Agglomeration of Knowledge in the German Regional Economy

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Abstract

This article investigates the geographical location of workers in jobs with high-knowledge requirements in the German economy. Our analysis takes individual-level data from the German socioeconomic panel (GSOEP) and combines them with the knowledge information for different jobs that comes from the US Department of Labor. We make use of the regional information inherent to the GSOEP that can be accessed only through a special user contract. High-knowledge employment is differently distributed across the German regions. Whereas high-knowledge employment in communication and media as well as public safety is rather concentrated across regions, high-knowledge employment in computers and electronics, engineering and technology, education and training and mechanical tasks is more dispersed. Eastern German regions display a lower share of high-knowledge workers in computers, engineering, mechanical tasks and public safety. The results are important to understand the regional development potential across the German regions. Our analysis detects a division in high-knowledge employment between the East and West of Germany.

Keywords: Agglomeration, Knowledge, Germany

JEL: R11, R12, J24

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Introduction

Previous studies have emphasized the importance of human capital, knowledge spillovers and innovation for the generation of productivity and growth (Becker, 1964, Lucas 1988, Jacobs 1969, Marshall 1890, Rauch 1993). Being in proximity to other people or firms has been found to foster knowledge spillovers and economic interactions (Glaeser 1992). Some other studies found that human capital became more concentrated over time (Florida 2002, Berry and Glaeser 2005). Various studies tried to disentangle which type of activities spur the development of regions. What we know from the US is that agglomeration enhances earnings of innovation- and creative-based occupations like IT workers, engineers, artists and financial executives (Gabe and Abel 2011), and science-, management and business-, and financial operations-based jobs determine regional development

(Florida 2008) as well as knowledge in administration and management, economics and accounting, mathematics, computers and electronics and telecommunications (Abel and Gabe 2011). Gabe and Abel (2011) classified knowledge workers according to the degree of interaction with either peers or customers.

Investigating the effect of knowledge for economic development is impeded by the problem to measure the concept of knowledge properly. Most of the former studies concentrated on measuring human capital, mostly by using the amount of years in schooling. Knowledge, however, can deviate considerably from the amount of years in school. Only recently have researchers made progress in measuring knowledge, using information from the US Department of Labor (Feser 2003, Gabe and Abel 2011 e.g.).

For the German economy, we know only little about the specific types of knowledge that would drive regional economic development. The present contribution aims to fill this gap. Making use of the detailed information on occupations' knowledge requirements from the US Department of Labor's O*NET classification, we will examine the agglomeration of employment in jobs with high-knowledge requirements across the German regions. Our individual-level data stem from the German socioeconomic panel. Our results demonstrate that employment is differently distributed across the German regions. While employment with high knowledge in communication and media is rather concentrated, employment in jobs with high knowledge in computers, engineering, education and training and mechanical tasks is rather dispersed. We find important differences in the concentration of employment between the Western and Eastern parts of Germany, which still demonstrate a considerable division between the East and the West.

The Knowledge Economy in Germany

The German case is special insofar, as the country has been divided into an Eastern part that was under a socialist regime after World War II, and a Western part that was led by the American, British and French Allies. The Fall of the Wall and Reunification are nowadays more than 25 years ago. From an economic geographer's viewpoint, following the reunification barriers to trade and barriers to migration had been removed and the degree of integration been increased. From the New Economic Geography models we know that an increasing degree of integration could first enhance concentration tendencies and when integration proceeds, this process could reverse and dispersion forces dominate, convergence in incomes and employment would result. However, Brakman and Garretsen (1993) argued that convergence between the German East and West might take time due to less favorable initial conditions in East Germany. Still, nowadays the gap in nominal wages between the East and the West is about 20%. After Reunification, West Germany offered larger markets for producers and consumers which first led to migration from the East to the West (Bickenbach and Bode 2013). However, due to

imperfect mobility of East German workers this process slowed down over time. Bickenbach and Bode conjecture that in the future redispersion towards East Germany might occur when resentments between the East and West German population, the "Wall in the mind", are put down. In their study, Bickenbach and Bode advocate that future research should consider heterogeneity of workers and firms, as knowledge spillovers might result from this heterogeneity. Our analysis will provide an insight into the heterogeneity of high-knowledge workers in the German regional economy.

