Cappellari/Jenkins (2003: 279):

$$y_{im}^* = \beta_m' X_{im} + \varepsilon_{im},\ m = 1, \ldots, M$$

$$y_{im} = 1 \text{ if } y_{im}^* > 0 \text{ and 0 otherwise}$$

ε_{im}, $m = 1, \ldots, M$ are error terms distributed as multivariate normal, each with a mean of zero, and variance-covariance matrix V, where V has values of 1 on the leading diagonal and correlation $\rho_{jk} = \rho_{kj}$ as off-diagonal elements.

Table 3.11: Appendix 3.E: Correlation coefficients between the error terms in the multivariate probit model

	rho	Co-operation with ... university	research inst.	municipality	network	chamber
Co-operation with ...	*company*	-0.133 (0.09)	0.116 (0.08)	0.006 (0.09)	-0.194 ** (0.08)	-0.262 *** (0.08)
	university		0.733 *** (0.05)	0.371 *** (0.08)	0.120 (0.08)	0.333 *** (0.07)
	research institutions			0.447 *** (0.08)	0.149 * (0.08)	0.302 *** (0.08)
	municipality				0.160 ** (0.08)	0.334 *** (0.07)
	network					0.379 *** (0.01)

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho61 = rho32 = rho42 = rho52 = rho62 = rho43 = rho53 = rho63 = rho54 = rho64 = rho65 = 0: chi2(15) = 28473.8; Prob > chi2 = 0.0000

Notes: Robust standard errors in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01.

Source: Establishment survey 2006/2007.

4 Does participation in clusters enhance firms' survival and growth? An establishment-level analysis using CORIS data

Under review at Regional Studies

Abstract

Though the effects of clusters on the economic performance of firms are the basis of an extensive literature, only few 'hard' tests are available. In this paper such an analysis is performed by using a strict evaluation design based on a control group approach. This is possible by exploiting a unique database which connects an establishment-reported cluster participation indicator with highly reliable longitudinal establishment data. Survival analysis (2002–2010) shows that participation in clusters reduces failure risk by roughly one third. In addition, participation in clusters has raised ten-year growth of establishments by 15.8 per cent on average.

JEL classification: R11, J01, O18

Keywords: Regional Clusters, Cluster Identification, Firm Survival, Firm Growth

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4.1 Introduction

The effects of regional clusters have been the subject of vigorous debate in an extensive literature. Still, the answer to the question on the impacts of clusters on firms is open. At the example of Eastern Bavaria, a cluster region in Germany, this paper aims to remedy this deficiency by taking a fresh look at the survival rates and employment growth of establishments in clusters. For this purpose, the paper

implements an evaluation design drawing on a control group approach. This is made possible by creating a unique cluster-oriented database for the region studied.

In the analysis of regional clusters the paper returns to the origins of the concept. What clusters are originally about is the practical participation of economic actors in regional value-added chains. Using resources coming from regional partners is supposed to generate higher benefits for firms and institutions than a similar interaction with partners further afield, a phenomenon already described by Marshall (2009 [1890], book IV (chapters XI, X), book V) as far back as the late 19th century economy. Porter in the early 1990s came back to this issue via research on strategic management and defined clusters as 'geographic concentrations of interconnected companies, specialized suppliers, service providers, companies in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate' (Porter 2000: 15).

The effects of clusters on the performance of establishments are mixed. Many previous studies find positive impacts of clusters (e.g. Delgado et al. 2010, Bönte 2004, Rosenthal/Strange 2004, Feldman/Audretsch 1999, Saxenian 1994), but there is also convincing evidence of negative effects (e.g. Schröder 2013, Torre 2008b, Combes/Duranton 2006, Boschma 2005, Staber 2001). In addition, the fuzzy definition implies that each cluster and each cluster region is unique. Hence, the discussion is not only about how successful clusters emerge and how evolutionary forces work in certain regions and value-added chains, but also if these structures could be put into effect in other economic spaces or even be created from scratch (Ter Wal/Boschma 2011, Sölvell 2008). The creation, promotion and development of clusters are important activities of regional economic policy since the early 1990s, starting from the premise of positive impacts. In many regions, cluster management organisations were pushed by different administrative units and are implemented at local, regional, national and even supra-national levels. The majority are financed by public funds, often to 100 per cent to start with, with a decreasing proportion over time. In many cases, even after a period of five years, the proportion of public money involved is still considerable (Sölvell et al. 2003: 54). Correspondingly, cluster policy has often been criticised for being arbitrary[1] and for the naïve transfer of the concept into practice (Maier/Trippl 2012, Kiese/Wrobel 2011, Benneworth/Henry 2004, Martin/Sunley 2003). This literature also bemoaned the lack of preparation based on cluster theory and of serious empirical testing as of its effectiveness.

1 Enright (2003), for instance, detected five categories of clusters. Besides working, latent and potential clusters he also found policy-driven and wishful thinking clusters, clearly referring to the lack of favourable conditions and local advantages being more or less successfully made up for by policy-makers' zeal.

This is the background and motivation to study the question of the effects of clusters on the performance of establishments. By studying survival rates and employment development of establishments in clusters between 2001 and 2010, this paper contributes to the discussion. It implements a strict evaluation design based on a control group approach. Establishment survival is analysed using the Kaplan-Meier estimator and a Cox proportional hazards model. Employment growth is explored with propensity score matching that constructs the counterfactual situation for cluster-participating establishments and compares their development as if they were not taking part. The differences in outcome can be attributed to cluster participation.

For all of these approaches data requirements are high. Hence, for the paper, a unique cluster-oriented database was created by connecting two data sources. The first of these is the web-based cluster-oriented regional information system CORIS[2]. Following Porter's well-known definition, CORIS, since 2001, collects the information which is required to prepare research for ten Eastern Bavarian value-added chains. The database comprises regional establishments and traces their interlinkages. For economic actors the web-based system holds only few obstacles to data entry. It is free of charge, open to all interested economic actors, regardless of their cluster membership or size, and leaves it to the user how broad and deep the information provided is kept. Hence, affiliation in the CORIS database is clearly indicative of the practitioners' interest in demonstrating their embeddedness in the regional economy. In contrast to political interests, this mirrors the pragmatic participation in regional value-added chains. Their idiosyncratic regional structures are carved out on the basis of the interrelations between the region's economic actors. The problems accompanying top-down approaches are mitigated by the complementary bottom-up methods (Atherton/Johnston 2008, Feser et al. 2001). CORIS allows the view of cluster participation instead of organisational cluster membership, thereby alleviating the self-selection problem. This facilitates a reliable application of control group approaches. Using record linkage methods, the cluster-oriented information is joined to the second data source, the IAB Establishment History Panel. This large database comprises all establishments and draws on the highly reliable German social security notifications. As a result, the newly created data source contains 1,176 establishments actively participating in regional clusters as a treatment group. The control group encompasses 50,985 firms in Eastern Bavaria existing throughout the period of 2001 to 2010.

Using this data set that allows the modelling of regional cluster structures close to reality, the paper returns to the origins of the concept. Against this

2 http://ostbayern.coris.eu, in German only.

background, it is hypothesised that establishments that practically participate in regional clusters profit from the structures and show higher survival rates and higher employment growth than firms that do not position themselves in clusters.

This chapter is organised as follows: Section 4.2 reviews the related literature on the effects of clusters on firm survival and growth. Section 4.3 describes the building of the database including some basic information on the region of Eastern Bavaria. In Section 4.4 the covariates are discussed, also with respect to survival and growth. Sections 4.5 and 4.6 contain the analyses of establishment survival and employment growth, respectively. Section 4.7 concludes.

4.2 Review of literature on clusters and their effect on firm survival and growth

In the last two decades a wide range of studies dealing with the effects of clusters on regions and on individual economic actors have been brought up from different fields, such as strategic management, regional economics, (new) economic geography, entrepreneurship, evolutionary economics or industrial organisation.

4.2.1 A brief perspective on cluster effects on regions

In many works the main focus was on the positive aspects of clustering. Taking a regional perspective, it was shown that economic spaces worldwide benefit from the presence and development of clusters by higher regional growth rates and innovation levels (Delgado et al. 2010, Feldman/Audretsch 1999, Saxenian 1994) as well as higher tax payments and wage levels (Wennberg/Lindqvist 2010) and reduced poverty (Fowler/Kleit 2013). Clusters are presumed to attract additional economic actors to their respective geographic areas and make the locations stronger. The regions profit by establishing a cluster-oriented profile in the international competition between locations, for instance by developing an image as an automobile, chemical or IT region.

