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The knowledge economy and the economic crisis in Germany. Regional development, structural change and labor market regions

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Abstract:

Regions in Germany are facing an intensifying structural change towards the knowledge economy which is affecting spatial patterns of growth. Features of such a change know many facets: fierce competition for skilled, mobile and motivated labor force, unemployment of non-qualified labor, longer commutes, multi-local households, re-concentration of the value chain, increased knowledge intensity of innovations, triple-helix collaborative ventures, structural weakness of public budgets, etcetera. These changes result in uneven spatial development, concentration in polycentric large-scale urban regions and increase in spatial disparities. The question arises how this structural change affects the territory of Germany, where securing equivalent living conditions still counts among the basic constitutional principles. We hypothesize that knowledge intensive employment tends to concentrate in two different spatial environments: (1) urban metropolitan centers and (2) network nodes with specialized knowledge resources. Both spatial configurations qualify by their combination of agglomeration economies and network economies. And both spatial environments tend to provide an optimum of geographical proximity and relational proximity, which eventually enable systematic knowledge creation. We test our hypothesis by analyzing the employment from 1998 to 2010 in 16 branches of the knowledge economy with a shift-share analysis. We argue that structural change and the economic crisis from 2009 intensify regional disparities while inducing relative employment shifts.

Keywords: employment growth, economic crisis, knowledge economy, labor market regions

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1 Introduction

The employment structure in German labor market regions is undergoing extensive changes. Several factors contribute to this development. Firstly, we observe a structural change towards knowledge intensive business activities, which affects the spatial organization of firms and people. Since knowledge creation is an interactive process which is enabled by geographical and relational proximity between these actors (Vissers and Dankbaar 2013; Lawson 1999; Amin and Roberts 2008; Bathelt, Malmberg and Maskell 2004), accessibility to specific knowledge resources and skills plays a significant role for economic performance (Bentlage, Lüthi and Thierstein 2013). The second factor is given by several economic crises and recessions such as the dotcom crisis at the beginning of this millennium and the financial crisis of the years 2008 to 2010, which caused an additional impetus on the transformation of the world and, in particular, of the German economy (Dicken 2007: 525; Zarth 2011a, 2011b; Martin 2011; Schwengler and Loibl 2010; Aalbers 2009). Thirdly, due to demographic changes the population and employment in Germany are both declining. Economic transformation and structural change go hand in hand with shrinkage and growth in labor market regions.

These development processes induce a reorganization of interdependencies and interrelationships between regions. Within the German context the Federal Institute for Research on Building, Urban Affairs and Spatial Development monitors regional disparities while looking at the development of demography, economy, labor markets, welfare, infrastructure and housing markets (BBSR 2011: 19). According to this spatial observation, economic output, given by the gross domestic product per employee, tends to concentrate in metropolitan regions in the western part of the country (BBSR 2011: 20). Generally, rural areas particularly close to the eastern boundaries of Germany are less competitive, although specialized locations with a high productivity might exist. The same holds true for the labor markets. Accordingly we expect to observe impacts on the spatial structure in Germany. Since spatial accessibility and the availability of highly qualified labor provide a competitive advantage, knowledge intensive business activities tend to grow in urban metropolitan regions. Thus, we assume that disparities between urban metropolitan regions and peripheral areas tend to increase.

Against this backdrop of increasing regional disparities, spatial planning in Germany aims to secure equivalent living conditions throughout the entire nation state. This planning principle is written down in the basic law of the federal state of Germany (Bundesministerium der Justiz und für Verbraucherschutz 2012: 72 and 74) and in regional planning programs. This normative planning approach with a ubiquitous provision of basic services and commodities faces an increase of uneven economic development within the last decades (Capello et al. 2012).

This paper examines the development of knowledge intensive employment in German labor market regions and shows preliminary results. The paper is structured as follows: the next section reflects the knowledge creation process on the German planning principle of equivalent living conditions and the

concept of central places. Section three provides the hypotheses. Section four describes the data base and the methods. Section five shows the results and section six concludes with our findings.

2 Knowledge economy and spatial development

Within the last two decades knowledge gained in importance for economic processes (Kujath and Zillmer 2010). This economic change is involved in a spatial reorganization of value chains and firm locations (Lüthi 2011; Thierstein et al. 2006). These observations indicate that accessibility to knowledge is a crucial precondition for economic development. The application and the transfer of knowledge represent the competitive advantage of firms. Agglomeration and network economies provide a profound setting to understand the importance of geographical and relational proximity as nuclei of the concentration of knowledge. This section introduces the theoretical background of knowledge creation from a spatial perspective.

Economic activities and knowledge as a resource in particular show an unequal distribution across space (Dicken 2011: 25). Indicators of knowledge assets such as the share of highly qualified personnel, numbers of patents or research and development activities tend to be strongly concentrated in certain locations and regions. Instead of considering the world a levelled playing field (Friedman 2007), Florida (2005) states the hypothesis that the 'world is spiky' due to the concentration of innovating and knowledge resources in interconnected cities (Florida 2005). Such regional disparities are also observable in the European context (Capello et al. 2012: 3-10). Capello (et al. 2012) have shown that research and development activities as well as ambitions to enlarge the knowledge base have different regional outcomes of economic performance (Capello et al. 2012: 42).

A number of concepts have been developed to define this process of knowledge creation. The innovative milieu (Fromhold-Eisebith 2004; Crevoisier 2004; Maillat 1998a, 1998b; Barrison, Kelley and Gant 1996; Crevoisier 1993), the learning region (Rutten and Boekema 2012, 2007; Hassink 2001; Geenhuizen and Nijkamp 2000; Maillat and Kebir 1999; Florida 2007, 1995) or regional and national innovation systems (Brenner et al. 2011; Zabala-Iturriagagoitia et al. 2007; Koch and Stahlecker 2006; Edquist 2004; Lundvall 1992; Cooke 1992) provide insights in learning processes within a spatial and social context. According to these approaches, there seems to be a shift from the view of knowledge as a commodity or object to the perspective in which "knowledge must be conceived of as activity and process" (Vissers and Dankbaar 2013): 702). In this regard, agglomeration economies assume that geographical proximity fosters innovation by making knowledge spillovers more likely (Lambooy 2010; Trippl and Maier 2010; Capello 2009; Simmie 2004; Howells 2002; Simmie 2002). These uneven spatial structures result in regional disparities regarding the ability to learn, absorb and produce knowledge.

The effect of agglomeration economies differs according to the type of value creation. Technological change has a clear influence on how the agglomeration effects are exploited (Phelps and Ozawa 2003). In times of an ongoing structural change towards knowledge intensive activities, spatial proximity combined with supra-regional connectivity represent an anchor point for knowledge creation (Bentlage 2014). In this regard cities within urban metropolitan areas represent the engines for growth. These cities provide a sheer size of the labor market with sufficient variety of talents and ideas. Additionally, access to air transportation, high-speed rail and intra-urban public transport networks foster the interaction between internal and external knowledge resources.