Recent studies found that the German economy comprises both concentrating and deconcentrating regions across time. Especially, knowledge-intensive services bear the tendency to further concentrate over time (Geppert et al. 2008). Some evidence has been found for knowledge spillovers and externalities to exist, although this field is still rarely explored for Germany (Lublinski 2003). Focusing only on bohemians and technological employees, Wedemeier (2010) that these professionals positively impact some growth indicators across the German regions (Wedemeier 2010). Moreover, the more creative professionals are present in a region, the more creative professionals will be attracted to a region (Wedemeier 2015). In the light of these studies, our approach to single out different high-knowledge fields and to examine where the knowledge workers locate in the German economy will enable a better understanding of regional development potentials.

Data and Modeling Framework

For our analysis we take individual-level data from the GSOEP database which is provided by the German Institute of Economic Research (DIW Berlin). The data set is a household survey that is conducted every year. It is representative for the German population and has been applied for many other studies in the literature before. The data set is based on a sample and covers around 0.025% of the German population. The data we had access to is taken from the year 2006. From the GSOEP we extracted data on occupations (variable *Occupation of Individual*) and made use of the regional information inherent to the GSOEP which can only be accessed through a special user contract. This information covers the location of individuals measured on the scale of planning regions in the German economy. We further considered only those individuals that were aged between 18 and less than 65 years to cover the working population.

To gain a measure for an occupation's knowledge requirements, we took the information about the *level* and *importance of knowledge* that is given for a wide range of occupations by the US Department of Labor's O*NET classification. The level of knowledge is measured on a scale 1 to 7 and the importance of knowledge is measured on a scale 1 to 5, higher values denoting a higher degree of knowledge requirements. Knowledge is ranked for a range of 33 subjects which are shown in Table 1. The subjects range from knowledge in

mathematics to law and government, personal services, engineering, production and processing to design and fine arts. The information was gathered from experts and workers through interviews.[1]

We then matched the knowledge information to the occupational variable in the GSOEP. In doing so, we assume that the categorization of US occupations is transferable to the occupations in Germany. We can expect that a US manager, teacher, charwoman etc. will have to have similar knowledge in subjects like administration and management, language, personal service etc. as in Germany. For some cases we had to match several occupations from the US system to the German occupational variable, in which case we took the average of the level and importance of knowledge scores. We constructed a knowledge index by multiplying the importance of knowledge and level of knowledge score as it is done in Gabe and Abel (2011). To define high knowledge requirements, we set a cut-off at 0.6 times the maximal knowledge score in a knowledge field. This is due to the fact that occupations require knowledge basically in every knowledge subject and for our analysis it is interesting to single out which are the jobs that require a high degree of knowledge in a given field. We then added 33 dummy variables to the data set, indicating for an individual's occupation whether it requires high knowledge in a knowledge field (1) or not (0).

To investigate the geographical concentration of employment in different jobs with high-knowledge requirements, we make use of the regional information in addition to the individual data of the GSOEP. We obtained additional information on 96 so called "Raumordnungsregionen" (see Table 3 in the Appendix for a list of regions), the planning regions in the German economy. These regions consist of one or several "Stadtkreise" and "Landkreise", the urban districts and counties, and their construction is based on commuter flows. We considered only those individuals who provided information on whether their workplace is located at their place of residence and for those who did not, we considered only those individuals who lived in a commuting distance to the workplace of up to 30 kilometers giving us a sample of 7055 observation units.

To measure the degree of geographical concentration, we employ the Krugman concentration index (Krugman 1991) in a modified way similar to the methodology taken by Midelfart-Knarvik et al. (2000)[2]:

$$KI_k = \sum_{r=1}^{R} \left| \frac{e_{kr}}{e_k} - \frac{1}{K-1} \sum_{k=1}^{K-1} \frac{e_{kr}}{e_k} \right| \qquad (1)$$

[1] See Peterson et al. (2001) for a detailed description.
[2] The index as measured by Midelfart-Knarvik et al. takes into account the deviation of a region's employment share from the mean of all other knowledge fields' employment shares, whereas the original Krugman index would just consider the deviation from only one other knowledge field.

where k denotes the knowledge field, e is employment, and r denotes the region. The higher the index value, the higher the degree of geographical concentration.