This has gained momentum in the last two decades through the advancing integration of markets, creating improved opportunities for firms to re-organise their internal production processes by division of labour, outsourcing and offshoring. Indeed, it is the cluster regions that attract relocating firms, as they apparently offer an environment favourable for business (Litzel/Möller (2011) for an overview). It can be observed 'that even as competition and economic activity globalize, [...] competitive advantage can be localized' (Enright 2003: 100). Porter (1990) calls this the 'location paradox'.

4.2.2 The establishment perspective in general

By locating in these cluster-oriented economic spaces, firms are expected to benefit. The regional value-added chains and specialised networks offer agglomeration economies[3] (Dauth 2010, Rosenthal/Strange 2004, Marshall 2009 [1890]), first, through their forward and backward linkages (Hirschman 1958). They include specialised suppliers allowing the sharing of inputs as well as critical and demanding customers signalling to suppliers their upcoming needs and how to improve their products and services (Bönte 2004, Porter 1990). Second, a diverse range of potential partners – not just for business, but mainly in regard to co-operation and embeddedness in networks – in geographic proximity can ease spillovers of tacit knowledge, leading to enhanced competitive capabilities (McEvily/Zaheer 1999) and higher innovation activity (Feldman/Audretsch 1999). Third, this also attracts personnel with cluster-specific skills or motivates people to acquire new know-how which extends the pool of labour, facilitates staffing and eases the matching between employers and employees, thus reducing the risk for both groups (Duranton/Puga 2004, Rosenthal/Strange 2004). These three 'Marshallian forces' allow access to external resources that firms do not need to hold or develop internally and that are often not traded on a market (Richardson 1972).[4]

However, there might also be negative effects of clustering (Torre 2008b, Boschma 2005). Dense agglomerations can create different kinds of congestion effects, from the common ones like high property costs and rents, traffic jams and long commuting times to cluster-specific ones. Knowledge spillovers can work in both directions and become knowledge leaks, attracting weaker firms and letting leading-edge firms avoid clusters (Schröder 2013, Shaver/Flyer 2000, Pe'er/Keil 2013). Industrial espionage might be eased, too. The 'Marshallian force' labour market pooling can also come with negative effects when fluctuation is high, raising firms' costs and leading to lower investment in training (Fallick et al. 2006, Shaver/Flyer 2000, Saxenian 1994), or when labour poaching is practised by nearby competitors, co-operation partners, customers or suppliers (Combes/Duranton 2006). For instance, no significant labour pooling effects were found by Bönte (2004) for the Northern German aeronautical cluster or Figueiredo (2014), using comprehensive Portuguese data, and using Italian survey data, Andini et al. (2013) detected weak and industry-specific effects for both firms and workers. Heavy

3 These economies fade rapidly with distance (Rosenthal/Strange 2004; Brakman et al. 2006). For biotech firms Folta et al. (2006) learned that above a cluster size of 65 member firms agglomeration economies (on patenting, attraction of alliance partners and private equity) turn negative.

4 What also comes in here is the implicit use of 'untraded interdependencies' (Storper 1997) like norms, conventions and practices that ease business contacts when shared. This leads to a differentiated view of proximity, and of its cognitive, organisational, social, institutional and geographic dimensions (Boschma 2005).

competition for all kinds of resources was found to be prominent in a declining cluster (Staber 2001). Another possible negative effect is lock-in in 'local systems which are plagued by excessive specialization or trapped in mono-activity' (Torre 2008b: 36, also found by Brixy/Grotz (2007) for industries in 74 German regions).

In addition to not being sure *per se* whether the positive or negative effects predominate, not all firms are affected equally (Pe'er/Keil 2013, McCann/Folta 2011, Shaver/Flyer 2000). Effects also differ for industries (Maine et al. 2010, Steinle/Schiele 2002) and for the development phases of clusters (Otto/Köhler 2008).

4.2.3 Clusters and establishment survival

As for the effects of clusters on firm survival, evidence on the prevalence of positive or negative impacts is mixed. Studies mainly focus on start-ups. It is supported that in cluster regions entrepreneurship in the respective value-added chains prospers and the newly founded firms reach higher survival rates than those outside the cluster region (Delgado et al. 2010). In a spatial analysis for Germany, Fritsch et al. (2006) showed that the regional factors strongly and positively influenced the development of new businesses and that these effects extended to the adjacent districts. For five Swedish clusters they followed over almost ten years, Wennberg/Lindqvist (2010) found that strong clusters contributed to new firm survival, and they also revealed economic benefits for the region as strong clusters contributed to increased job creation, tax payments and salaries.

When heterogeneity of start-ups is put in the focus of attention, it becomes evident that firms are affected differently by the positive and negative externalities of clusters. Analysing 15 years of independent entrepreneurship in Canadian manufacturing, Pe'er/Keil (2013) showed how the total effect depended on the initial endowments. Start-ups with below-average assets benefited more from clusters. Start-ups with above-average human capital also draw advantages from clustering. De Vaan et al. (2013) argued that project-based industries might react differently than the manufacturing sector, so they studied the global video game industry and found that being located in one of the world's four large clusters worldwide had positive impacts on survival, but the main (and eight times stronger) positive effect came from being a spin-off of an experienced firm. A closer look unearthed the fact that in smaller clusters the negative localisation effects prevailed, but that above a cluster size of 55 firms the positive effects on survival outweigh the negative ones. Folta et al. (2006) found a very similar result for 25 years of biotech firms in the United States, which was that clusters only extended survival above a

total of 53 member firms. Focusing on a declining sector, the knitwear industry in south-west Germany, which is characterised by strong co-operation, Staber (2001) concluded that firm failure increased if co-location of similar firms was high, probably due to hard competition, and decreased if the firms were located in regions with diverse but complementary industries.[5] Shaver/Flyer (2000) observed the location decision of foreign greenfield investment in the United States. The newcomers chose locations where similar industries were present, but in the end they faced lower probability of survival. Stuart/Sorenson (2003) found the same for US biotechnology.

4.2.4 Clusters and establishment growth

Evidence is also mixed for the effects of clustering on firm growth. In a study on the British aerospace industry Beaudry (2001) found higher individual growth rates for firms that are co-located with own-sector companies, but lower growth if other-sector employment is high. These results are confirmed and put on a broader basis in a paper about 56 industries in Britain, where this pattern was detected for about half of the sectors, mainly in the fields of manufacturing, key infrastructure and financial services (Beaudry/Swann 2009). A different measure for growth is used by McCann/Folta (2011). They analysed performance with patents in biotechnology and found significant positive cluster effects on firms with a higher knowledge stock. A study of young successful technology-based firms (biotech and ICT) measured firm growth by sales over five years (Maine et al. 2010). They did not detect an effect for a location within a cluster, but they did for close proximity to a cluster, declining with distance. Globerman et al. (2005) examined the impacts of clusters in Toronto on IT firms and found positive effects on employment growth that tend to be localised to the postal code range, but not beyond. Their results showed no impact on survival. Via a survey of 200 German ICT firms, Schröder (2013) detected that firms belonging to clusters experienced lower growth rates than outsiders. Kukalis (2010) argued that joining a cluster should be detectable in the better financial performance of a firm. Based on the examples of US semiconductor and pharmaceutical firms with data covering a 31-year period, he distinguished between early and more mature stages of the industry life cycle and found that clustered firms only perform better than firms outside clusters in the third decade.

5 Dauth (2010) also concluded that the presence of different, but interrelated industries was conducive to employment growth.

4.2.5 Contributions

Against this background of rather mixed evidence and costly cluster policy the paper makes two contributions at the establishment level. First, it creates and uses a unique cluster-oriented database that allows the identification and modelling of Eastern Bavaria's ten clusters and their structures close to reality. The fresh look here is the focus on participation in clusters, going back to the origin of the concept and contributing to a better understanding of what really happens in a cluster region. To generate benefit from clusters and the 'Marshallian forces' it is not necessary to be part of some artificial construct, but it is vital to practically participate in regional value-added chains and use what regional resources have to offer – be it called 'cluster' or not. CORIS singles out the establishments that demonstrate their interest in the ten regional value-added chains independent of their size, age and industry affiliation. This contrasts studies that rely on top-down cluster identification strategies, which, due to data constraints, often include all firms of certain industries, whether they are active cluster members or not. Other studies focus on cluster membership lists, but this comes with strong self-selection constraints. The approach in the present paper connects a pragmatically-oriented cluster participation indicator with highly reliable longitudinal establishment data. Hence, the positive effects of clusters are detectable in a more direct and less biased manner.

Consequently, the key hypothesis is that establishments located in a cluster region benefit from active participation in the regional clusters. In line with the mainstream they are expected to have a higher probability of survival and higher employment growth than establishments that do not participate. The second contribution that extends the view is the testing of this hypothesis with a control group approach. The treatment and the control group draw on the IAB Establishment History Panel that is supplied with administrative data and thus is highly reliable. As the literature overview revealed, it is necessary to control for establishment characteristics as well. The database contains a range of such variables on an annual basis for the entire period of 2001 to 2010.