Krätke (2007) describes a process of "Metropolisation" as "a paraphrase for the increasing concentration of economic development potentials of the research-intensive industries and knowledge-intensive services on metropolitan regions and urban agglomerations." (Krätke 2007: 5). This perception indicates clearly that each economic system corresponds to a spatial setting. Nevertheless there mismatches between these processes and spatial structure might occur. By means of centrally places spatial planning in Germany aims to provide equivalent living conditions throughout the country and therefore acts as a counterforce against this tendency of concentrating knowledge in metropolitan areas.

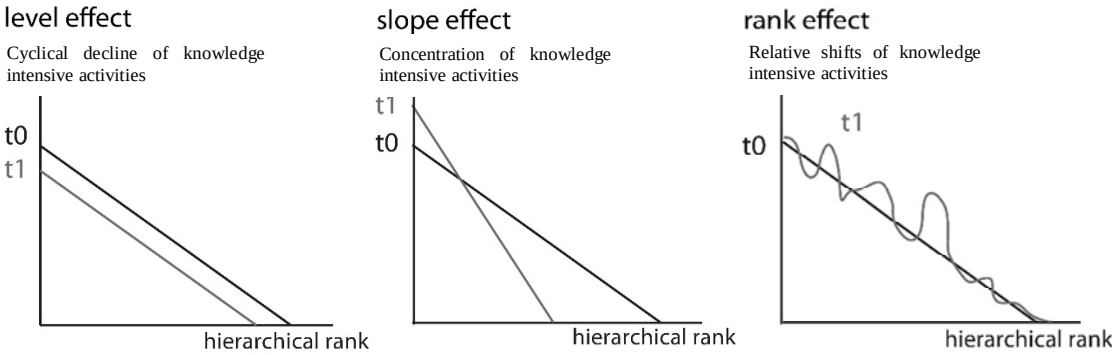
3 Hypothesis

The spatial patterns of structural change towards the knowledge economy, as described above have distinct consequences. Uneven spatial development, concentration in polycentric, large-scale urbanized regions and increases in spatial disparities are the rule and not the exception. This might affect the planning principle of equivalent living conditions (Kuhn and Klingholz 2013; Einig 2008; Herfert 2007; Akademie für Raumforschung und Landesplanung ARL 2005). Although, this spatial structural change is constantly increasing the importance of knowledge for spatial development, this process experiences an additional impetus due to the economic crisis. The financial crisis of the years 2007 to 2010 represents a catalyst for economic change (Schwengler and Hecht 2011; Zarth 2011a, 2011b; Harvey 2011; Schamp 2011; Martin 2011; Thierstein 2009; Brandt 2009; Aalbers 2009). Innovation represents a crucial driving force against the structural crisis (Thierstein 2009: 43) and that applies in particular for Germany and Central Europe, which face declining population sizes and a high shares of an older population. Thus, the overall market area will shrink in the future in volume. These demographic changes result in a decline of domestic demand. Consequently, firms have to explore new markets, develop innovative products and processes in order to realize growth again. The knowledge economy is instrumental to these innovation and development processes. The reorganization of this part of the economy with regard to the crisis might fundamentally affect the German urban systems.

Three future scenarios might be realistically possible for the formation of German labor market regions: a level effect, a slope effect, and a ranking effect (see Figure 1). The t_o and t_1 display points of time at

the beginning and the end of the time interval. Given that the period before the financial crisis represented an era of strong consumption and global interconnectedness, the collapse of this system might affect the level of global activities negatively. If the financial and economic crisis causes a decline of global demand for commodities, the value creation of knowledge intensive firms might follow this decline. Therefore, the level of business activities might become lower than before the crisis.

Figure 1: level effect, slope effect and rank effect (author's illustration)



However, spatial preconditions differ clearly. Thus, regions with global accessibility, a highly qualified labor force and proximity to educational infrastructure and knowledge intensive firms might provide better conditions for future development. In this regard the functional urban hierarchy might get steeper due to the concentration of knowledge intensive activities in urban regions. This process is strongly supported by a strong re-urbanization of cities such as Munich, Hamburg and Frankfurt.

Rapidly developing countries such as Brazil, India and China, all with a strongly growing population, are important trading partners for Germany. The positive development and the increasing demand for commodities such as cars and electronic equipment in these countries have compensated for the overall recession of the entire world economy. Therefore, German regions with intense trade and interrelations to these countries might benefit stronger than regions that are more dependent on the traditional partners within Europe and USA where markets are saturated to some extent. This might result in changing ranks within the functional urban hierarchy.

4 Methodology

In order to test the spatial patterns of structural change, we firstly introduce the shift-share analysis. Afterwards we will describe the data-base and provide a definition of the knowledge economy based on three different employment classifications (WZ 93, WZ 2003, WZ 08).

4.1 Shift-share analysis

The shift-share analysis compares employment growth in one region with the development on a higher spatial level such as the nation state (Dunn 1960). The shift-share analysis calculates the differences between the 'real' employment figures with those that are expected while assuming, first that growth in one region is proportionate to growth in the higher-level region or, second that growth in one sector in one region corresponds to the growth of that sector on the higher spatial level. Therewith, it is possible to differentiate employment growth into three factors: the economic cycle, structural change and location factors (Farhauer and Kröll 2006: 4-5).

Regional factor: this factor represents the impact of growth within the total region on the development of all sub-regions. Thus, it displays employment figures that might appear when growth in all sub-regions equals the higher-level growth rate. After calculating these expected figures, a comparison with the real figures is carried out. Regions that have positive differences represent an above-average development. Negative differences indicate below-average characteristics in terms of the business cycle. This indicator is also called a cyclical factor of the nation (Farhauer and Kröll 2006: 4-5).

Structural factor: this factor takes structural differences within the regions into account. It calculates the growth rates of each sector on the higher-level scale and transposes these change rates to the sub-regions. A comparison of these expected figures with real figures shows that regions with positive differences experience an advantageous employment structure.

Location factor: this last factor represents all other influences apart from economic cycles and structural composition. As the residual of the two other factors the location factor is considered as an indicator for competitive advantage in terms of social capital, infrastructure or regional governance. This factor also reflects the change of market shares between all regions. Positive values indicate a specific gain of employment that is not observable elsewhere.

4.2 Data

This study uses processed administrative employment data originating from obligatory annual notifications of establishments on their employees to the social security administration. This data is processed and anonymized for research purposes at the Institute for Employment Research (IAB). The Research Data Centre (FDZ) at the IAB produces the Establishment History Panel (BHP) which provides comprehensive aggregate establishment level data on employment as well as industry information and regional codes. Our analysis data is derived from the BHP by aggregating employment data to the industry-region level for the years 1998-2010.