We can graphically depict the distribution of employment for different knowledge fields by plotting the values of regional Balassa indices per subject of knowledge. The Balassa index is measured as follows:

$$BI_r = \frac{\frac{e_{kr}}{e_r}}{\frac{e_k}{e}} \quad (2)$$

The same notation as for the Krugman index applies. The Balassa index captures the relation between the regional and the knowledge field's employment level. A Balassa index value of 1 defines equidispersion across regions, an index value from 0 to 1 defines regional dispersion and a value greater than 1 displays regional specialization for a given knowledge field. For the graphical depictions the geographical coordinates for the 96 planning regions have been obtained from the "Bundesinstitut fuer Bau-, Stadt- und Raumforschung" (BBSR) and we used shapefiles to graph the regional concentration of employment.

Agglomeration of employment in jobs with high-knowledge requirements

The results in Table 2 –displaying Krugman indices-- show that specialists, workers with high knowledge in food production, sociology, telecommunications, physics, foreign language, transportation, personnel resources, fine arts, history, geography and communication and media are more concentrated across German regions, whereas workers with high knowledge in design, education and training, customer and personal services, language and clerical tasks are more dispersed across regions. In the following, to be succinct, we will select only a few occupations of interest, to further show their geographical dimension.

From Figure 1, plotting the Balassa indices, we can conclude that workers in professions that require high knowledge in communication and media locate in only a few regions, specifically in the regions of Munich, Augsburg, Donau-Wald, Braunschweig, Westmecklenburg, Bremerhaven, Hamburg, Berlin, Dortmund, Rheinhessen Nahe, Rhein-Main and Unterer Neckar (see the list of regions in the Appendix). In these regions the TV and movie industry is present (especially in Munich, Berlin, Hamburg), as well as newspapers and radio stations. Clustering of activity indicates that fewer contact with people in other knowledge fields but more contact with peers is demanded. It is worthwhile to stress that it is not the product, for example the TV show or the radio broadcast, which is relevant for this type of analysis, but it is the knowledge about the topic of communication and media of the high-knowledge workforce. The use of the product of communication and

media would be widely spread over the regions, however the concentration of the workforce follows a different pattern.

For the knowledge field of computers and electronics a different picture emerges. Figure 1 shows a greater dispersion of employment across regions. Computers and electronics knowledge is demanded by various people and not only the peers. What we can also see from the depiction is that there are regions in the East of Germany that bear less employment activity in high-knowledge computers and electronics tasks.

For employment that requires high knowledge in the areas of mechanical tasks and engineering and technology, Figure 2 displays that employment is far more dispersed over the regions. The dispersion of employment indicates that knowledge is disseminated not specifically to peers but to other clients in the economy. However, a greater clustering of economic activity becomes present in case of mechanical tasks in the regions of Schwarzwald-Baar-Heuberg, Donau-Iller, Allgaeu, Bodensee, Ostwuertemberg, Osthessen, Arnsberg and Braunschweig. In some of these regions important automobile companies operate like VW in the planning region Braunschweig. In Ostwuertemberg and Arnsberg a large intermediate firm activity for automobile parts is present. In the current phase of globalization and the splitting-up of value chains it is not surprising that especially the intermediate goods production dominates employment structures and their distribution. Baden-Wuertemberg, the very South-Western state in Germany, is well-known for its automobile production which is due to the invention of the first automobile with a combustion engine by Carl Benz in 1886 in Mannheim. The depiction further shows, that in the Eastern parts of Germany fewer high-knowledge employment in these knowledge fields is present. A large amount of the high-knowledge employment in engineering and technology in fact is present in the Southern states Bavaria and Baden-Wuertemberg.

From Figure 3, we can see that high-knowledge employment in education and training is overall quite dispersed. However, it is evident that in the Eastern German parts a higher share of high-knowledge employment is present than in some Western German parts. This might display recent years' support and campaign of the Ministry of Culture and Education to gain new teachers and specialists in education and training in East Germany. Another interesting fact from Figure 3 is that employment with high knowledge in public safety and security is comparatively low in the Eastern German parts. This complies with the well known shortage of police officers and other security personnel especially in East Germany. The government has to continue efforts to increase the presence of these workers in the regions.

Summary and Conclusions

The present contribution has examined the concentration of employment in jobs with high-knowledge requirements across the German Regional Economy. Making use of information on knowledge for different jobs given by the US Department of Labor, we could assign high-knowledge indicators to individuals' occupations in the German economy using the GSOEP data. Moreover, we made use of the regional information to the GSOEP that could be accessed through a special user contract.

The results reveal that high-knowledge employment is following different location patterns across the German regions. We find important differences in the concentration of employment between the Western and Eastern parts of Germany, which demonstrate a division between the East and the West. Employment in jobs with high knowledge in communication and media is highly concentrated whereas employment in computers and electronics, mechanical tasks and engineering and technology and education and training is far more dispersed across the regions. We could detect a lower degree of concentration of employment in jobs with high knowledge in computers and electronics, mechanical tasks and engineering and technology for the Eastern German regions. High-knowledge employment in education and training, though, is comparatively more concentrated in Eastern German regions. Employment with high knowledge in public safety is less present in Eastern German regions and this indicates that efforts should be undertaken to increase employment in these regions. Moreover, incentives to receive the education, to increase the motivation to move to the East, to set up firm activity and produce should be strengthened especially for the technological branches of computers and electronics, engineering and technology, and mechanical tasks in order to achieve convergence across regions and to increase the regional development potential. Our analysis gave also insight about several occupations' tendency to cluster around peers or other clients in the economy.

The insights about the concentration processes of employment in high-knowledge activities can be further used to analyze the economic development, productivity and growth across the German Regional Economy. Given the elaborations of theoretical models that point to the relevance of knowledge spillovers and innovations in the development process, further analyses that examine their existence and geographical spread can be undertaken.

Literature

Abel J. R., Gabe T. M. (2011). Human Capital and Economic Activity in Urban America. *Regional Studies,* 45, 1079-1090.

Becker G. (1964). Human Capital, Columbia University Press, New York.

Berry, C., Glaeser, E. (2005). The divergence of human capital levels across cities. *Papers in Regional Science*, 84, 407-444.

Bickenbach, F., Bode, E. (2013). New Economic Geography and Reunified Germany at Twenty: A Fruitful Match?. *Spatial Economic Analysis*, 8, 120-153.

Brakman, S., Garretsen, H. (1993). The relevance of initial conditions for the German reunification. *Kyklos*, 46, 163-181.

Feser E. J. (2003). What Regions Do Rather than Make: A Proposed Set of Knowledge-based Occupation Clusters. *Urban Studies,* 40, 1937-1958.

Florida R., Mellander C. and Stolarick K. (2008). Inside the black box of regional development—human capital, the creative class and tolerance. *Journal of Economic Geography,* 8, 615-649.

Florida R. (2002). The Rise of the Creative Class and How It's Transforming Work, Leisure, Community, and Everyday Life, New York.

Gabe T., Abel J. R. (2011). Agglomeration of Knowledge. *Urban Studies*, 48, 1353-1371.

Geppert, K., Gornig, M., Werwatz, A. (2008). Economic Growth of Agglomerations and Geographic Concentration of Industries: Evidence for West Germany. *Regional Studies*, 42, 413-421.

Glaeser E., Kallal H., Scheinkman J. and Shleifer A. (1992). Growth in cities. *Journal of Political Economy,* 100, 1126-1152.

Jacobs J. (1969). The Economy of Cities, New York.

Krugman P. (1991 b). Geography and Trade, MIT Press, Cambridge, Massachusetts.

Lublinski, A. (2003). Does geographic proximity matter? Evidence from clustered and non-clustered aeronautic firms in Germany. *Regional Studies*, 37, 453-467.

Lucas R. (1988). On the Mechanics of Economic Development. *Journal of Monetary Economics*, 22, 3-42.

Marshall A. (1890). