

# Spatial Distribution and Dynamics of Innovation-Related Employment in Germany

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## 1 ABSTRACT

During the last decades science, knowledge as well as research and development (R&D) have become main drivers of Germany's technological and economic performance. In the first instance the creation of new knowledge depends on innovative companies and their skilled and well-educated employees. That is why the competitive capacity of a region more and more depends on the presence of innovative and future-proof branches of industry and their R&D capability.

However, these innovation capabilities are not evenly spread within the country. More precisely data from the German Federal Employment Agency (Bundesagentur für Arbeit) and Stifterverband der Deutschen Wissenschaft indicate strong evidence that innovation-related employment is spatially concentrated, although the German city-system is characterised by a comparatively polycentric structure. In this context especially the urban centres and metropolitan regions seem to offer advantages concerning innovative processes. While big agglomerations usually cover various technological fields, some districts or even regions show a relatively strong dependence on single branches or even firms. This is most likely the case in less dense areas, where a broad basis of private research is missing in many instances. However, positive examples of knowledge-based employment structures can also be identified in rural areas. But in respect of demographic change, leading to an increasing lack of human capital, cities and regions are faced with a strong competition on innovative companies and related R&D staff. Thus, German districts have different future prospects concerning innovative and competitive capacity.

The study is carried out on the spatial level of German districts (Kreise), focusses on different settlement types ranging from urban centres to rural regions and discusses the following main questions:

- To what extent is there a concentration of innovation-related employment in Germany?
- Where are the main centres of innovative activity and which special cases can be found?
- Do there exist large-scale disparities within Germany?
- Which trends can be observed concerning innovation-related employment - regional convergence or divergence?

## 2 INTRODUCTION

During the last decades knowledge, science as well as research and development (R&D) have become main drivers of Germany's technological and economic performance (BMBF 2010). Particularly in respect of Globalisation the highly developed countries more and more depend on knowledge and the creation of new products.<sup>1</sup> Successful innovation activity is associated with the access to temporary monopoly profits and strengthens competitive advantages on the national and regional level.

In the first instance the creation of new knowledge depends on innovative companies and their skilled and well-educated employees. Due to that fact, human capital has become the crucial resource in knowledge-based economies. In this context recent studies emphasize the role of tacit knowledge (cf. Polanyi 1966) that is considered to be the source of all new findings. This implicit form of knowledge is bounded to people and to routines in companies and can only be transmitted by personal contact (cf. Nonaka 1994). That is why recent conceptions of the innovation process assume that interaction and learning processes within and across organisations are main determinants enabling the creation of innovations (Lundvall 1988). Apart from these intentional knowledge transfers, various authors stress the fact that knowledge spillovers, resulting from the quasi-public character of knowledge<sup>2</sup>, have a significant impact on firms' innovation efforts (cf. Romer 1986, Griliches 1992). Out of these mentioned aspects theoretical and empirical studies draw the

<sup>1</sup> "Knowledge is the fundamental resource in our contemporary economy and learning is the most important process" (cf. Johnson/Lundvall 1994: 24).

<sup>2</sup> This results from the fact that knowledge can be shared by various firms at the same time (non-rivalry). Furthermore it is hard to protect knowledge from unauthorized usage once it is published (non-excludability).

conclusion that knowledge in many cases is spatially bounded and space is a not negligible factor of innovation.

There exists a varied theoretical framework dealing with the above-mentioned interface between innovation and space. Built on evolutionary theories of economic and technological change (Nelson/Winter 1982; Dosi et al. 1988), different approaches, like creative milieus (cf. Camagni 1991), learning regions (cf. Florida 1995; Asheim 1996), clusters (cf. Porter 1990) or regional innovation systems (cf. Cooke 2001) consider innovation as a locally embedded process that depends on so called “untraded interdependencies” (cf. Storper 1995; Maskell/Malmberg 1999). These concepts evolved the fact that geographical proximity and thus the concentration of different innovation-related players tend to promote the propensity for innovation. For instance, the approaches show that innovative firms can benefit from geographical proximity as it enforces trustful cooperations and networks (e.g. with customers, suppliers, service industry or research institutions) as well as it provides opportunities for the exchange of tacit knowledge. Apart from that the studies figured out that knowledge spillovers do not tend to travel over large geographical distances (cf. Jaffe 1989; Audretsch/Feldman 1996). Consequently merely firms within a certain area can benefit from the accumulation of knowledge and human capital. These aspects, combined with classical positive benefits from agglomeration effects, imply the tendency of innovation-oriented firms to concentrate or rather to cluster. Porter et al. (2001) thereby mention that “the real locus of innovation is at the regional level” and that the vitality of the U.S. economy depends on “regional hubs of competitiveness and innovation” (Porter et al. 2001: 1).

Hence theoretical work as well as empirical findings suggest that innovation capabilities are not evenly spread within space. More precisely there is strong evidence that innovation-related human capital is spatially concentrated and especially spaces of high density, like big urban centres and metropolitan regions, offer advantages concerning knowledge creation. Research dealing with the spatial distribution of human capital dates back to the 1950s, when Ullmann (1958) already identified the crucial role of human capital for regional development and is still vivid in recent debates e.g. respresented by Florida (2002) and his theses about the creative class. Since then different studies have shown that human capital tends to cluster in major urban centres, such as Glaeser (1994) who identified a divergent development in the concentration of high-qualified labour in the US. As reasons for that, he identifies the presence of universities in terms of their educational and research functions as well as high wages and social amenities. Thus, especially innovation-oriented jobs are considered to be “extremely spatially concentrated, favoring only a small set of regions in the world, and empirical studies show this pattern is quite stable over time” (Boschma 2009: 4).

Those cities or regions appear to have a privileged initial position in global competition as studies point out the relevance of regional stocks of knowledge (e.g. as embodied in the personnel of university research and private R&D, e.g. Anselin et al. 2000) or the availability of skilled labour (cf. Czarnitzky/Binz-Hottenrott 2009) for regional productivity and innovation performance. But in fact all German regions are increasingly faced with global competitors and the need to innovate because also non-high-tech areas or rural-peripheral regions are in growing progress of losing their advantages in respect of standardised or labour-intensive production. Concerning this, there can be observed some positive German examples of highly competitive and innovative structures in rather rural areas (e.g. medical engineering industry in the Tuttlingen area or chemical industry in Oberbayern) that have developed independently from the fundamental agglomeration advantages of dense areas.

But cities and regions are confronted with an increasing competition on skilled people and related future-proof companies serving the objective of avoiding shrinking phenomena with problems like population losses or unemployment. Moreover, the impact of demographic change that leads to an increasing lack of human capital will intensify the outlined situation in future. Hence Czarnitzky/Binz-Hottenrott (2009) notice that “it may be in the government’s interest to design regional innovation policy conducive to the agglomeration of highly skilled labour and high-tech industry, to remain competitive in the process of further globalisation” (Czarnitzky/Binz-Hottenrott 2009: 96). So the main research questions in this field range between how to provide advantageous environments for innovative firms and the question of individual benefits<sup>3</sup> (education opportunities, wage differentials, availability of jobs, living costs, locational preferences) that enhance spatial mobility of high-potential workers.

<sup>3</sup> cf. theories and empirical work on spatial factor mobility.



This article does not claim to answer these questions fully, but merely to open them up to further debate by showing starting positions of regions for the example of Germany. Therefore, the following analyses try to shed light on the question of spatial distribution and dynamics of innovation-related employment in Germany. The article discusses the following main questions:

- To what extent is there a concentration of innovation-related employment in Germany?
- Where are the main centres of innovative activity and which special cases can be found?
- Do there exist large-scale disparities within Germany (especially between the western and the eastern part)?
- Which trends can be observed concerning innovation-related employment - regional convergence or divergence?

### 3 STATISTICAL DATA AND STUDY AREA

The data used in this paper stem from the German Federal Employment Agency (Bundesagentur für Arbeit) and Stifterverband der Deutschen Wissenschaft. Data provided by the Federal Employment Agency cover the workforce paying social insurance contributions and represent about 75 % of total labour. Not factored in are civil servants, self-employed persons, marginally employed people and unpaid family workers. Stifterverband collects data on research and development for Germany. On a regional level every second year surveys were conducted querying firms about their innovation activities.

In this study innovation-related employment is defined by means of three different indicators:

- R&D employment (absolute, R&D employees per 1.000 employees subject to social insurance contributions)
- High-qualified workers (absolute, high-qualified workers per 100 employees subject to social insurance contributions)
- Employment in research-intensive industries and knowledge-intensive services (absolute, employment in research-intensive industries per 100 employees subject to social insurance contributions)

Concerning R&D employees it is assumed that these workers highly contribute to the innovation performance of a region and can be considered as a central factor in innovation creation.<sup>4</sup> That is why the study puts its main focus on this employment category. High-qualified workers are characterised by superior educational qualifications earned in higher colleges/academies, polytechnics or universities.<sup>5</sup> That is why they are considered to play an important role in knowledge-intensive society. A similar impact comes from employees in knowledge-intensive (business) services. As those branches, like business, technical or informative consultancy, market research or advertising highly rely on skilled people it is not surprising that there is a remarkable correlation between those two indicators. Hence the results for employees in knowledge-intensive (business) services are merely shown rudimentarily in this paper, while the focus will be on highly qualified staff.<sup>6</sup> The classification of research-intensive sectors is carried out by means of average R&D expenditures of the different industrial sectors (cf. Legler/Frietsch 2007). The identified R&D-intensive branches show R&D expenditures greater than 2,5 % of turnover. However, using this indicator one has to bear in mind that not all people employed in those sectors are entrusted with innovation-related tasks. Furthermore, as a general rule employment data represents an input indicator that does not allow to draw any conclusions concerning the efficiency of innovation activity.

The study is carried out on the spatial level of German districts and district free cities (Kreise und kreisfreie Städte). This small-scale perspective, below the level of functionally related regions, opens up the possibility to identify the cores of innovative activity as well as potential special cases. Therefore, the study focusses

<sup>4</sup> E.g. Andersson et al. (2005) show that the presence of private R&D facilities increases the number of patents in a certain region.

<sup>5</sup> R&D-workers are commonly well-educated – but not all highly qualified jobs deal with innovative activities.

<sup>6</sup> In addition to that the innovative capability/performance of industrial sectors is higher than the innovative potentials of services. Thus, the main emphasis of this study is set on industry employment.

on four different settlement types (see Fig. 1) provided by the Federal Office for Building and Regional Planning (Bundesamt für Bauwesen und Raumordnung, BBR):

- core cities (dark red)
- urbanised surroundings (red)
- rural surroundings (green)
- rural areas (dark green)

This distinction takes into account spatial relationships between cities and surrounding areas and consequently implies the factors of density as well as spatial proximity. Fig. 1 shows the spatial patterns of the different settlement types. At a first glance core cities are rather equally distributed, however, the big agglomerations (core cities and urbanised surroundings) occur more frequently in the western parts of Germany. Rural areas, for the most part, are located in the peripheral parts of Germany - in many cases near the border.

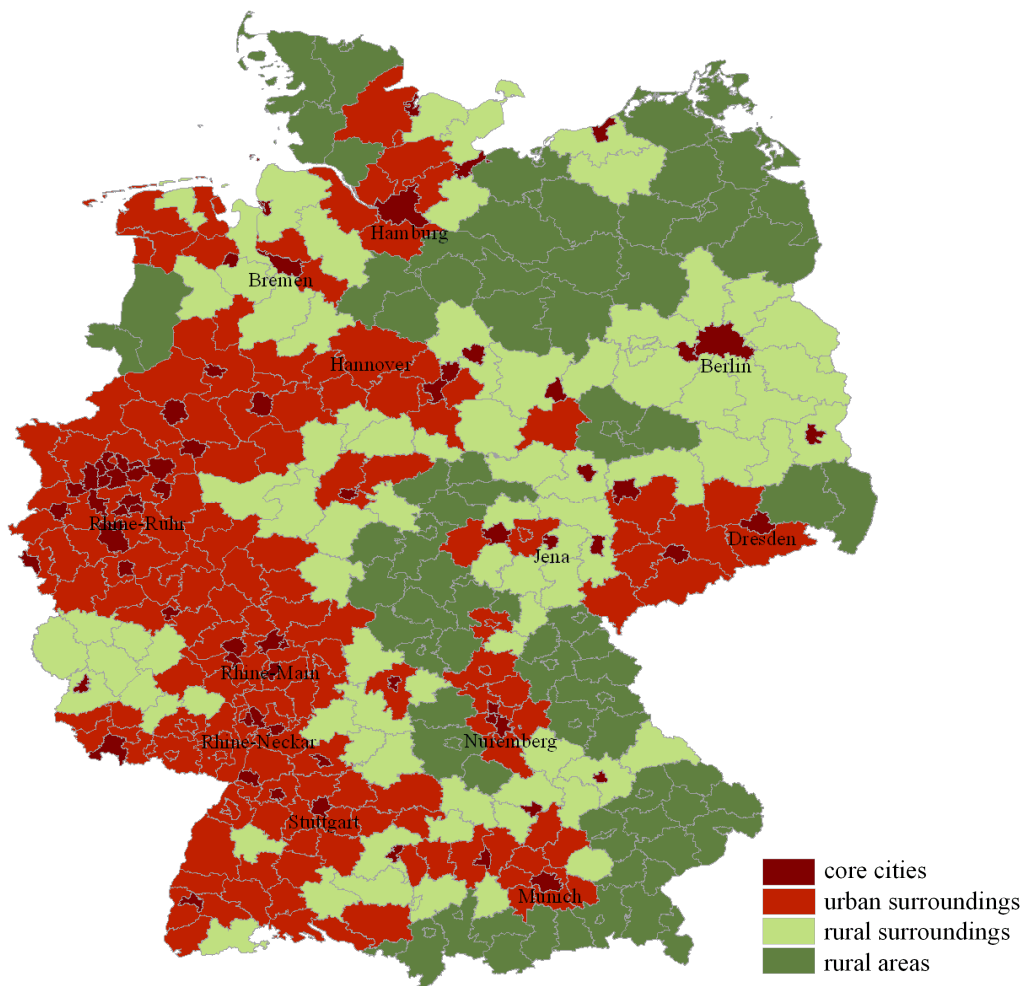


Fig. 1: Settlement types

#### 4 CONCENTRATION OF INNOVATION-RELATED EMPLOYMENT

In 2007 Germany has about 320.000 employees working in the R&D field. As expected the number of highly qualified workers is higher and slightly exceeds the 2,65 million mark. Following the question about the concentration of innovation-related employment a starting-point is the comparison of absolute numbers of employees. The general extent of inequality in the distribution of innovation-related employment can be measured with the Gini coefficient. Fig. 2 illustrates by means of the Lorenz curve that R&D employment shows the strongest concentration among the chosen differentiations of labour. But also high-qualified labour and the high-tech-industry-staff is much more focussed on designated locations than workers in traditional branches of industry. This can be regarded as a first hint that innovation-related jobs have a stronger affinity to agglomerations.

Looking at the leading districts for the example of R&D employment a corresponding pattern can be observed. 50 % of the R&D staff is concentrated in just about 24 of the 413 overall districts and district free cities. As expected these main sites of private research are located in core cities or their urbanised surroundings, where nearly 90 % of all R&D personnel is located. The highest numbers of R&D workers are to be found in the two cities of Munich and Stuttgart as well as the district of Böblingen.<sup>7</sup> The large-scale perspective shows that there is a dominance of the southern part of Germany, especially regarding Baden-Württemberg and Bavaria, which together cover nearly half of the German private research staff. Those two federal states are traditionally considered to be the main research locations in Germany.

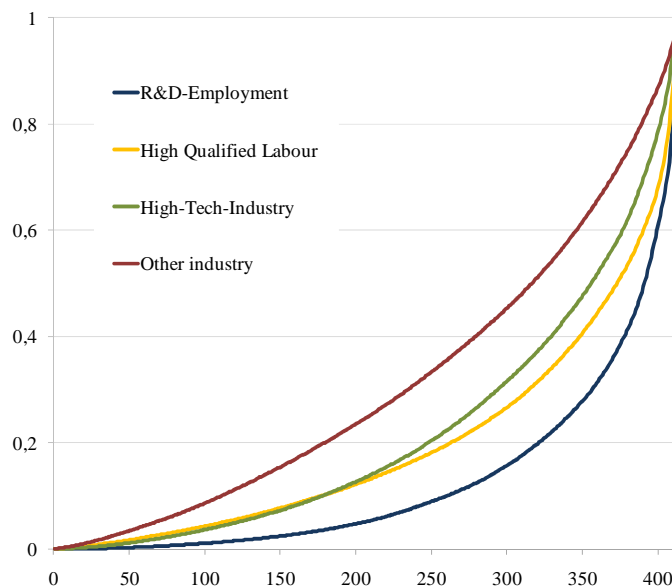


Fig. 2: Lorenz curve (413 districts and district free cities)

The absolute distribution of high-qualified workers reveals a little different pattern as those jobs are even more related to the big German core cities. As a result it is not surprising that Berlin, Munich, Hamburg and Frankfurt hold the leading positions in regard to highly qualified employees. Concerning the absolute number of employees in research-intensive branches some additional and, for the most part, highly specialised cities appear on the front line (e.g. Ludwigshafen: chemical industry).