The definition of knowledge intensive employment is based on Legler and Frietsch (2006). The authors define knowledge intensive sectors according to a high share of highly qualified personnel and intensive

research and development activities (Legler and Frietsch 2006). Our definition of the knowledge economy is shown in Table 1. We use the NACE Rev. 1.1/ WZ2003 classification on a four digit-level in order to form 16 different branches of Advanced Producer Services and High-Tech sectors. Several studies have used a similar classification of the knowledge economy. For further reading see (Growe 2012; Kujath and Schmidt 2010; Zillmer 2010; Krätke 2007)

Table 1: Knowledge intensive sectors and WZ 2003 Codes (Lüthi 2011based on; Legler and Frietsch 2006)

Advanced producer services (APS)	**High-tech**
Banking & Finance: 6511, 6512, 6521, 6522, 6523, 6711, 6712, 6713, 7011, 7012	Chemicals & Pharmacy: 2330, 2413, 2414, 2416, 2417, 2420, 2441, 2442, 2451, 2461, 2463, 2464, 2466, 2511, 2513, 2615
Advertising & Media: 7440, 2211, 2212, 2213, 2214, 2215, 9211, 9220, 9240	Machinery: 2911, 2912, 2913, 2914, 2924, 2931, 2932, 2941, 2942, 2943, 2952, 2953, 2954, 2955, 2956, 2960
Information and Communication Services: 6430, 7221, 7230, 7240, 7250, 7260	Electronics: 3110, 3120, 3140, 3150, 3161, 3162, 3210, 3320, 3330
Insurance: 6601, 6602, 6603	Computer & Hardware: 3001, 300
Logistics (3p & 4p): 6030, 6110, 6220, 6230, 6340	Telecommunication: 3220, 3230
Management- & IT-Consulting: 7210, 7222, 7413, 7414, 7415	Medical & optical instruments: 3310, 3340
Design, Architecture & Engineering: 7420, 7430	Vehicle construction: 3410, 3430, 3511, 3520, 3530
Law: 7411	
Accounting: 7412	

The classification NACE Rev.1.1 / WZ2003 provides the basic classification for our analysis and is valid for the years 2003 to 2007. Since our analysis focuses on the time period from 1998 to 2010, two other target industry classifications are required: NACE rev. 1/ WZ 1993 which covers the years till 2003 and NACE Rev. 2/ WZ2008 for the year 2008 onwards. We map both the NACE Rev.1 / WZ 93 and the NACE Rev. 2/ WZ 2008 classification into our target classification NACE Rev. 1.1/WZ 2003 to obtain a time consistent industry classification. In order to produce this time-consistent data we follow the methodology proposed by Eberle et al. (2011). This method uses the BHP to extrapolate valid industry information in the WZ 2003 for establishments in the first step, assuming that they did not change their industry activity when the WZ 2003 was not valid. In the second step, for all establishments from whom we do not observe any valid industry code in the WZ 2003 classification, we use correspondence tables provided by Eberle et al. (2011) that include the mode of industry changes between our target classification and earlier resp. later classifications. From this imputation procedure we obtain a time consistent industry classification for establishments in the BHP (Eberle et al. 2011).

Employment data in the BHP data is available on the level of establishments. This data also contains location codes of German counties that enable a broad spectrum of spatial analyses. For the analysis we use labor market regions (LMR) within Germany that are defined for purposes of regional policy ("Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur", GRW). The classification was provided by BBSR (2012). LMR represent a functional delineation, which is based on commuting

data for the German counties as reported in the BHP. The LMRs are adjusted to the boundaries of the federal states. Exceptions are the regions of Bremen, Hamburg, Mannheim and Ulm. These LMRs comprise areas ranging across the boundaries of federal states. Other conditions are given by the fact that 65 % of the labor force has to work within the LMR and that commuting duration of 45 min limits the range of the LMR. Using the counties as a building block of the LMR we are able to combine other statistical data such as spatial accessibility and indicators of the settlement structure.

5 Results

The dotcom crisis from the year 2001 as well as later the economic and financial crisis in the years 2008 and 2009 influence Germany's economic development in the years 1998 to 2010. This section presents the analytical results of employment development in a top-down approach. Firstly, we present the employment structure in knowledge intensive sectors for Germany. Secondly, we apply a shift-share analysis in order to decompose employment growth in German labor market regions in a cyclical and structural effect. This analysis will be expanded in a third step with principal component and cluster analysis, which reveal similarities and differences in regional employment development paths.

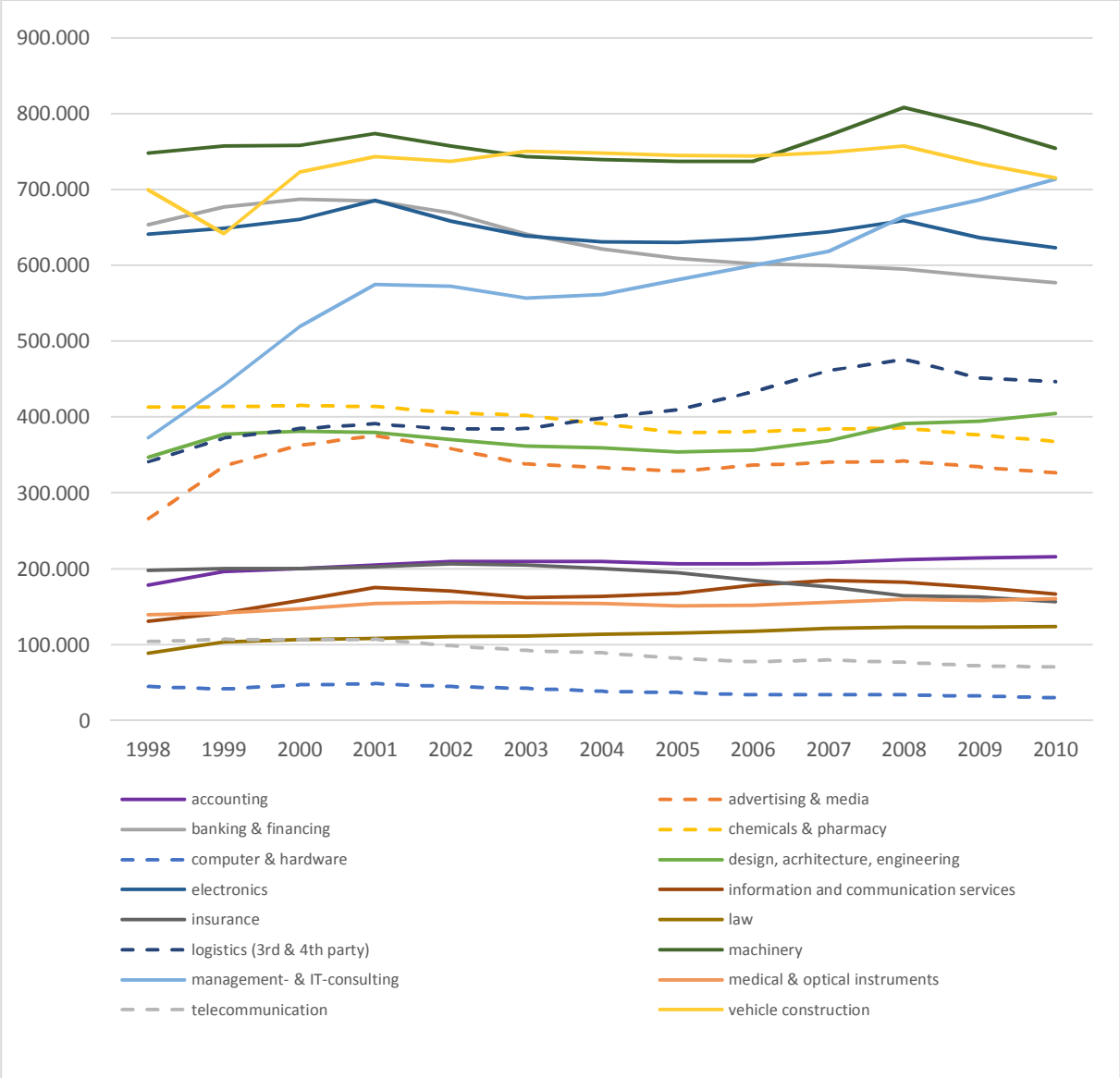
5.1 Economic Development in Germany and the knowledge economy