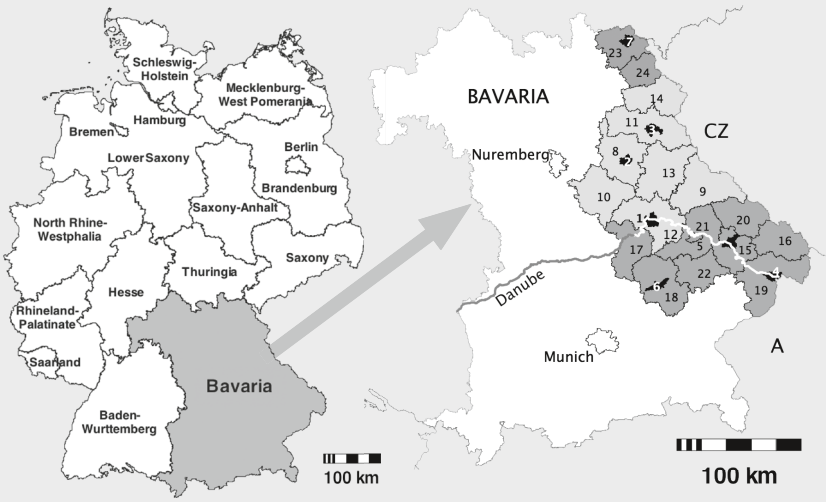
4.3 Building the database

This section first sketches the region from which the data stems. Second, it introduces cluster participation and outlines the respective data collection, and third, it presents the longitudinal database and the construction of the treatment and control groups.

4.3.1 The region under study

The region under analysis is Eastern Bavaria, depicted in Figure 4.1. It is located in the south-east of Germany and is clearly demarcated to the east by the national Czech-German border, the former Iron Curtain. The delineation to the neighbouring Bavarian regions is softer, as 'Eastern Bavaria' is not defined by administrative boundaries.[6]

Figure 4.1: Eastern Bavaria



Notes: On the left, the Federal State of Bavaria in the Federal Republic of Germany. On the right, Eastern Bavaria with the university cities in black: district of Upper Palatinate (light grey) with university cities Amberg (2), Regensburg (1) and Weiden (3); parts of the district of Lower Bavaria (dark grey) with the university cities Deggendorf, Landshut (6) and Passau (4); parts of the district of Upper Franconia (dark grey) with Hof (7). Regarding the list of districts, please see Appendix A.

Source: author's own illustration.

The shape of the economic space originates from the research project's strong orientation towards functional considerations described in Section 3.2. It traced the main arteries of regional value-added chains along their interlinkages between economic actors. Hence, the study area is delimited to the south by the strong economic pull of Munich with its international airport and European metropolitan region. To the west there is a vital agglomeration, the European Metropolitan Region Nuremberg, which draws commuters and business with an effective public transport system, for example. In this triangle there is an economic space that was

6 'Eastern Bavaria' is not an official denomination. However, it is used in different contexts – culture, sports, tourism or marketing, for instance.

poor and lethargic for decades, but which started a catching-up process in the early 1980s (Möller 1997). This was mainly triggered in the city of Regensburg by the founding of the university in 1968 and the university of applied sciences in 1971 as well as the setting-up of an automobile plant in 1982. The latter brought demand for geographically close first- and second-tier specialised suppliers already located in the region and also attracted new plants, clustering for instance in the Innovation Park Wackersdorf since 1990. Some large electronic producers and innovators also increased their activities. A second university and five more universities of applied sciences were founded in the smaller towns during the 1990s. As the region shares a border of 357 km with the Czech Republic (CZ)[7], the Fall of the Iron Curtain in 1989 and the Czech accession to the European Union in 1994 brought some major changes and opportunities to economic actors in Eastern Bavaria (for labour market effects see Moritz (2009)).[8]

Eastern Bavaria's economic centre is the city of Regensburg (no. 1 in Figure 4.1), one of the boom towns in Southern Germany (for framework data see Appendix 4.A). From 2001 to 2010 the population increased by roughly seven per cent, hence a great deal more than in all Bavaria. Eastern Bavaria's northern and eastern districts faced a population loss. This is an area characterised by the rural and touristic Bavarian Forest. The districts and towns along the River Danube and an important motorway gained in population. The development of employment shows a similar pattern. What is rather impressive is the catching-up that was achieved concerning the numbers of highly qualified employees, of which Bavaria gained about 29 per cent, Eastern Bavaria 38 per cent and Regensburg 41 per cent. Employment in manufacturing, traditionally a strong sector in the region, grew by about three per cent in Bavaria and Eastern Bavaria, and about eight per cent in Regensburg in figures, but the shares in total employment fell in all three regions. These dynamic developments and structural changes as well as the cluster background make Eastern Bavaria rather an interesting region to study.[9]

4.3.2 Cluster participation database

A research project on cluster structures in Eastern Bavaria started in 2000. As no cluster organisations existed yet, the first aim was to unearth the region's cluster potential. After an analysis of statistical data and documents, roughly 120 semi-

7 Regierung der Oberpfalz.

8 For instance, as a response to the neighbouring European metropolitan regions the trinational cross-border European Region Danube-Vltava was founded in 2012 (A-CZ-D).

9 The dynamism can also be detected in the popular location rankings in which the Regensburg agglomeration has reached national top ranks in dynamics and innovative capacities for over a decade (e.g. Wirtschaftswoche Dynamikranking (www.wiwo.de), Prognos Zukunftsatlas (www.prognos.com)).

structured face-to-face interviews with experts from firms and institutions were followed by a written establishment survey.[10] The methodology is a combination of methods – starting with a bird's eye view and complementing the analysis with a fine-grained bottom-up approach. The main focus was to trace establishments' activities as suppliers, producers, customers, or service or co-operation partners along the characteristic regional value-added chains.[11] With a set of five criteria[12] the data collected was used to identify Eastern Bavaria's functional specialisation or cluster potential. Ten clusters were identified.[13]

The second aim was to depict the uncovered cluster structures in the web-based cluster-oriented regional information-system CORIS, online since 2001. It shows the establishments and institutions involved as well as their forward and backward interlinkages and co-operations. A tool for establishments to (newly) supply and update their information is also implemented. On December 31st, 2010, the online database contained cluster-related data on 1,514 establishments.[14]

4.3.3 Delineation of the treatment and the control groups

The paper's hypothesis is that establishments participating in clusters show better economic performance over ten years than that of establishments not participating. As it is impossible to observe the same establishments in both situations simultaneously, the counterfactual situation for each participating establishment is constructed by identifying an establishment with similar characteristics in a much larger group of others to perform a comparison of potential outcomes. To create the necessary treatment and control groups, two databases are linked: The IAB Establishment History Panel (*Betriebshistorikpanel* BHP) and the CORIS database.

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10 A rough idea of the value-added chains was derived from document analysis and the analysis of administrative data. Such top-down approaches can yield valuable insights into regions and clusters (Brachert et al. 2011, Sternberg/Litzenberger 2006). An exhaustive set of potential clusters was also pre-identified by means of interviews with institutional representatives. When this information was complemented by bottom-up methods – these are necessary if cross-industry linkages of regional value chains, vertical clustering and spatial particularities are considered (Atherton/Johnston 2008, Feser et al. 2001) – not all could be confirmed.

11 Thus, in the interviews and the written survey (315 questionnaires returned) questions focused on the topics that constitute Porter's cluster concept and are the daily business of management personnel and straightforward for them to answer. As the notion 'cluster' was hardly known to practitioners and even today is considered a fuzzy concept (Enright 2003, Martin/Sunley 2003), the surveys were designed to avoid this term.

12 Identification was made with a set of five criteria: concentration of industries in space, labour market pooling, presence of technology or market leaders, existence of support institutions and network activities.

13 Automotive Industry, Electronics & Electrical Engineering, Specialised Machinery, Plastics Industry, Biotechnology, Information Technology, Glass & Glass Processing Industry, Porcelain & China and Logistics & Specialised Trade, complemented with Sensor Technology in 2005.

14 It also contained 132 institutions and 104 co-operation projects not used in the analysis here.

The BHP contains annual data for all establishments in Germany with at least one (marginal part-time) employee liable to social security (data description see Gruhl et al. (2012))[15]. As the BHP draws on the German social security notifications, administrative data stored in the 'Employment History', it is quite a reliable source that is used in many research projects. Regional information is available in detail, so longitudinal data for Eastern Bavaria could be extracted. The second database is CORIS.[16] The latter is employed only to identify the establishments participating in the ten Eastern Bavarian clusters. This classification is done with the ReLOC record linkage method (Schäffler 2014). Hence, the analyses in the following sections are performed with BHP data only.

This newly created cluster participation database has the necessary properties to study the research question and makes a strict evaluation design possible based on a control group approach. Affiliation in CORIS allows the straight identification of the treatment group. This web-based information system is (a) open to all interested establishments for data entry, irrespective of size, industry affiliation or location in the region; (b) free of charge; (c) straightforward to handle; (d) run by a university and a research institute, so the purpose of data collection is a neutral and scientific one and explicitly does not serve the operators to earn money. Hence, the hurdles for data entry are rather low and affiliation is not *a priori* restricted to some predefined subgroups or cluster members. This reduces self-selection, a problem in many studies based on membership in organised clusters that usually involves cost and can be time-consuming. Another difference from other analyses is the focus on ten clusters simultaneously.

CORIS is designed to appeal to firms to show their embeddedness in the Eastern Bavarian value-added chains. They can benefit from demonstrating to potential business and co-operation partners their horizontal, forward and backward linkages and existing co-operation projects within the region to generate further business contacts. To fully utilise and contribute to the regional structures it requires transparency and awareness, so participating establishments make the effort to supply this specific information in CORIS. This does not appeal to all establishments that would supposedly fit into one or more of the ten clusters by their industry affiliation, for instance; concurrently it appeals to some establishments that would not have been detected by top-down analyses as being

15 Reported annually on June 30th since 1975. It includes information on total employment, the share of qualified as well as highly and low qualified employees, location, industry affiliation (5-digit) and the date of the first and last record.

16 Only establishment information is used. Institutions and co-operation projects are excluded.

part of these value-added chains.[17] Hence, the approach chosen here returns to the origins of the cluster concept. What is contained in the database mirrors the practical participation of economic actors in regional value-added chains irrespective of what 'the cluster concept' declares. The pragmatic participation in clusters should be detectable by better economic performance.

For modelling a corresponding [0,1]-dummy variable is used. No difference is made between the affiliations to the ten clusters, as merely cluster participation in general is important here. The analysis is restricted to the period between 2001 and 2010, delineated by the year CORIS went online and the latest available BHP version. Table 4.1 displays the numbers of establishments in the treatment and control groups used for the two analyses.

Table 4.1: The treatment and the control group for the two analyses

	Treatment group: CORIS	Control group: BHP
Total entries	in 2010: 1,514 unmatched 1,176 matched[18]	2002–2010: 152,397
For survival analysis (Chapter 4.5) all start-ups 2002–2010 excluded	937	88,855
For growth analysis (Chapter 4.6) all start-ups and exits 2002–2010 excluded	782	50,985
Notes: Number of establishments		
Source: BHP; CORIS; author's own data selection.		

4.4 Covariates and hypotheses

In the following the covariates used for both the survival analysis and the propensity score matching are introduced and discussed. All are based on the information supplied for 2001, before analysis time starts.

4.4.1 Establishment size

As for the relationship between firm size and establishment survival a vast range of studies showed that larger establishments have a higher probability of survival

17 For instance, there are production plants in the electronics industry that only serve the (inter)national markets and are not embedded in the Eastern Bavarian cluster. One example of an establishment outside the typical industries is a gardener, surprisingly part of a cluster.

18 1,176 of the 1,514 cluster-participating establishments could be identified, the rest being small ones with no employee liable to social security and thus not included in the BHP.

than smaller ones (Fackler et al. (2013), also using the BHP; Bernard/Jensen 2007, Evans 1987). This can be seen as a stylised fact. One Canadian research project studied the relation between firm survival and growth and found a trade-off between the two outcomes. It was not the firms with hyper or strong growth that had the highest seven-year survival rates, but the ones with slow employment growth (Halabisky 2006).

The effect of an establishment's size on its employment growth is not a straightforward one. Many recent studies challenged Gibrat's Law of Proportionate Effect from 1931, according to which a firm's employment growth rate is independent of its size at the beginning of the time of analysis. Lotti et al. (2009) found that the law still holds when the failure of firms over the observation period was taken into account. Only the most efficient firms survived, and their employment development was independent of their initial size. However, there is also evidence for smaller firms having higher growth rates than larger ones (Harhoff et al. 1998, Evans 1987).

Establishment size here is measured by the total number of employees liable to social security on June 30th, 2001, including part-time employees (Gruhl et al. 2012). As for survival, a positive relation with establishment size is expected. Concerning the size effect on establishment growth it is anticipated to be insignificant as only the establishments existing throughout the ten-year observation period are included in the analysis.

4.4.2 Establishment age

Most studies concerning firm survival and growth focus on start-ups, but often do not include mature companies – some exceptions are reviewed here.[19] The evidence is quite mixed. In his overview of German studies, for instance, Wagner (2006) summarised that the risk of closing-down was high for the first years of a firm's existence but continuously declined with age (also Evans (1987) for the US). Some studies find a U-shaped firm-specific hazard function of age. Fackler et al. (2013) and Schindele/Weyh (2011), for instance, both used the BHP and found a minimum risk at 15 to 18 years of age, and Loderer et al. (2009) found a turning point at age 37 for all exit forms. The hazard of bankruptcy stayed quite constant over firm age with 2.5 per cent for start-ups.

As for the causality between establishment age and growth, Wagner (2006) condensed his review in the evidence that employment growth slowed

19 Fort et al. (2013) observe firms' employment development after exogenous shocks and find that the interplay between firm size and firm age when analysing exit and growth is rather important to include. When only looking at firm size it is omitted that many older firms are also small and react differently.

down with age (in line with Evans (1987), Schröder (2013) and Harhoff et al. (1998)). Halabisky (2006) showed that start-ups contributed most to aggregated employment growth and firms older than eight years of age contribute most to lay-offs. Barba Navaretti et al. (2013) focussed explicitly on both positive and negative employment growth and detected a negative age effect on growth for expanding firms, whereas downsizing happened independent of age.

In the present paper establishment age is measured pre-analysis time in 2001. The BHP dataset starts in 1975, so 20.4 per cent of all establishments that were founded earlier are listed by the date of foundation of January 1st, 1975. They are treated as [0,1]-dummies. All the younger firms are included with their age in years. As for hazard rates, a U-shaped relation with establishment age is expected. As for the minimum of the curve, or the maximum of survival probability, it is likely to be beyond the reportable age of 26 years. A negative effect is anticipated for the influence of establishment age on employment growth.

4.4.3 Share of highly qualified employees

For survival analysis the share of highly qualified employees in firms is rarely the focus of attention. This may be due to the emphasis of studies on young firms (overview by Teixeira (2002)), so qualification is addressed mainly with regard to the founder. The few studies that dealt with it directly used different measures and found that the higher the percentage of qualified employees, the lower the exit probability (Fackler et al. 2013, Bernard/Jensen 2007, Mata/Portugal 2002). This direct result is confirmed by a detour via the resource-based view of a firm (Penrose 1959). It is the firm-specific combination of resources including human capital being crucial for success. Highly qualified employees adapt training measures better and subsequently contribute to establishment productivity, market performance and hence employment growth (Rauch et al. 2005 Black/Lynch 1996). Human capital also influences innovation outcome, as highly qualified employees adapt new technologies better, coming into the firm for instance via knowledge spillovers through co-operation.[20] However, even if innovation is a strong contributor to firm survival in the long run, in the early years it causes instability and increases the probability of exit (Buddelmeyer et al. 2010). However, mostly a positive relation is found (Pe'er/Keil 2013, Cefis/Marsili 2005, Blechinger/Pfeiffer 1999).

Concerning establishment growth, most studies deal with the qualification of the management. One of the few to analyse the impact of highly qualified

20 This is called the 'absorptive capacity' of a firm, see Cohen/Levinthal (1990).

employees directly found a positive effect (Koch et al. (2012) with the same data source as the present paper).

Here, the measure is derived from the BHP dataset that 'contains the number of employees in an establishment who have a degree from a specialised college of higher education (Fachhochschule) or a university degree' (Gruhl et al. 2012: 31). For the present analysis the named figure is set in relation to the total number of employees. It is hypothesised that a higher share of highly skilled employees exerts a positive influence on both establishment survival and growth.

4.4.4 Location in a city with a university

Eastern Bavaria possesses seven towns and cities with over 40,000 inhabitants and all but one hosts a public university or university of applied sciences. So the outcome measured here could also be interpreted as a city-size effect. However, as one of the institutions is located in an even smaller town and Regensburg is the only city with over 100,000 inhabitants, arguing with outcomes of agglomeration studies is not convincing, even if the smaller towns are regionally relevant hubs. However, the foundation of these institutions was part of the declared policy of the State of Bavaria to lead more young people from the periphery to higher education in order to keep these qualified people in their regions, thus also raising the number of degree holders as potential employees for firms located outside the agglomerations. Consequently, the following brief insight into the literature and also the interpretations in the course of the paper concentrate on analyses of university-industry links.

Building on this discussion, universities are a prominent location factor (Goldstein 2009, Saxenian 1994) and feature prominently in the cluster literature (Porter 2000). What is expected are positive effects of knowledge spillovers between establishments and academia (Hall et al. 2003, Cohen et al. 2002, Jaffe 1989) that are seen as key elements for both firm survival and growth.

The spillovers of tacit knowledge happen more easily through face-to-face contacts and thus are bounded to an economic space (Muscio 2013). However, geographic proximity is only part of the story (Boschma 2005), even if studies like Anselin et al. (1997) showed that universities' co-operation impact radius was 75 miles and Andersson/Karlsson (2007) detected that knowledge flows stayed mainly within the functional urban region. From a policy perspective, a maximum distance of about one hour's travel time between partners is given as a rule of thumb for creating successful clusters (Sölvell et al. 2003). In addition, for knowledge transfers from academia to firms, the fit between the scientific orientation of universities and industries also has to be good enough (Bonaccorsi

et al. 2013). A second important role of universities in a region is the development of qualified labour (Goldstein 2009), which also enables firms to gain access to highly educated personnel (Hall et al. 2003). Abel/Deitz (2012) found that it is mainly increased research and development in firms due to the spillovers creating a higher demand for skilled labour that led to growing regional human capital.

In the model, the location of an establishment in one of the seven cities with a university or a university of applied sciences is included as a [0,1]-dummy variable. Eastern Bavaria's institutions of higher education are quite evenly scattered, so they can easily be reached by establishments. They were all founded in the late 1960s or later and are well aligned with the regional industries. Consequently, being located in such a city is not expected to have a significant effect on establishment survival or growth.

4.4.5 Industry affiliation

As there are industry agglomeration externalities on establishment growth (Beaudry/Swann 2009, Harhoff et al. 1998) and survival (Renski 2012, Cefis/Marsili 2005, Audretsch et al. 2000), industry controls are included in the models with the help of 14 dummy variables that are constructed by grouping five-digit industries of the WZ93, the German industry classification.

4.5 Survival analysis

The purpose of this section is to check the hypothesis that establishments participating in clusters have a higher probability of survival than those in the control group of non-participants.[21] In a first step, descriptive results are displayed by the survivor functions of the two groups (see Figure 4.2). They are calculated with the standard non-parametric Kaplan-Meier estimator (Kaplan/Meier 1958), which renders the probability of surviving beyond the period of analysis. The event of failure is defined as the exit year of an establishment available in the BHP database.[22] Survival time, correspondingly, is the time to failure. Data is right-censored. Of the 88,855 establishments in the control group, 50,985 or 57.4 per cent survived beyond analysis time and 782 of 937 in the treatment group (83.4 per cent).

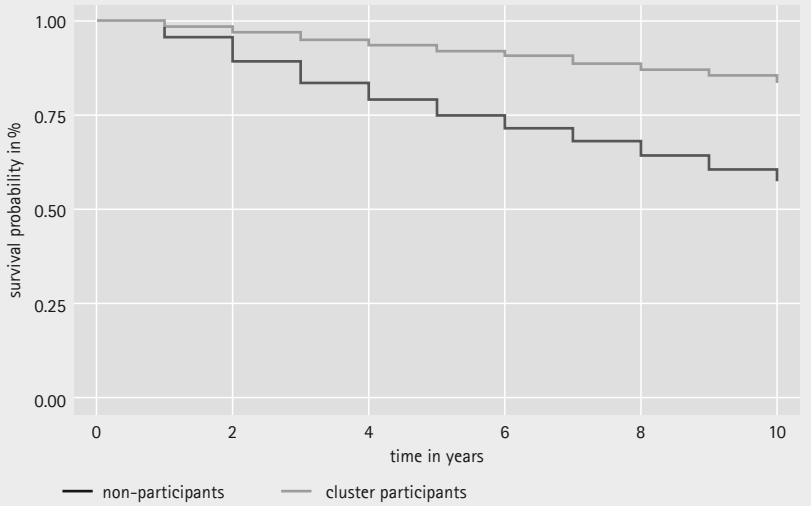
It is evident from Figure 4.2 that firms in the sample of cluster-participating establishments have a higher probability of survival than those in the control

21 For a comprehensive overview of the literature, see Manjón-Antolín/Arauzo-Carod (2008).

22 Fackler et al. (2013) also used the BHP and distinguish clearly between four forms of exit. Takeovers make up around 2 per cent and unclear reasons 0.8 per cent of all exits in the sample.

group (for the annual values of the survival functions see Appendix 4.B). The log-rank test for equality of survivor functions, checking if the two Kaplan-Meier curves are equivalent, confirms that the difference between the survival patterns of two groups is statistically significant. Hence, there is some indication from descriptive evidence that regional cluster participation is conducive to staying in business.

Figure 4.2: Kaplan-Meier estimates of establishment survival



Notes: Estimates of cluster participants and non-participants; N (control group) = 88,855; N (treatment group) = 937.

A drawback of the Kaplan-Meier estimates is that they do not take into account that the treatment and control group might differ with respect to other characteristics that could be relevant for survival time as well. Therefore, in a second step, Cox proportional hazards models are estimated (Cleves et al., 2010: 129 ff.). A Cox model takes the opposite view of firm survival, as it is based on the hazard rate. It measures the risk of establishment failure at time *t* relative to the probability of establishment failure past time *t* (survival). To compare the risk of two groups, the hazard ratio is used. The Cox model does not make assumptions about the shape of the hazard function and allows for the simultaneous controlling for additional explanatory factors of establishment survival. The covariates considered here are those introduced in Section 4.4, all taken in the analysis with their values in 2001.

The baseline model, with the cluster participation dummy as the indicator variable, renders a hazard ratio of 0.33 (column 1 of Table 4.2). So over the observation period the hazard for cluster participants of going out of business is about one third of the risk for non-participating establishments. The Cox model

assumes that the hazard ratio as the relation between the two hazard functions stays constant over time. This assumption is fulfilled here.

Table 4.2: Results of Cox proportional hazards models (hazard ratios)

_t (time to event)	(1)	(2)	(3)
Dummy cluster participation	0.3306*** (0.027)	0.4704*** (0.038)	0.5549*** (0.051)
Participation x total employment			1.0161*** (0.001)
Total employment		0.9885*** (0.001)	1.0318*** (0.001)
Share highly qualified employees		0.9544 (0.053)	0.9218 (0.052)
Share HQ x total employment			1.0304*** (0.007)
Age in 2001		0.9895*** (0.001)	1.382*** (0.005)
Age in 2001 (squared)			0.9957*** (0.000)
Age x total employment			0.9993*** (0.000)
Location in city with university		1.115*** (0.015)	1.148*** (0.016)
Univ. loc. x total employment			0.9911*** (0.001)
Time x total employment			0.9907*** (0.000)
Time x age in 2001			0.9647*** (0.000)
Industry controls	no	yes	yes

Notes: standard errors in parentheses; * p > 0.10, ** p > 0.05, *** p > 0.01;
N (control group) = 88,855; N (treatment group) = 937.

To check which predictors could be relevant to the final model univariate, analyses are conducted for all available variables, with log-rank tests of equality for categorical variables and univariate Cox proportional hazards models for continuous variables (following IDRE 2013). Each covariate has a p-value of above 0.25. All the significant variables are included in the basic model (column 2). The analysis shows that the hazard ratio of the cluster participation dummy changes from 0.33 to 0.47, so part of the difference in risk of failure between participating and non-participating establishments is explained by the covariates included in Model 2. The hazard ratios of both establishment size and age in 2001 are highly

significant and, at 0.99, rather close to unity. This result indicates that these two covariates hardly affect establishment failure. It is interesting to note that the share of highly qualified employees does not have a significant influence on the time-to-event. Furthermore, Table 4.2 shows that being located in a university city rather than in a location without a university *ceteris paribus* increases the probability of failure by 12 per cent. This is unexpected, but might reflect that the economic space of Eastern Bavaria is indeed well-endowed with universities and universities of applied sciences scattered across the region. As no establishment is more than the critical distance of 120 km away (Anselin et al. 1997), a peripheral location might not have too large an effect. It might also reflect an urban-rural divide. Business life in cities can be more dynamic, also bringing higher risk with it.

Model 3 also considers squared terms and interactions (column 3). The quadratic term for age is included to check if there is a non-linear influence on establishment risk of failure.[23] For interpretation, its 'raw' coefficient, the logarithm of the hazard ratio, is needed. It is slightly negative, which is associated with an inverted U-shaped graph. The effect of age also changes sign. The maximum is outside the defined range, indicating that the effect of age on survival time is stronger for older establishments. This does not support the corresponding hypothesis. For the interactions the possible combinations backed by theory are checked individually and again only the significant ones are included in Model 3. The relevant interactions without time all contain the total number of employees. This explains the coefficient of establishment size changing sign. The interaction of the cluster participation dummy and establishment size has a positive coefficient (logarithm of the hazard ratio) of close to zero.[24] Hence, the effect of cluster participation on the probability of failure increases slightly with firm size. Smaller establishments profit slightly more from clustering than larger ones. Being located in a university city slightly increases the effect on the risk of failure for smaller establishments. The interaction term of age and firm size has a hazard ratio of almost one, so there is hardly a difference in the size effect between older and younger establishments. The interaction of the share of highly qualified employees and establishment size shows that the effect of qualification on the risk of failure is stronger for larger establishments.

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23 A squared term was also checked for establishment size in 2001, as Harhoff et al. (1998) found an inverted U-shape with its maximum risk at around 18 employees for manufacturing and services. Both size and age, analysed separately in models with the respective covariate and its squared form only, are highly significant. However, the quadratic term's hazard ratio of the total number of employees in the short test equation as well as in the larger model is very close to unity, so only age squared is included.

24 If an establishment is not participating in clusters (dummy = 0), then the interaction term is also 0 and the influence of establishment size on the probability of survival is the coefficient of the covariate establishment size (0.03). If an establishment would participate (dummy = 1), then the effect changes to the coefficient of the total number of employees plus the coefficient of the interaction term.

Checking the proportionality assumption for covariates that vary with time, two are identified as significant. First it is noted that the effect of cluster participation is time-invariant. As for the total number of employees and age in 2001 both hazard ratios hardly indicate a difference between the treatment and the control group. For the covariates already contained in Model 2, most interpretations still hold. The newly introduced interactions explain part of the difference in risk between cluster participants and non-participants, as the hazard ratio of the dummy changes from 0.47 to 0.56, so in Model 3 cluster participation reduces the risk of business failure by 44 per cent at any point in time.[25] The paper's first key hypothesis can be confirmed.

4.6 Analysis of growth rates

In this section it is analysed whether there is a difference in the employment development of those establishments participating in clusters and those that do not. The outcome variable is the establishment-level employment growth rate throughout the entire observation period. It is constructed with the 'unconventional' measure also used in Davis et al. (1996: 26) that puts the establishment employment change between 2010 and 2001 in the numerator and the average employment in this time period in the denominator.[26]

$$WR_{i,\,2010} = \frac{\mathrm{emp}_{i,\,2010} - \mathrm{emp}_{i,\,2001}}{0.5 * (\mathrm{emp}_{i,\,2010} + \mathrm{emp}_{i,\,2001})} \qquad (i = 1, \ldots, N) \qquad (1)$$

First an OLS regression is used to check how the covariates influence the ten-year growth rate (see Table 3) and whether the hypotheses can be supported or not. If an establishment was participating in clusters, it had a 0.118 times higher employment growth between 2001 and 2010 than a non-participator, controlling for all other variables. Most covariates are highly significant and confirm the hypotheses: establishment size exerts a small negative influence on growth; the share of highly qualified employees contributes positively and the establishment age in 2001 slightly negatively to the ten-year growth rate. The location in a city with a university displays a negative coefficient. Hence, the hypothesis that a nearby university reduces failure risk is not supported.

25 The likelihood ratio test for the two nested models 2 and 3 shows that Model 3 fits significantly better.

26 The advantage of this measure in contrast to the conventional growth rate is the range of values between 2.0 and -2.0 (instead of $+\infty$ and -1.0) creating symmetry around zero (Davis et al. 1996: 190). This eases interpretation, as positive and negative growth is constructed equally.

Table 4.3: Results of OLS regression

$WR_{i,\ 2010}$	Coef.	(s.e.)
Cluster participation	0.118***	(0.022)
Total employment (x100)	-0.017***	(0.000)
Share highly qual. employees	0.086***	(0.025)
Age in 2001	-0.005***	(0.000)
Location in city with university	-0.028***	(0.007)
Industry controls	yes	yes
Constant	0.163***	(0.013)

Notes: standard errors in parentheses; F-Test (14, ,140) = 43.33;
* p < 0.10, ** p < 0.05, *** p < 0.01; N (control group) = 50,985; N (treatment group) = 782.

The actual analysis of growth rates is performed with propensity score matching (PSM, following Caliendo/Kopeinig (2008)). This method is based on the assumption that a comparison of two outcomes which are incomparable in reality is possible by calculating the difference between the employment development of establishments in the cluster-participating (treatment) group as if they were not participating (control group) to get the populations' average treatment effects. A simple look at the mean growth rates of the two groups would ignore the bias of selection into treatment caused by firm characteristics (*ibid.*: 34). Hence, the idea is to construct the counterfactual situation for each treated firm by finding and matching a similar one in a much larger group of untreated firms and do the comparison of potential outcomes (*ibid.:* 32, Roy-Rubin Model). Similarity is based on a set of covariates that characterise an establishment and are observable before the treatment starts in 2001. They are the same as in the survival analysis in Section 4.5. As it will be hard to find an exact statistical counterpart for each treated establishment even in such a large control group, the construct of a propensity score is used. It is defined as the probability that an establishment participates in the treatment given these characteristics. Several algorithms exist to find good matches (*ibid.*: 41 ff.). The one implemented here is the nearest neighbour matching algorithm with replacement and oversampling with three nearest neighbours (*ibid.*: 42). It matches the three establishments that are closest in terms of the value of the propensity score. The estimation's functional form is a probit model, owing to the binary treatment variable. The analysis is performed using the STATA ado-file *psmatch2* (Leuven/Sianesi 2003). After matching, the balance between the unmatched and the matched situations is checked and the results are rendered by the average treatment effect on the treated (ATT).

The pre-PSM data checks with regression analysis reveal that the influence of cluster participation on the ten-year growth rate varies considerably with establishment size. To deal with this, subclassification is used and the sample is split into quartiles with regard to total employment of all 51,547 firms.[27]

Table 4.4: Size distribution of establishments

		Q1	Q2	Q3	Q4	Total
Cluster participants (treatment group)	*N*	50	52	101	579	782
	%	6.39	6.65	12.92	74.04	100
Non-participants (control group)	*N*	11,833	11,362	14,265	13,525	50,985
	%	23.21	22.28	27.98	26.53	100

Notes: Q = quartile.

In Table 4.4, the subclasses are displayed for cluster-participating establishments and non-participants. Evidently the size distribution for the treatment group has a negative skew with 74 per cent of the establishments being concentrated in the fourth quartile. Hence, the majority of the effects to be estimated would be driven by the large establishments. This causes problems with implementing propensity score matching as the probability of finding a nearest neighbour in the control group is not evenly distributed over the total sample. Consequently, PSM is conducted in two steps: First, an individual and complete propensity score matching analysis is carried out for each of the quartiles, stratified by total employment. In a second step, the four results are merged into one final model. This ensures that even in the full model the matching partners are picked from the same size class or quartile (Caliendo/Kopeinig 2008: 40). As for covariate sample sizes in the split version, no difficulties occur.

For the subclasses Q1 to Q4 the regions of common support are checked graphically and no problems become evident. In Q4 the seven largest establishments are off support. The full range of covariates is included in all four sub-models, but squared and interaction terms are chosen individually to find the best covariate balance with the lowest biases between the matched and unmatched results for each sample (*ibid.:* 43). After this procedure the values of the weight variable (automatically generated by *psmatch2*) of each model are filed. Combining the four results leads to a new weight variable that is integrated in the final PSM model with all the initial covariates.[28]

27 This differs from Rosenbaum/Rubin (1983), who split along the propensity scores.

28 This leads to a double-robust estimate of the treatment effect.

The test results for checking the matching quality are provided in Appendix 4.C. They show that the matching quality of the model is satisfactory and the distributions between the two groups get balanced. It can be used to estimate the ATT, which is the core value to answer the research question of whether cluster participation is conducive to establishment growth.

Table 4.5: Calculation of the average treatment effect on the treated (ATT)

		Treated	Control	Difference	Standard error	T-stat
Employment growth rate 2001 to 2010	*Unmatched*	0.1383	0.0725	0.0658	0.0207	3.21
	ATT	0.1397	-0.0181	0.1578	0.0294	5.36

On the first line, Table 4.5 contains the unmatched case. The establishments participating in clusters display a ten-year growth rate of 13.8 per cent, the non-participants 7.3 per cent. The second line displays the ATT calculated with the final model.[29] The treated establishments have a mean contribution to the ten-year growth rate of 14 per cent. If these establishments would not participate in clusters and thus be members of the control group, they would lose 1.8 per cent of their employees within this decade. The average benefit of cluster participation for the establishments that join the treatment is 15.8 per cent, which is calculated as the difference between these two potential outcomes. Owing to the properties of ATT, this is a causal result and the t-value of well above 1.96 indicates that it is significant. The paper's second key hypothesis is therefore confirmed. Hence, cluster participation greatly contributes to establishment growth.

4.7 Conclusions

This paper contributes to the extensive cluster literature by tackling the research question of whether firms in clusters achieve better economic performance than those outside clusters, an issue which still remains unresolved. The approach here is a novel one, as the delineation of clusters is neither done in a top-down manner nor with the narrow definition of membership in managed clusters, but by analysing establishments' cluster participation. In the region under study, Eastern Bavaria, the database CORIS was built starting in 2001. It depicts ten clusters identified along the regional value-added chains. This was done by

29 The probit model shows that establishment age does not contribute significantly to predict whether an establishment is participating in clusters.

following the main 'arteries' of establishments' forward and backward linkages and co-operation activities. Hence, this goes back to the origin of the concept and contributes to a better understanding of what really happens in a cluster region. To generate benefit from clusters, establishments have to participate practically in regional value-added chains and use what regional resources have to offer. CORIS singles out the establishments that demonstrate their participation in the ten regional value-added chains independent of size, age and industry affiliation. This information on practical cluster participation is connected with the IAB Establishment History Panel, comprising all establishments and drawing on the highly reliable German social security notifications. For the analyses of establishment survival and growth, the cluster participation treatment group contains 1,176 establishments, and the control group over 50,000 for a period of ten years. Hence, this is a unique database that allows a strict evaluation design based on a control group approach.

As for establishment survival, descriptive results show that participating in regional clusters is conducive to staying in business – the shares of establishments still existing after ten years are 83.4 per cent versus 57.3 per cent. Taking covariates into account, the full Cox proportional hazard model renders a reduced risk of business failure for cluster participants by 44 per cent at any point in time. It also shows that smaller establishments profit slightly more from clustering than larger ones, but their risk increases when located in a university city.

For the comparison of growth rates, propensity score matching is used to construct establishments' counterfactual situations of cluster participation and non-participation. The average benefit of participating in clusters for the establishments that join the treatment is 15.8 per cent, so their growth rate on average is considerably higher than if they were not participating in clusters.

Both analyses clearly show that it pays for establishments to participate in the regional cluster structures. For regional economic policy it therefore should be of concern to focus on existing value-added chains and make the structures more transparent. Thus, the existing potential can be accessed by more establishments without having to create new cluster organisations to generate benefit for individual establishments. A valuable direction for future research will be to take a closer look at the individual clusters with their diverse characteristics. A second path would be a comparison with other cluster regions.

Appendix Chapter 4

Table 4.6: Appendix 4.A: Additional region-specific information

	Bavaria		Eastern Bavaria		Regensburg (city)	
	2010	2001	2010	2001	2010	2001
Pop. (31.12.)	12,538,696	12,329,714	2,375,920	2,396,645	135,520	127,198
Pop. density (pop./km²)	178	175	117	118	1,679	1,576
No. of empl. (30.06.)	4,567,987	4,431,011	818,207	792,509	99,332	91,763
No. of unempl. (30.06.)	299,396	332,569	58,463	75,675	4,317	5,365
Unempl. rate, ann. avg. (%)	4.5	6.0	4.6	7.1	6.0	9.0
no. HQ (30.06.)	480,807	371,774	50,745	36,771	14,164	10,033
share HQ (30.06., %)	10.53	8.39	6.2	4.64	14.26	10.93
share empl. manuf. (30.06., %)	27.12	31.57	32.85	37.03	28.73	32.02

Abbreviations: Ann. avg. = annual average, empl. = employees, HQ = highly qualified, no. = number, pop. = population, manuf. = manufacturing.

Source: Statistics of the German Federal Employment Agency, German Federal Statistical Office, author's own calculations.

Districts depicted in Figure 4.1:
Amberg-Sulzbach (8), Cham (9), Neumarkt (10), Neustadt/Waldnaab (11), Regensburg (12), Schwandorf (13), Tirschenreuth (14), Deggendorf (15), Dingolfing-Landau (22), Freyung-Grafenau (16), Kelheim (17), Landshut (18), Passau (19), Regen (16), Straubing-Bogen (21), Hof (23), Wunsiedel (24); city of Straubing (5).

Table 4.7: Appendix 4.B: Kaplan-Meier survival function estimates

Year	No. of survivors	Survival function estimates (s.e.)	No. of survivors	Survival function estimates (s.e.)
	Non-participants		Cluster participants	
2001	88,657	0.9555 (0.0007)	932	0.9882 (0.0035)
2002	84,716	0.8913 (0.0010)	921	0.9732 (0.0053)
2003	79,021	0.8383 (0.0012)	907	0.9517 (0.0070)
2004	74,323	0.7908 (0.0014)	887	0.9378 (0.0079)
2005	70,113	0.7502 (0.0015)	874	0.9206 (0.0089)
2006	66,512	0.7142 (0.0015)	858	0.9077 (0.0095)
2007	63,319	0.6793 (0.0016)	846	0.8873 (0.0104)

Table 4.7 continued

Year	No. of survivors	Survival function estimates (s.e.)	No. of survivors	Survival function estimates (s.e.)
	Non-participants		Cluster participants	
2008	60,221	0.6428 (0.0016)	827	0.8702 (0.0110)
2009	56,988	0.6066 (0.0016)	811	0.8552 (0.0115)
2010	53,782	0.5733 (0.0017)	797	0.8337 (0.0122)

Notes: 203 observations missing (5 cluster participants, 198 non-participants).

Table 4.8: Appendix 4.C: Check for matching quality of the final PSM model

Variable		Mean		%bias	%bias reduction	T-test	
		Treated	Control			t	p>|t|
Total employment	unm.	190.16	12.17	28.5		41.46	0.00
	m.	127.76	114.73	2.1	92.7	0.91	0.36
Share highly qual. employees	unm.	0.075	0.022	40.1		14.46	0.00
	m.	0.074	0.085	-8.4	79.0	-0.02	0.13
Age in 2001	unm.	6.405	7.075	-8.7		-2.36	0.02
	m.	6.435	6.366	-0.9	89.6	-0.30	0.81
Loc. in city with university	unm.	0.234	0.176	14.5		4.24	0.00
	m.	0.230	0.248	-4.6	68.4	-0.82	0.41
Industry controls	unm.	yes	yes	yes	yes	yes	yes
	m.						

Abbreviations: unm. = unmatched, m. = matched.

Assessment of the test results is first done by looking at the %bias column. For each covariate, the mean of the treatment and the control group should be balanced after matching, therefore the difference ought to be no greater than five per cent. This is fulfilled by all covariates. Generally, the mean between the two groups should be reduced by matching, so the second inspection focuses on the bias reduction. What is expected is a positive and preferably high value. Again, all covariates show this pattern. Thirdly, a glimpse of the p-values is also taken. However, they might be quite sensitive to sample sizes, so this step is only made for confirmation. For most covariates there is an evident pattern of the treatment group having a significantly different mean than the control group before matching and an insignificant one after matching.

Summary and conclusions

This thesis is based on CORIS data gathered as part of a cluster research project implemented with the participation of the author. The in-depth information on clusters and cluster participants in the two regions covered, Eastern Bavaria and the Nuremberg region in Central Franconia and adjacent districts, provides a unique data source for studying regional clusters. After a description of and introduction to CORIS, Chapter 2 opens the topic and – against the background of international economic integration – broadly discusses the literature on the presumed effects of clusters on the economic performance of firms. The forward and backward linkages as well as horizontal and diagonal interlinkages in a cluster region demonstrate intra-regional integration. We show that these cluster features, including co-operations, are remarkably well developed in the Nuremberg region and that for establishments the local customers and suppliers are of great importance. One result was the admission of Nuremberg as a European metropolitan region in 2005, which put the agglomeration on the international stage and led to its climbing several positions in international performance rankings.

From this broad spectrum of influences, from which positive externalities for innovation and economic prosperity can be expected, Chapter 3 picks out and highlights intra-regional co-operation. We use CORIS data to study the regional drivers of co-operation with six different groups of potential partners in the eight clusters identified. This question is of some importance, as previous studies have revealed that co-operation in some fields is a key factor for innovation and growth. One of our contributions is the differentiation between cluster affiliation and cluster awareness. The first notion is used to term the allocation of establishments to clusters based purely on functional criteria like products and core competencies, hence this is a 'technical' top-down approach to forming the eight clusters in the region. Cluster awareness, in contrast, encompasses establishments that classify themselves as cluster members in our survey, independent of their functional affiliation. They are supposed to be better informed about the potential rewards of co-operation, guiding them to invest more resources in finding out about possible partners and being more open for co-operation. The main result is that the 'technical' affiliation with clusters has no impact on the general propensity to co-operate. Our second contribution, the differentiation by clusters, reveals only few significant influences, for instance, that co-operation with research and development institutions and universities is a field for manufacturing-oriented clusters like automotive, electronics and medical technology. Co-operation with other establishments is mainly driven by the clusters which are characterised by the business-relatedness of their products and services offered, namely logistics

and transport technology and information and communication technology. What really drives co-operation – apart from projects with research and development institutions – is cluster awareness, hence, whether the establishments know about the cluster structures in the region and are prepared to use them.

Chapter 4 builds on these results and sheds even more light on the difference between 'technical' cluster affiliation and practical cluster participation, focusing directly on the economic performance of establishments. The approach allows the return to the origins of the cluster concept. In short, positive effects of clusters come from regional opportunities offered by forward and backward linkages, co-operation and labour market pooling. For establishments to benefit, it is not necessary to be part of some perhaps artificial construct, but it is vital to participate practically in regional value-added chains and use what regional resources have to offer – whether this is called a 'cluster' or not. With their affiliation in CORIS Eastern Bavaria, economic actors demonstrate their interest and openness towards this participation. With this data, the cluster participants can be identified in the IAB Establishment History Panel, which comprises all establishments in the region with at least one employee subject to social security. This new and unique database allows a strict control group approach. Hence, highly reliable data for the period 2001 to 2010 can be used to compare the economic performance of the 1,176 establishments participating in clusters with the situation of over 50,000 non-participants. Establishment survival is analysed with the Kaplan-Meier estimator and a Cox proportional hazards model. Both results show that over ten years the risk of cluster participants experiencing business failure decreased by about one third at any point in time. Employment growth is explored with propensity score matching. This method constructs the counterfactual situations for participating and non-participating establishments. As the same firms cannot be observed in both situations simultaneously, an establishment with similar characteristics is identified in a much larger group of other establishments to perform a comparison of potential outcomes. The difference in outcome can be attributed to treatment. Concerning firms' employment development, the average growth rate is 15.8 per cent higher for cluster participants than if they were not participating in clusters.

All three chapters of this doctoral thesis come to the conclusion that it pays for establishments to participate in regional clusters. It is shown that the firms embedded in economic structures and value-added chains achieve higher employment growth and run less risk of going out of business (Chapter 4) and that being aware of the cluster structures pushes the propensity to co-operate with different partners. As a wide range of studies show that the positive effects of co-operation by far outweigh the negative effects, the results of Chapter 3

also underline the importance of clusters. Chapter 2 observes that co-operation together with regional forward and backward linkages standing for intra-regional integration strengthens the economic space in the progressing international competition between locations.

For practitioners of regional economic policy the results show that it should be of concern to strengthen existing cluster features and value-added chains. It should be perceived that the positive impacts of clusters are not accomplished because they are called 'clusters', which comes with the risk of creating wishful-thinking or policy-driven clusters, but because some of their features contribute to growth. Hence, one aim of policy should be to create the framework in such a way that regional cluster prerequisites can grow. Likewise, it should be made easier for economic actors to access the opportunities the location has to offer. This can, of course, be done by implementing well-designed cluster management organisations, but the overall aim should be to add transparency to the region's economic structures.

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Abstract

Regional clusters have attracted a great deal of attention for more than two decades. The interest comes from two major fields: regional economics and regional economic policy. At the interface between research and policy, the cluster-oriented regional information system CORIS is located. This research project generates information on supply chains, clusters, cluster participants and their embeddedness in two Bavarian regions. It provides a unique data source used for analyses in the present publication.

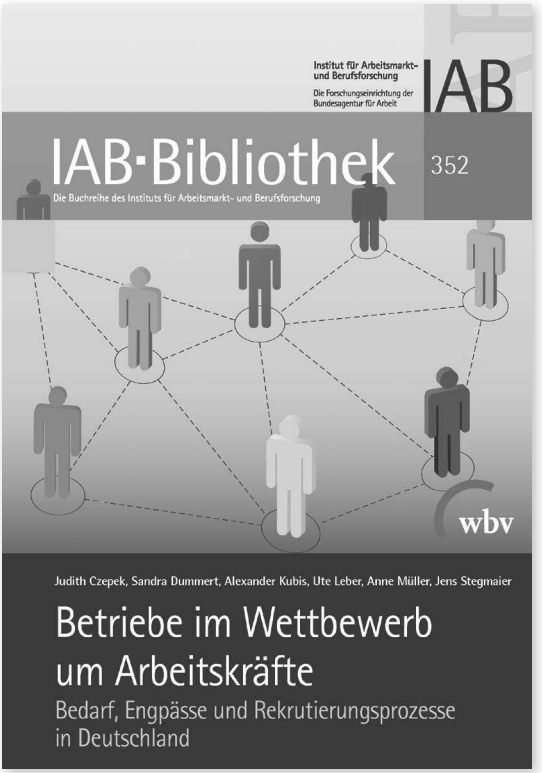
The author first discusses the role which clusters can play in the progressing integration of markets and the international division of labour that accompanies it. For the Nuremberg region, an economic space with a coherent cluster strategy developed early by German standards, establishments' forward and backward linkages as well as horizontal and diagonal interlinkages are analysed. From this spectrum of influences, from which positive externalities for innovation and economic prosperity can be expected, Chapter 3 picks out and highlights intra-regional co-operation. The authors find that it is mainly the establishments' awareness of the cluster structures in the region that drive co-operation. The last chapter investigates the impacts of clusters on establishments directly, implementing an evaluation design based on a control group approach. It is revealed that both survival rates and employment growth of establishments demonstrating their cluster participation are significantly higher than that of firms that do not position themselves in clusters.

Kurzfassung

Seit mehr als zwei Jahrzehnten stehen Wirtschaftscluster im Fokus sowohl der regionalökonomischen Forschung als auch der regionalen Wirtschaftspolitik. An der Schnittstelle zwischen Wissenschaft und Praxis ist das cluster-orientierte regionale Informationssystem CORIS angesiedelt, ein Forschungsprojekt, das für zwei bayerische Regionen Informationen über ihre Wertschöpfungsketten, Cluster, Clusterakteure und ihre Einbettung erhebt. Diese Daten bilden die Basis für die vorliegende Publikation.

Die Autorin setzt sich zunächst mit der Rolle von Clustern im Zuge der fortschreitenden Integration von Märkten und der damit einhergehenden internationalen Arbeitsteilung auseinander. Für die Region Nürnberg, einem Wirtschaftsraum mit langjähriger schlüssiger Clusterstrategie, werden die Vorwärts- und Rückwärtsbindungen der Betriebe sowie ihre horizontalen und diagonalen Verflechtungen betrachtet. Aus diesen möglichen Einflussgrößen, von denen positive Wirkungen auf wirtschaftlichen Wohlstand und Innovation erwartet werden, greift Kapitel 3 die Kooperationen innerhalb einer Region heraus. Es zeigt sich, dass hauptsächlich das Bewusstsein für die Clusterstrukturen im Wirtschaftsraum die Kooperationsneigung der Betriebe antreibt. Im letzten Kapitel werden mit einem Kontrollgruppenansatz die Einflüsse von Clustern auf Betriebe direkt untersucht. Die Autorin kommt zu dem Schluss, dass aktiv an regionalen Clustern und Wertschöpfungsketten beteiligte Betriebe sowohl eine höhere Überlebensrate als auch höheres Beschäftigungswachstum aufweisen.

Arbeitskräftenachfrage am deutschen Arbeitsmarkt



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Judith Czepek, Sandra Dummert, Alexander Kubis, Ute Leber, Anne Müller, Jens Stegmaier

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As many establishments are embedded in regional economic structures, their competitive advantages also depend on local conditions. In many regions, these are shaped by regional clusters. Hence, for more than two decades, clusters have attracted a great deal of attention from regional economics and regional economic policy.

Which role can clusters play in the progressing integration of markets and the international division of labour that accompanies it? What drives intra-regional cooperation between establishments? And do establishments that position themselves in clusters differ from others in terms of survival rates and employment growth? These are the questions Nicole Litzel addresses using the example of two economic areas in Bavaria, based on data from the cluster-oriented regional information system CORIS.

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