The observations of employees in absolute numbers, particularly the above comparison to the employees of the remaining branches of industry, indicate that innovation-related human capital is unequally distributed. But obviously the measure in absolute numbers skews the estimation as administrative units with a large number of occupants are structurally favoured. In order to eliminate these “size effects” relative numbers as well as location quotients convey an appropriate prospect. The location quotient is a measure comparing characteristics of a regional unit to the characteristics on the national level.

The proportion of R&D employees in core cities is more than twice the number compared to rural surroundings or rather rural areas (Tab. 1). Just the surrounding urbanised areas are able to stick with the core cities to some extent, which underlines the overall dominance of agglomerations. As shown in Tab. 1 employment in high-tech-industries is less concentrated than R&D employment. The disparities between urbanised and rural parts of Germany are far smaller and core cities even show the lowest proportions (Tab. 1). This indicates that there are still functional divisions within research-intensive industries, whereupon the substantial knowledge-creating research and development processes tend to occur in agglomerations. Otherwise high-density areas commonly do not seem to play a particularly remarkable role for research-intensive industries, supposedly especially for less innovation-oriented processes. Concerning high-qualified people higher concentration patterns again can be observed as the non core city settlement types are considerably below the average proportion of Germany. The affinity of high-qualified jobs to urban centres can be generally explained with the presence of higher educational institutions and the existence of knowledge-intensive branches (especially in business services), which eminently rely on the capacity of human capital.

<sup>7</sup> Böblingen is located directly next to Stuttgart.

Fig. 2 shows the proportion of R&D employees in German districts and district free cities. Comparing the maps of settlement types (Fig. 1) and R&D intensity (Fig. 2) one can also graphically identify the more important role of urbanised locations. Besides Fig. 2 clearly strenghtens the patterns observed regarding absolute numbers. The highest shares of R&D workers can be found in the southern part of Germany, where the cities of Munich and Stuttgart again frame the cores of private R&D activity. Besides the Rine-Neckar region as well as the Rhine-Main region feature remarkable R&D intensities. In the northern parts of Germany especially the region around Hannover, Wolfsburg and Göttingen is worth mentioning. Dense regions without appreciable private research activity are mainly to be found in the eastern and the north western part of Germany, especially in the agglomerations of Westphalia, where traditional branches of industry are still dominant. Talking about “regions” implies the finding that R&D activity tends to cluster independently from administrative units or settlement types. The best examples are the regions of Stuttgart, Hannover, Munich and the Bodensee region, whose cluster structures can also be proved by means of local Moran coefficients that detect local spatial autocorrelation and such cluster structures (not shown, cf. Anselin 1995).

Settlement Type	distribution R&D absolute (%)	distribution High-qual. absolute (%)	distribution total workforce (%)	shares of R&D employees (per mille)	shares of High-qual. employees (%)	shares of research-int. Industry (%)	Locali-sation quotient R&D	Locali-sation quotient High-qual
Core cities	46,07	53,18	37,94	14,39	13,85	9,9	1,21	1,40
Urbanised surroundings	41,97	31,97	38,92	12,78	8,11	13,3	1,08	0,82
Rural surroundings	5,73	7,12	11,36	5,98	6,19	10,1	0,50	0,63
Rural areas	6,23	7,73	11,77	6,28	6,49	10,6	0,53	0,66

Table 1: Distribution of innovation-related employment 2007

With regard to individual districts a high R&D intensity is obviously connected with the presence of headquarters or main research centres of major innovative enterprises (cf. Kreuels 2010). While big agglomerations usually cover various technological fields (e.g. Munich, where clusters of information technology, biotechnology as well as automotive and aerospace industry can be found) some districts and even regions show a relatively strong dependence on single branches or even firms - for example the automotive industry in Wolfsburg. Besides this is most likely the case in less dense areas, where a broad basis of private research is missing in many instances.

The well-placed rural surroundings and rural areas are nearly all located in the western part of Germany and feature higher densities (Ländliche Kreise höherer Dichte) or are situated in the direct surroundings of agglomerations or urbanised areas. Generally those rural districts either benefit from large-scale cluster structures or spillover effects (Stuttgart, Munich), developed their own clusters (Schweinfurt, Traunstein/Altötting/Mühldorf) or are home to a dominant innovative firm (Dingolfing-Landau). In total about 45 % of West German rural surroundings and rural areas are above the all-German median of R&D personnel intensity. Mainly this can be traced back to fact that innovation activity in eastern Germany is considerably underrepresented - apart from a few main centres of research (Berlin<sup>8</sup>, Dresden, Jena). 80 % of the districts in the newly formed states range below the all-German median. Especially the rural-peripheral districts in the north-eastern parts show low R&D personnel intensities. But even the neighbouring districts of the well-equipped core citities do not seem to benefit from spread effects or innovation impulses (cf. Gehrke et al. 2010). The proportion of employees in research-intensive industrial branches underline this innovation capability gap between East and West Germany as the relation between east and west is similar to the values of R&D personnel (share of employees in research-intensive industry: East: 6,4 %; West: 12,5 %). However, concerning the shares of highly skilled personnel eastern Germany exceeds the former states (East: 11,2 %, West: 9,6 %) and seems to have a qualification advantage. On the other hand the following data show a downward trend in the eastern states connected with a decreasing qualification level, while western Germany can benefit from an ongoing growth of highly qualified people. Another thought-provoking fact about east German innovation activity affects disadvantages in productivity. That means that despite of the

<sup>8</sup> The importance of Berlin for the eastern German innovation system mainly results from the cities' size and is not less associated with relative strength regarding innovation activity.

presence of high qualified labour various innovation output indicators were considerably below-average (cf. Braun 2004). Reasons for this can be traced back to the above indicated unfavourable composition of branches within manufacturing industry as well as to infrastructural shortcomings, lower capital intensity or the lack of big industrial companies (cf. Günther 2003).

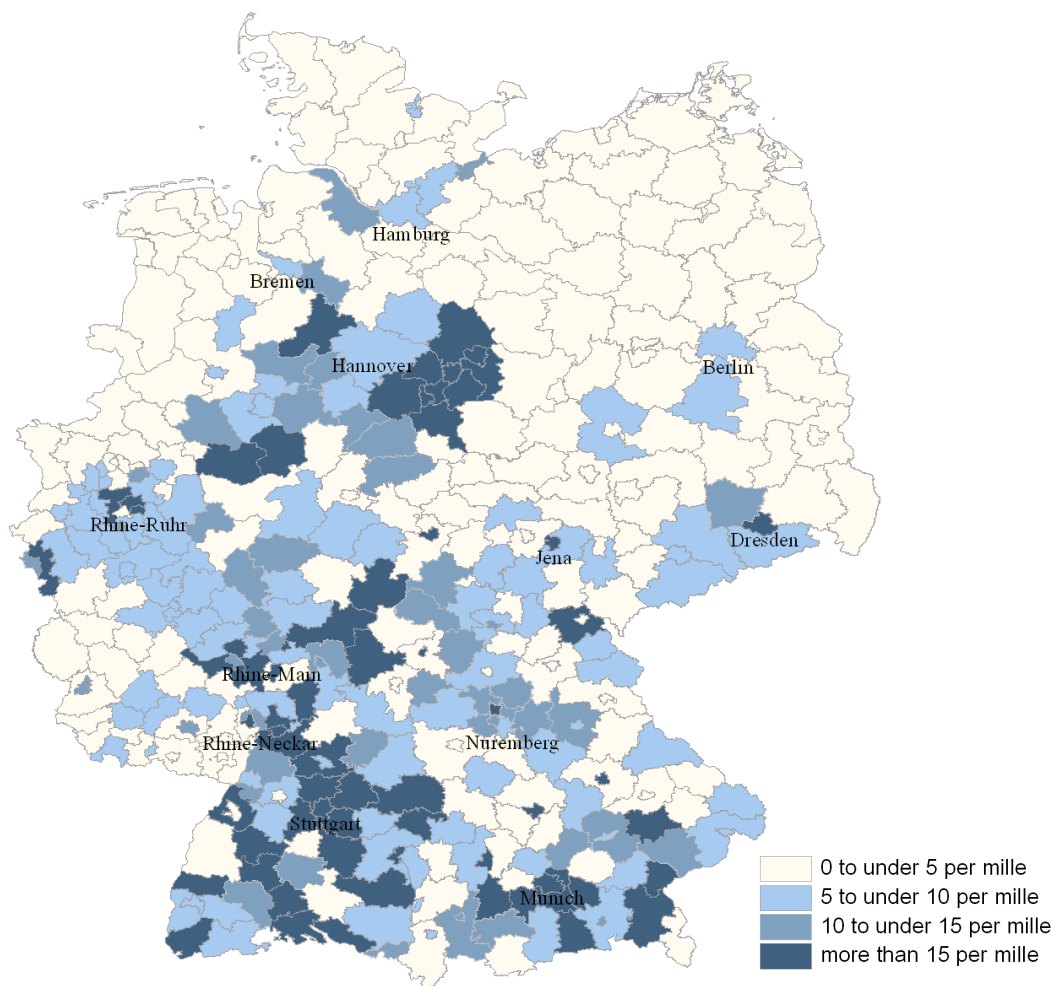


Fig. 3: Share of R&D personnel per 1.000 employees subject to social insurance contributions 2007

## 5 DYNAMICS OF INNOVATION-RELATED EMPLOYMENT

The analysis of the development of the spatial distribution tries to shed light on the question whether the existence of qualified human capital in urbanised areas enhances a further agglomeration of enterprises and human capital in those dense places. Otherwise possible negative effects of agglomeration and further suburbanisation processes, even with respect to knowledge-intensive functions, can lead to general decentralisation tendencies (e.g. Bade 2004). On the level of districts the analysis gives hints about the future positioning of German districts and about possible future lifecycles of cities and regions.

In general R&D employment in Germany rose by 8,1 % between 2003 and 2007. On a large-scale level this increase can be mainly traced back to the development in western Germany (8,3 %), while the expansion of R&D personnel in the eastern parts takes place more slowly (5,5 %). This indicates a further divergent development between former and new states. A similar trend can be observed for high-qualified labour. The eastern states actually show the above mentioned negative trend concerning highly qualified human resources between 1999 and 2007 (-4,3 %). In contrast to that the number of high qualified workers in West Germany increased by 23 % in the same period.

With regard to settlement types a very slight catching-up process arises, while the R&D employment growth in rural surroundings and rural areas has been slightly higher than in agglomerations. In particular the R&D employment in core cities is characterized by a stagnating tendency both in western and in eastern Germany. On the other hand urbanised surroundings and rural areas have shown highest growth rates since 2003 in

both parts of the country (Tab. 2). Nevertheless, one can not talk about a convergence process as the base levels of rural locations were still significantly lower.

Settlement Type	West/East	Share of R&D personnel 2003	Share of R&D personnel 2007	2003 – 2007 (%)
Core cities	West	16,2	15,9	-2,8
	East	9,0	8,8	-2,7
Urbanised surroundings	West	11,0	13,4	22,5
	East	3,8	4,9	23,0
Rural surroundings	West	7,9	7,3	-6,8
	East	3,1	3,6	13,5
Rural areas	West	6,2	7,6	24,5
	East	2,8	3,8	28,6

Table 2: R&D personnel (per 1.000 employees subject to social insurance contributions, change 2003-2007 in %)

Contrary to R&D personnel the development of high-qualified workforce principally follows the general German trend that the all-over employment in cities has shown an above-average development since 1999 (Geppert/Gornig 2010). Consequently academics show a clear tendency to increasingly cluster in core cities and urbanised areas. Fig. 4 suggests that there are higher growth rates in dense areas of Germany.

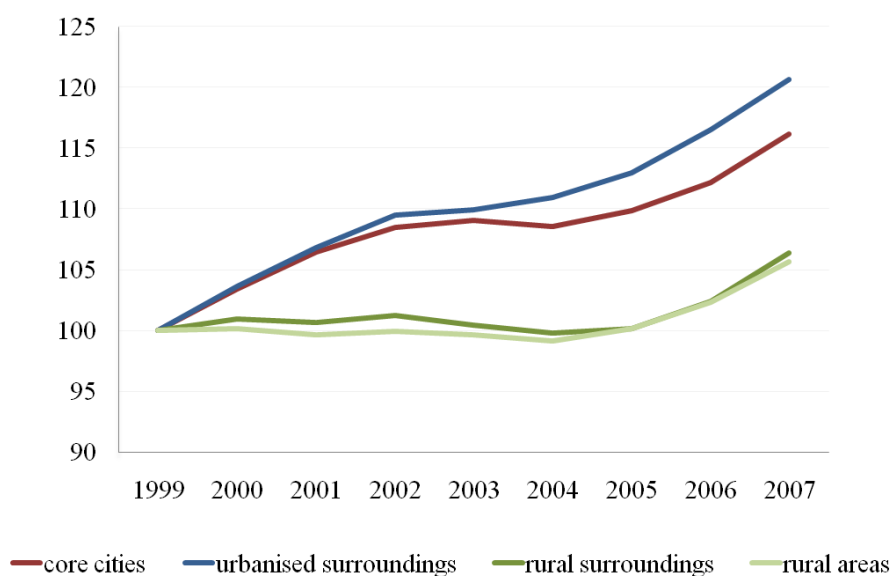


Fig. 4: Development of high-qualified jobs (settlement types, 1999-2007, 1999 = 100)

But comparing the former western Germany to the eastern states the above-mentioned diverse development can be noticed (see Fig. 5). In the western states all settlement types, especially rural parts, benefit from a growth of highly qualified labour, what hints at a slight catching-up process (cf. Fromhold-Eisenbith/Schrattenecker 2006). In contrast to that the eastern parts have shown unfavourable dynamics until a turning point in 2005. Thereby they very likely still have been affected by brain drain tendencies of well qualified young specialists in favour of western regions (Gans/Kemper 2003, Schultz 2008). Another reason for the below-average development must be sought in the lower dynamics of employment in knowledge-intensive (business) services in East Germany (not shown). Thus, only the eastern core cities have been marked by a slight increase concerning high-qualified workers since 1999, because they were most likely to participate in the dynamics of knowledge-intensive economic branches and to offer access to supra-regional markets (Geppert/Gornig 2010). The development of the proportion of high-qualified labour seems to be more homogenous than concerning R&D employment, since nearly 90 % of the districts and district free cities show increasing tendencies between 2003 and 2007. For many districts, e.g. in the eastern part of Germany, the reason lies in the fact that other industries or less qualified jobs have been even more characterised by a continuing downward trend. However, most districts with a decreasing share of highly qualified are located in the eastern part of Germany.





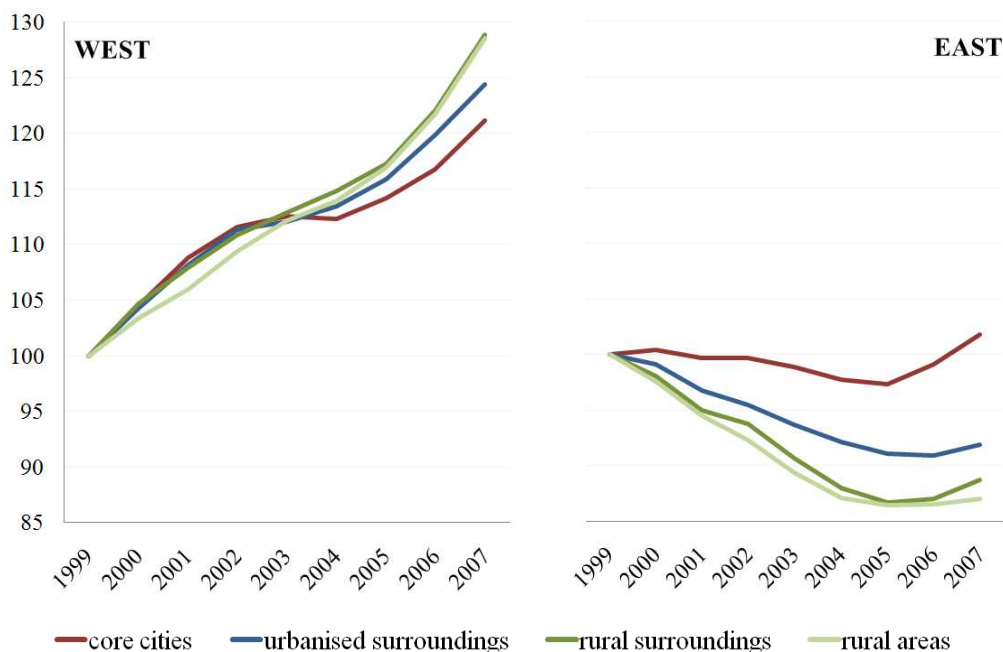


Fig. 5: Development of high-qualified labour (West/East, settlement types, 1999-2007, 1999 = 100)

Certainly, on a small scale, a heterogeneous development and remarkable deviations can be observed beyond the large-scale tendencies. Some districts have been subject to enormous changes in recent years. In R&D employment or research-intensive industry several districts benefit from structural changes in firms (that e.g. shift R&D capacities into a region or enlarge capacities) or firm foundations in high-technology branches. Like this Hannover, Hildesheim or Fulda as well as many districts in Baden-Württemberg increased their R&D intensity. The agglomeration areas thereby benefit from existing structures like the availability of universities and research institutions or evolved networks between enterprises and/or politics. According to Metzger et al. (2008) the example of Nuremberg region shows that these factors, together with the existence of comparatively big established firms and a broad sectoral mix built a favourable climate for firm foundations and innovative activity. Thus, in those regions obviously even rural districts (e.g. Fürth Land, where the proportion of R&D workers increased from 2,9 % (2003) to 10,5 % (2007)) can benefit from spread effects from metropolitan development. In line with recent data on firm foundations a strong growth of high-tech-start-ups and a corresponding employment growth can also occur in less dense areas such as the development of Oberfranken in north-eastern Bavaria shows. There regional politics also pursue the goals of setting up and expanding knowledge infrastructure as well as network structures among the regional players. Those policies in order to foster structural change and the attraction of innovation-related companies and corresponding staff become more and more common on the regional and even on the local level. Accordingly those objectives e.g. are also being pursued by districts in the Rhine-Ruhr area where traditional mining and manufacturing industry still dominate the labour market. An example for that is "Neanderpark" where the district of Mettmann attempts to attract high-value industry on a 10 ha area. Thereby aspects like proximity to higher education and research institutions, location advantages or quality of life were emphasized. With regard to the attraction of high potentials the latter point seems to play an increasing role (Buch et al. 2010). That is why those regional strategies accentuate amenities ranging from cultural and leisure time facilities or housing right up to family-friendly environment. While cities can rely on various cultural or consumption offers, rather rural areas aim at scenic aspects or living environment in this context.

In highly rural-peripheral areas decisions of single firms have significant effects on the innovative capability and the long-term competitive position of a region. As an example Dingolfing-Landau or Landshut have benefited from the automotive industry between 1999 and 2007. Since 1999 there exists a centre for innovation and technology ("Landshuter Innovations- und Technologiezentrum") in Landshut, established by a big car manufacturer. However, also broader cluster structures in rural areas can lead to continuing growth concerning innovation activities, as the positive example of ChemDelta Bavaria (covering the districts of Traunstein, Altötting and Mühldorf) shows, where about 25 chemical enterprises are located.

On the other hand the heterogeneity of the development of innovation-related jobs becomes apparent in negative trends being noticed in various districts. One-third of German districts or district free cities have lost R&D capacities between 2003 and 2007, whereby once again decisions of single firms mainly influenced these developments. A though-provoking development is the continuing downward trend of Berlin that affects the whole East German innovation system (e.g. Gehrke et al. 2010). However, federal government and east German regions also pursue strategies to particularly foster innovation in the eastern states. A recent example is “Innovationsprogramm Sachsen-Anhalt 2010/2011” that is adapted to actual region-specific requirements.

Following comprehensive approach linking R&D employment and high-qualified labour concludes this paper. Therefore, the innovation-related human capabilities in German districts and districts free cities are regarded by means of two perspectives/questions:

- Proportion (2007) of R&D employment and high-qualified workers above or below German average?
- Development (between 2003 and 2007) of R&D employees and high-qualified workers above or below German average?

This leads to the following typification of German districts in each case for both R&D and high-qualified staff:

- Leading districts (above-average proportion and above-average development)
- Matured districts (above-average proportion and below-average development)
- Catching-up districts (below-average proportion and above-average development)
- Lagging districts (below-average proportion and below-average development)

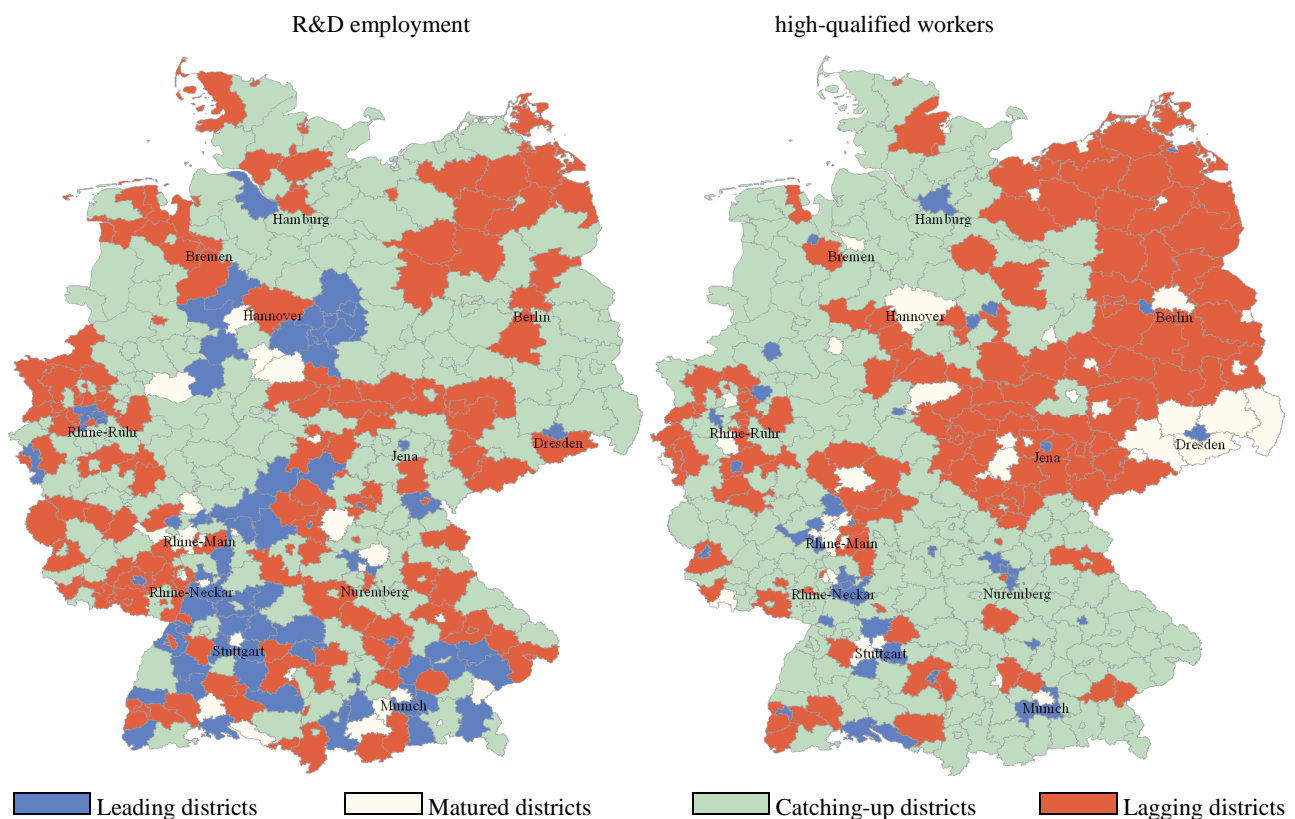


Fig. 6: Typification of German districts (R&D employment and high-qualified workers)

Concerning R&D employment Fig. 6 strengthens the above-characterised patterns as a south-north and a west-east gap can be identified in respect of main centres of private research activity. But the overall pattern shows a heterogeneous development - positive and negative trends often proceed in the immediate vicinity of each other. However, many districts, especially in urbanised surroundings, have improved their good positions.



With regard to highly educated staff the ongoing concentration processes in favour of core cities as well as urbanised surroundings become obvious. In contrast to that, noticeable negative trends appear in large parts of eastern Germany. Only Dresden and Jena have an outstanding knowledge-intensity within East Germany.

Merging the results for R&D personnel and high potentials 15 districts (3,6 %) show above-average results in all four analysed categories. There every considerable research region (Munich, Stuttgart, Bodensee, Rhein-Main, Braunschweig/Wolfsburg, Nuremberg) as well as the two lighthouses in eastern Germany (Jena, Dresden) are represented by one or more district (all districts are core cities or urbanised surroundings). Another 10 % of the districts belong to leading districts in one category and catching-up districts in the other category. On the other side of the scale there are 54 out of 413 districts where gloomier future prospects prevail, since those districts rank below German averages. A closer look indicates that nearly half of those districts are located in the new states and likewise half of the districts belong to rural parts of Germany. The other districts lagging behind with respect to innovation-related jobs, for the most part, are situated in the northern and north-western parts of Germany (20 % out of 54 can be numbered among the Rhine-Ruhr area). 20 % of German districts are characterized by catching-up processes in both, R&D personnel and well-educated workforce, even though not a few of them come from a very low level. The other districts run through heterogeneous developments whereby stagnation or shrinking go hand in hand with a still decent position or simultaneous growth processes.

## 6 CONCLUSION

Analysing spatial aspects of innovation-related employment as a main determinant of regional innovation activity the study identifies considerable concentration patterns in favour of core cities and urbanised regions in Germany. However, many positive examples of knowledge-based employment structures exist in rural areas. As R&D personnel, employment in research-intensive industries or high-qualified workers are merely input variables of the innovation process this study could only feature a deterministic point of view, which requires further research about the actual role of human capital and conditions that foster knowledge-creating processes among workers as well as the generation of innovations. However, regional government initiatives conducive to the attraction of highly skilled labour and high-tech industry have become very common, even in rather rural districts. Nevertheless, the presence of universities, research institutions or business services, the proximity to other innovation-related firms, networks or resulting spillover-effects seem to be central requirements for broad innovative activities and illustrate the advantages of dense areas. In rural or less dense areas innovative jobs are usually connected with specialisation and thereby often unilaterally depended on the development of single branches or even firms.

Since not all regions seem to have a favourable position regarding innovation-related employment and globalisation as well as demographic change will tighten the interregional competition on firms and highly skilled people on the local level, politics are asked to shape programs to foster innovative activity and to gain future-proof enterprises. Existing network structures, the prospect of access to complementary research and infrastructures as well as amenities concerning quality of life will thereby play an important role.

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