Germany experienced a positive economic development till the year 2008. The economic and financial crisis caused a clear decline for the year 2009. Bavaria and Baden-Württemberg recovered relatively well from the crisis and realized a GDP per employee, which is as high as it was before the crisis. This might be due to the higher shares of export oriented industries such as 'machinery', 'pharmaceuticals and chemicals' and the 'mobility sector' in the states of Bavaria and Baden-Württemberg that benefited from the growing demand in emerging economies such as China. Contrastingly, Hamburg and Hessen as the leading states in terms of GDP per employee seem to stagnate on a high level of productivity after the crisis. This might be due to high shares of globally operating sectors such as financing and logistics. Nevertheless, each federal state increases its productivity from 2000 to 2012 and each state experienced a decrease of productivity in the year 2009. Within the following shift-share analysis, we will refer to this as the cyclical development.

Figure 2 shows the employment growth in 16 branches of the knowledge economy in Germany for the years 1998-2010. In contrast to GDP per employee it is a less clear trend of growth. During this period the country passed two important crisis. The first one, the so-called dotcom crisis, took place in the year 2001 and predominantly affected the ICT-services and the new economy. A second and even more fundamental crisis was triggered by the financial crash in the years 2008 onwards. Export oriented branches such as 'vehicle construction', 'machinery' or 'electronics' were hit hardest. In order to reduce

redundancies because of a declining demand caused by the crisis, the federal government of Germany used short-time working arrangements. These regulations last for 24 months and helped to control the impacts of the financial crisis in the German economy (Schwengler and Hecht 2011: 124).

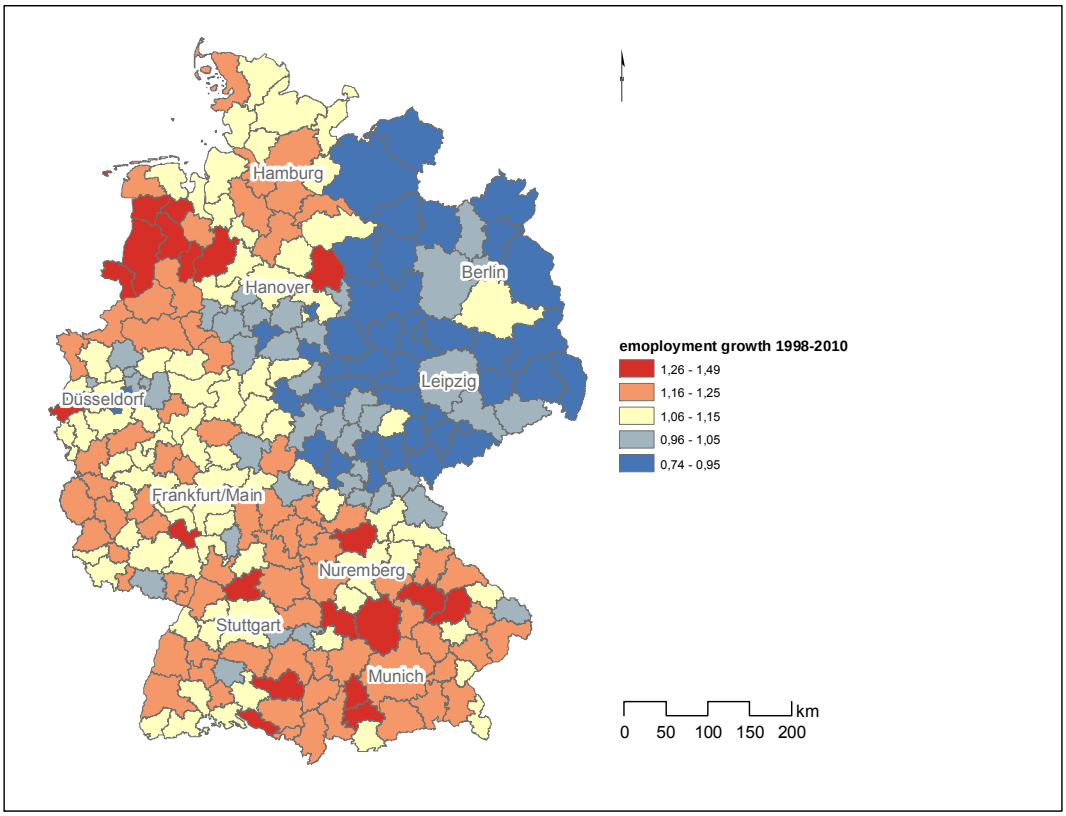
Figure 2: employment development in 16 branches of the knowledge economy in Germany for the years 1998-2010 (author's illustration)



Obviously, service oreiented knowledge intensive branches perfom slightly better than high-tech industries. Above all 'management & IT-consulting' almost doubled its number of employees within this period. 'Accounting', 'law' and 'design, architecture, engineering' display a higher emplyoment in the year 2010 as in 1998. Nevertheless, financial services such as 'Banking & finance' and 'Insurance' lost a significant number of employees.

Looking at the development in total employment the difference between the eastern and westren part of Germany is striking. From 1998 to 2010 western Germany grows cleraly, wheeras the eastern part experiences declining employment figrues (Figure 3).

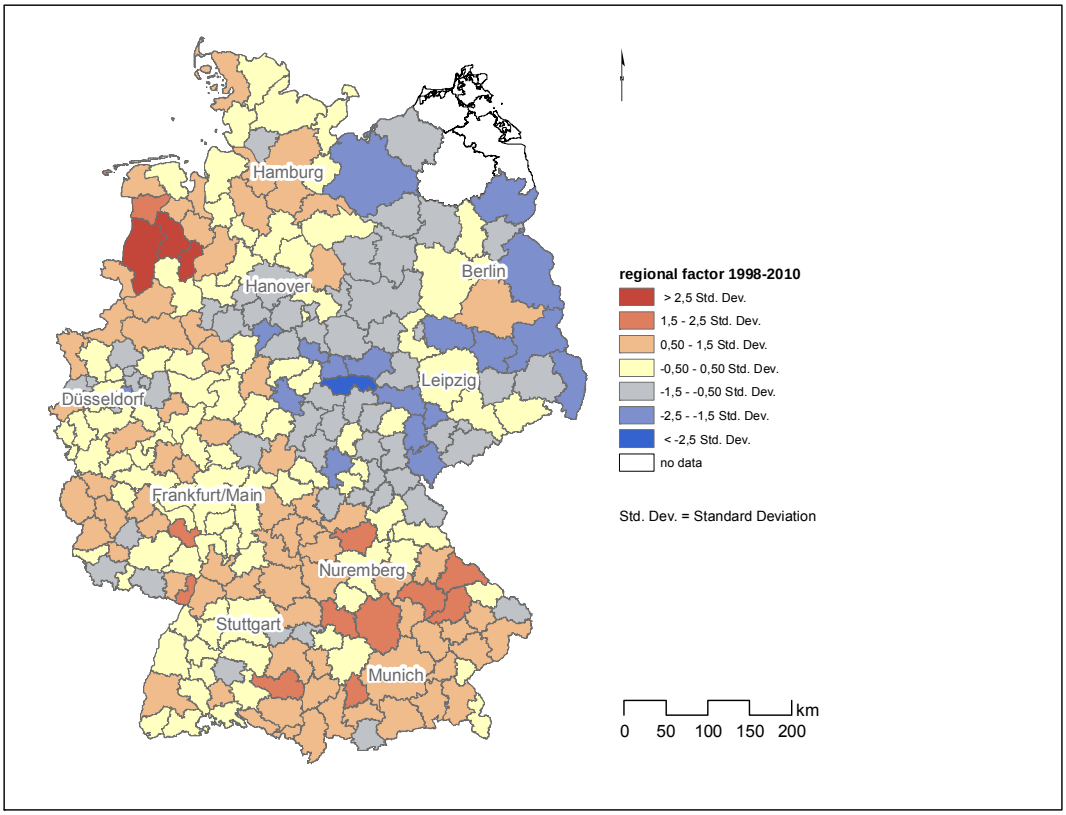
Figure 3: employment growth in Germany for the years 1998-2010 (author's illustration)



5.2 Spatial structrual changes in knowledge intensive employment

The shift-share analysis enables to decompose the cuauses of employment growth into a regional, structural and locational factor. The regional factor shown in Figure 4 displays how a region corresponds to the overall cyclical development. High values indicate that a region's growth rate is higher than the national average. Low values represent a below average growth rate. The map reveals similar patterns as the overall employment growth. Nevertehless, this picture is more diffrentiated as the aformentioned analysis of emplyoment growth.

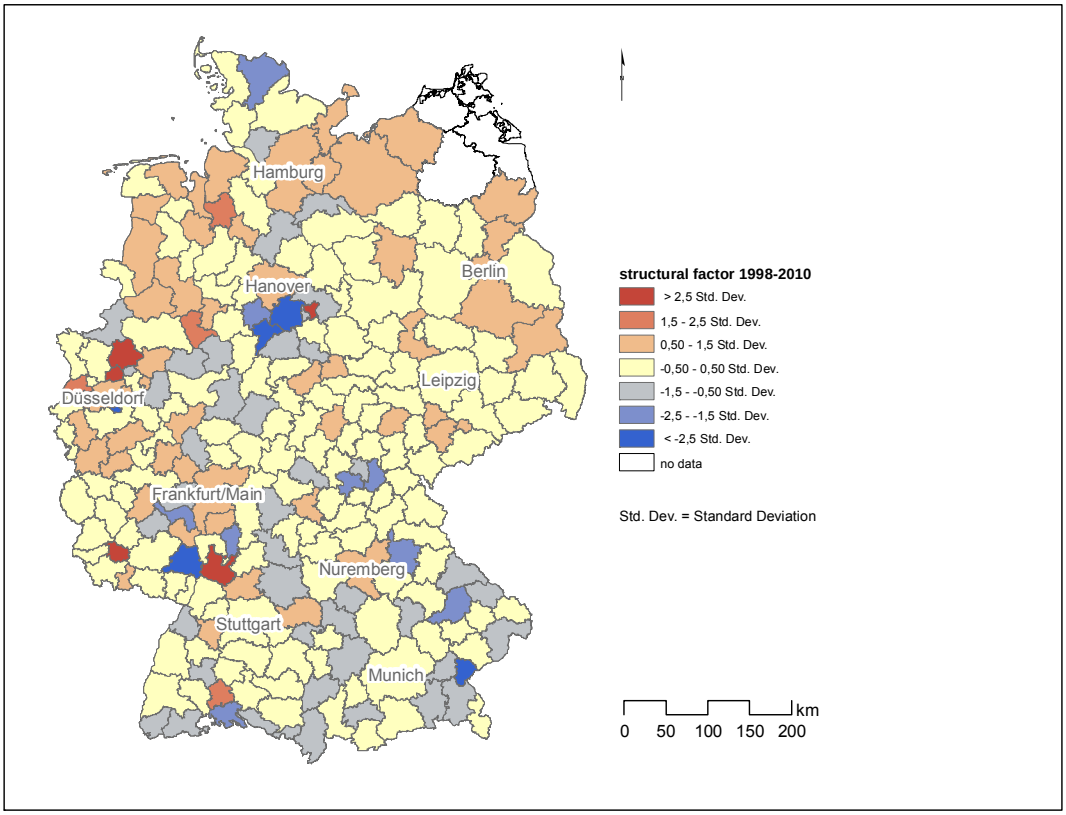
Figure 4: regional factor 1998—2010 (author's illustration)



The northrwestern regions reach the highest values. This area is home to a vibrant maritme economy (Bentlage et al. 2014; Brandt, Dickow and Drangmeister 2010). The southern part of Germany and the region of Ingolstadt and Regensburg in particular display high values as well. These regions employ a high number of personnel in car production and the mobility sector (Thierstein et al. 2011).

The results of the structural factor display a more complex pattern of employment growth (Figure 5). Surprisingly, the effects of structural changes within the knowledge economy seem to contradict the spatial patterns of overall employment growth. In particular, regions in Bavaria and Baden Württemberg with a high degree of specialization in high-tech industries display a negative structural effect.

Figure 5: structural factor 1998—2010 (author's illustration)



Other regions such as St. Wendel in the federal state of Saarland realized employment growth that is strongly driven by a restructuring of the economic base. However, such a development has different causes. Firstly, St. Wendel is a rather small labor market region. Therefore, relative small growth rates changes might have a high impact in terms of absolute numbers. A second explanation might rest on the impacts of the financial crisis in the years 2008 and 2009. In particular export oriented sectors were hit hard by this global decline of demand. This data does not entirely cover the post-crisis era of recovery. Therefore, we will employ a PCA and cluster analysis to take the annual developments better into account.

5.3 Employment development paths: regional differences and similarities

Various factors influence the employment development form year 1998 to 2010. Within this period the global economy experienced the financial crisis which caused structural changes in employment. This has an impact on regional growth and shrinkage patterns in Germany. Applying a Principal Component Analysis (PCA) in this context enables to detect certain development phases based on the similarities of the structural and regional factors for each year and returns similarities in regional development paths. This analysis aims at differentiating between structural and regional impacts on employment growth based on the shift-share analysis in the previous section.

Table 2 shows 6 different components that correlate with the annual structural and regional factors. In contrast to the aforementioned analyses both factors the regional and the structural were calculated for each year in order to take annual changes into account. Components 1 to 3 have high correlations to the structural factors. Positive values represent an employment structure that favors employment growth in a certain region. The other components represent employment development with reference to the national development. Positive values indicate that employment growth was higher than the national average.

Table 2: Principal component analysis and simultaneous growth rates

	Shift share effect		PC 1	PC 2	PC 3	PC 4	PC 5	PC 6
	from year	to year						
structural factor	1998	1999	-0.9202					
	1999	2000	0.7374					
	2000	2001	0.7438					
	2001	2002						
	2002	2003	0.7524					
	2003	2004			0.8112			
	2004	2005	0.5317		0.6904			
	2005	2006	-0.8272					
	2006	2007	-0.5408	0.7171				
	2007	2008		0.8709				
	2008	2009	-0.8787					
	2009	2010	-0.9238					
regional factor	1998	1999				0.8109		
	1999	2000					0.5698	
	2000	2001				0.7797		
	2001	2002				0.6293		
	2002	2003						
	2003	2004						
	2004	2005				0.8031		
	2005	2006						0.5831
	2006	2007						0.6807
	2007	2008					0.6761	
	2008	2009					0.5719	
	2009	2010						0.6667

Factor 1 correlates to a number of structural factors. This component reaches high values for regions such as Ingolstadt or Wolfsburg that have a high employment shares in branches that have grown in the years between 2000 and 2006. For example the sector of ‘vehicle construction’ increased its number of employment during this period. From the year 2006 onwards employment in this sector declined significantly. This shrinkage might be an early sign of the economic crisis, since the demand of private households went down which in turn affects export oriented branches such as the car industry.

Factor 2 is more focused on the years before the crash. This component correlates to growth in the sectors of ‘machinery’, ‘electronics’ and ‘logistics’. All these sectors display an era of boom and strong growth in the years 2006 to 2008, which is followed by a significant decline in the year 2009. Regions with high factor loadings benefitted from this boom phase, whereas regions with low values were less affected in the same time.

Germany experienced a phase of high unemployment in the years 2003 to 2005. Factor 3 represents this structural deformity. It scores high for those regions that have high employment shares in sectors, which were affected by high unemployment at this time. Therefore, those regions have a negative structural factor.

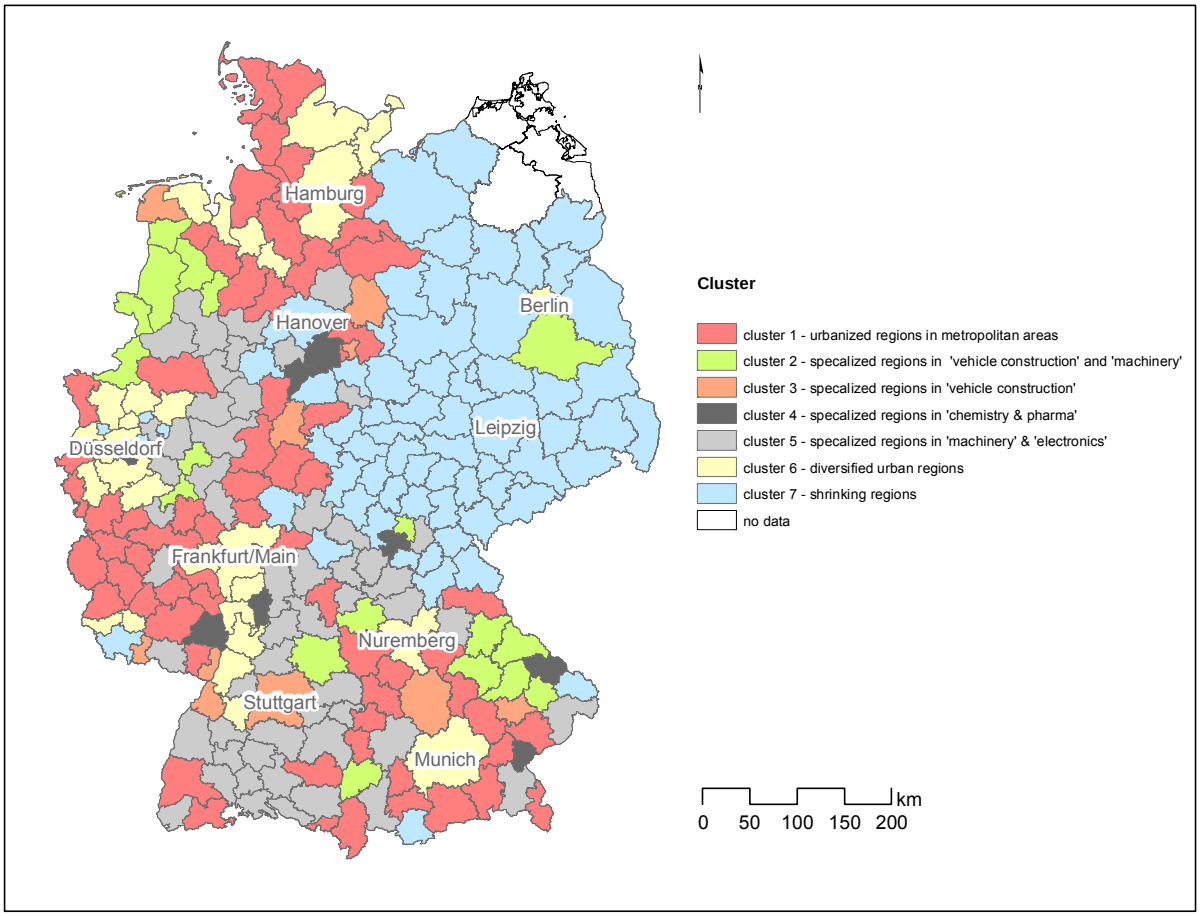
Factor 4 shows a development path, which is complementary to factor 1. Whereas factor 1 draws employment growth back to the preconditions in employment structure, factor 4 adds a cyclical component to this. Factor 5 indicates a growth rate, which is above the national average. This factor reaches high values in regions that were more robust during the financial crisis than the national average. Regions with high scores in this factor circumvent the effects of the crisis. Factor 6 refers to a development path that describes an over-average growth rate before the crisis and a positive era of recovery.

In order to analyze spatial patterns of these development paths, we apply a cluster analysis. This procedure aims to detect subgroups that show a high degree of similarity within and a clear differentiation to other groups. The result is a number of 7 clusters. Figure 6 shows these seven clusters and those regions that have similar development paths in the time period from 1998 to 2010.

According to the analysis the seven clusters are described as follows:

Cluster 1 represents LMRs that host a number of firms in high-tech industries such as ‘machinery’, which are mainly influenced by the cyclical development of Germany. Those regions had a negative employment structure which was affected by employment losses in the years 2003-2005. The employment development in Cluster 2 is mainly driven by the cyclical development of Germany in the years between 2003 and 2006. Nevertheless, these LMRs experienced a strong decline of employment growth during the economic crisis. Both Clusters 1 and 2 have input-output relations to other high-tech branches such as ‘vehicle construction’ or the maritime industries (see Figure 8 in the Appendix).

Figure 6: Cluster analysis of structural and regional development factors of the knowledge economy (author's illustration)



The highly specialized regions of 'vehicle construction' and mobility sector such as Ingolstadt, Wolfsburg and Baden-Baden are assigned to Cluster 3 (see Figure 7 in the appendix). These regions experienced moderate growth in the years 2000 to 2006. However, compared to the development of the branches in Cluster 2, the car industry in these regions did grow as intensive as 'machinery' or 'electronics' did. Therefore, the decline during the crisis was less strong. Interestingly, Stuttgart as the center of an urban metropolitan area is also within Cluster 3. This indicates that the LMR of Stuttgart is strongly depending on the sector of 'vehicle construction' with its specific development path during this time span. Other major city regions such as Munich, Frankfurt or Hamburg seem to be more balanced in terms of a higher share of globally operating services.

Cluster 4 hosts regions that are specialized in 'chemicals & pharma'. This is a rather small cluster with only 8 different LMRs such as Ludwigshafen, Burghausen and Leverkusen (see Figure 9 in the appendix). These LMRs experienced a sectorial vulnerability in particular in the years from 2003 to 2005. Employment development within this cluster is below the national average. Cluster 5 consists mainly of LMRs that are in western Germany with close proximity to urban metropolitan areas. These

LMRs have a high degree of specialization in ‘machinery’ and ‘electronics’. As shown in Figure 2 these branches experienced an upswing phases before the crisis and a rapid decline within the crisis.

Cluster 6 represents mainly urbanized metropolitan regions such as Frankfurt, Munich, Berlin and Hamburg. These LMRs experienced under-average development before the crisis but remained rather robust during the crisis. In contrast to the Clusters 2 and 3 shares of APS within this cluster is higher and the LMRs have a rather diversified industry mix (see Figure 10 in the appendix). Therefore, the impacts of the crisis are less strong, which induces a relative growth of employment compared to those regions that dependent on export-oriented manufacturing sectors.

Declining employment is observable in LMRs of Cluster 7. These regions have an employment development below the national average.

Table 3 shows average values for selected indicators of spatial structure and the overall employment.

Table 3: Indicators of spatial structure and employment growth for clusters (author’s calculation)

	accessibility by air in min	accessibility by high-speed rail in min	accessibility of 41 metropolitan areas in Europe in min	total employment development 1998-2010
Cluster 1	56,00	28,18	249,68	1.17
Cluster 2	66,67	31,72	262,06	1.24
Cluster 3	43,20	20,60	254,00	1.16
Cluster 4	58,88	31,50	253,38	1.02
Cluster 5	51,93	26,64	249,00	1.12
Cluster 6	35,32	20,75	227,57	1.11
Cluster 7	51,52	27,90	273,19	0.93

Finally, the impacts of cyclical and sectorial developments on the German labor markets differ strongly. Still 25 years after the German reunification, we observe a significant gap between eastern and western regions. The regions in southern Germany experienced a positive development in the years before the most recent economic crisis in 2008. As a result of short-term employment regulations, the impacts of the crisis could be substantially reduced in these industrial regions. The growing demand in emerging countries fosters the process of recovery temporarily.

6 Conclusion

Comparing employment development in the sectors with knowledge intensive employment we identify regional differences and similarities in employment growth. The cluster analysis shows clear differences in how German labor market regions develop between 1998 and 2010. Interestingly to mention, that major cities and agglomerations show a high degree of robustness against the economic crisis.

Furthermore employment growth happens mainly in those regions that have a high degree of specialization in high-tech industries. These regions are susceptible to exogenous shocks. However, a distinction must be made in how strong those depend on exports or on a domestic or European market.

The future of the German economy and the welfare state depends not only on the structural change towards the knowledge economy and its subsequent spatial logic, but seems to be even more depending on relative shifts within the knowledge economy. The spatial preconditions for knowledge creation tend to differ clearly and might become even more important areas of study during times of shrinking population and employment. A relevant topic for the future will be, how the welfare state and spatial planning will sustain comparable living and working conditions in places that do not provide a dense labor market, physical accessibility and highly connected environment of knowledge generation. In light of such a foreseeable future friction point, further longitudinal research is required which applies the co-evolution of spatial structure and the relational perspective upon economic activities.

On the scale of Germany, the knowledge economy does not reveal a clear structural change in terms of magnitude of employment shifts. This requires further research with regard to the definition of the knowledge economy in which knowledge could be differentiated in more detail. Nevertheless, the juxtaposition of an economic crisis, an ongoing change in business activities and regional differences while adopting these changes drive a reorganization of spatially localized value chains. In other words, the sheer number of employment in certain sectors might not change fundamentally, but qualities and spatial references within these sectors seem to cause decisive relative changes in Germany's economic landscape. This induces a redistribution of economic activities and increasing regional inequalities.

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8 Appendix

Table 4: Cluster and mean of principal components (author's calculation)

	PCA 1	PCA 2	PCA 3	PCA 4	PCA 5	PCA 6
Cluster 1	-0,106	0,519	-0,670	0,512	0,229	0,051
Cluster 2	0,120	0,604	0,109	1,344	-1,424	0,069
Cluster 3	3,277	0,883	0,187	-1,645	-0,313	0,212
Cluster 4	0,146	-1,081	-3,011	-0,867	-0,789	-0,769
Cluster 5	0,335	-1,002	0,518	0,558	0,067	-0,176
Cluster 6	0,221	0,249	0,218	-0,040	1,520	0,410
Cluster 7	-0,783	0,055	0,425	-0,937	-0,382	-0,032

Figure 7: Location quotient in 'vehicle construction' (author's illustration)

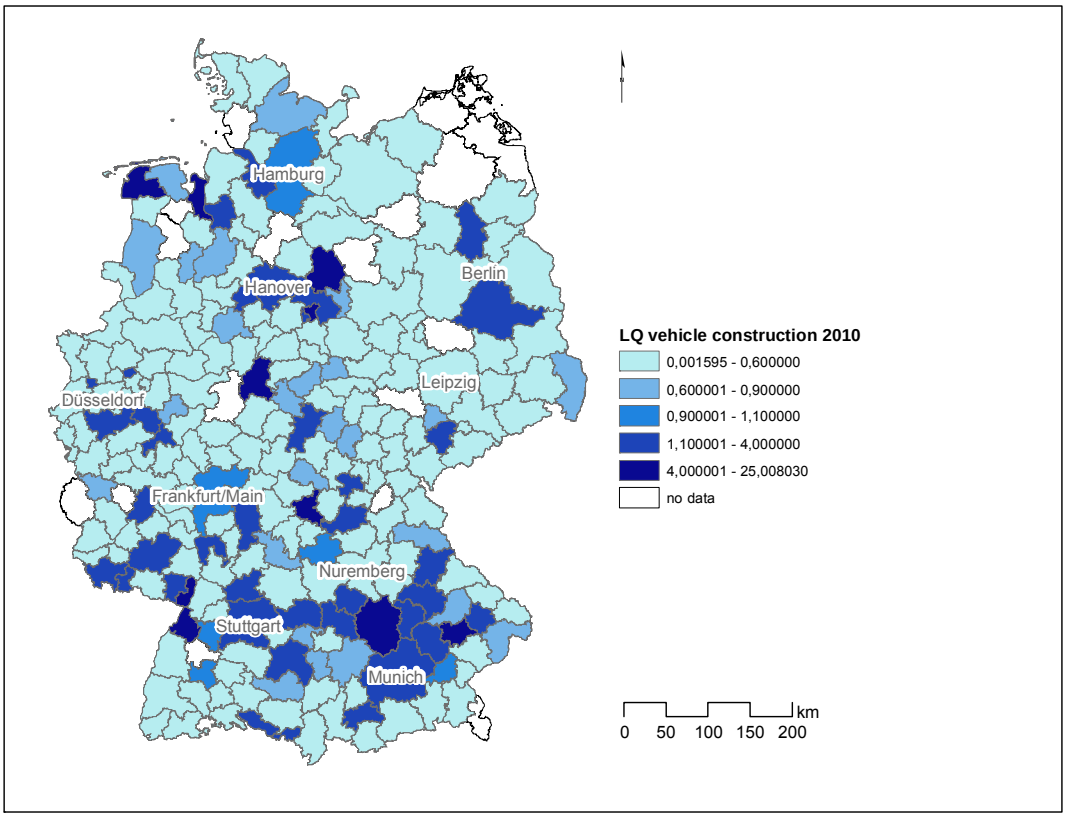

Figure 8: Location quotient in ‘machinery’ (author’s illustration)

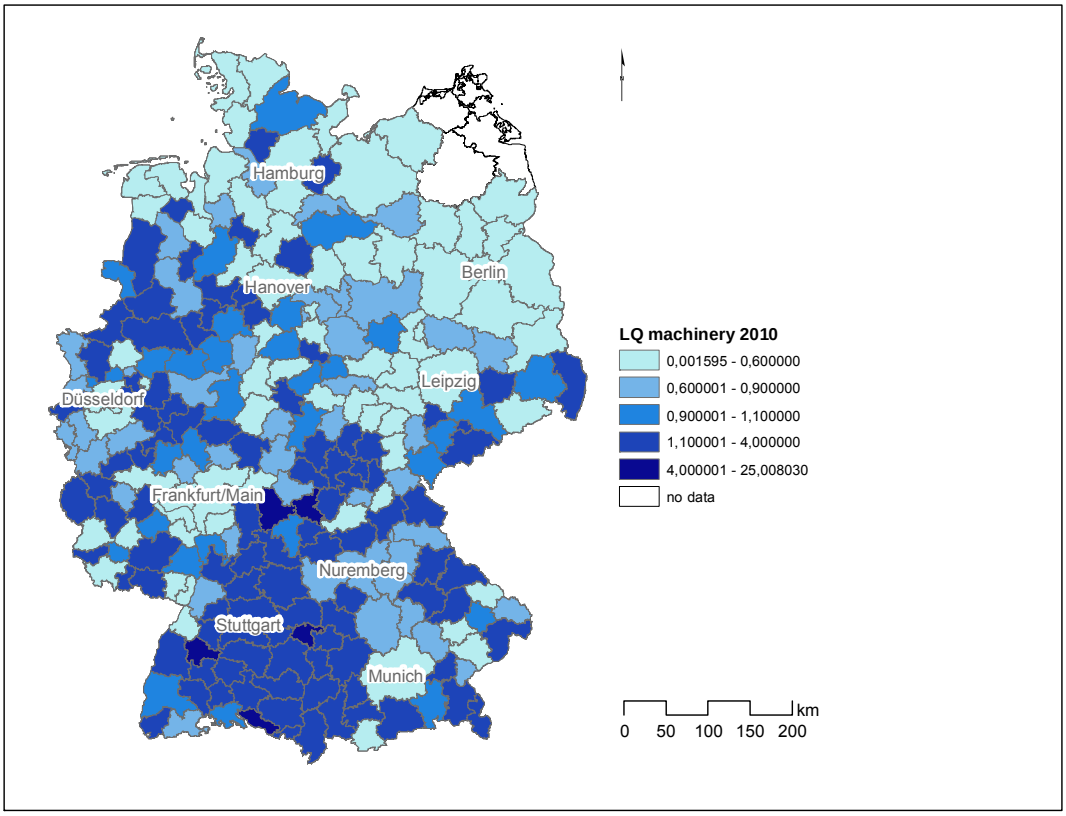

Figure 9: Location quotient in ‘chemicals & pharma’ (author’s illustration)

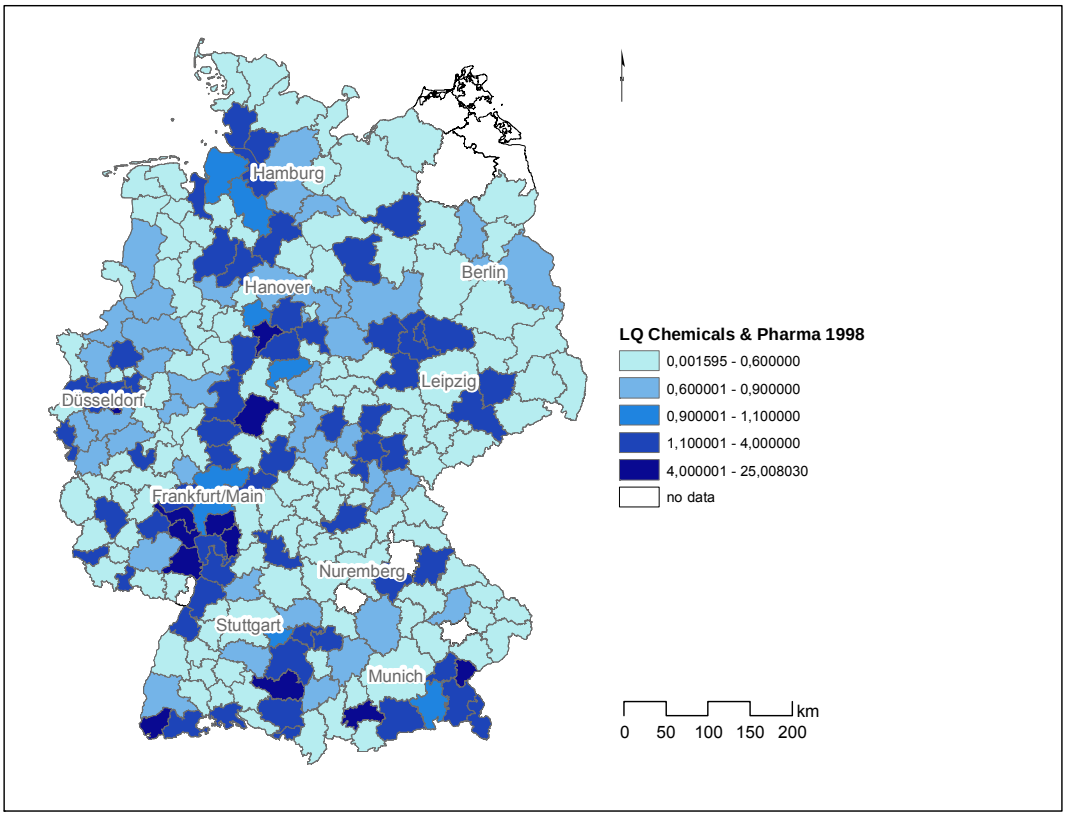

Figure 10: Hirshman-Herfindahl Index of the knowledge economy (author's illustration)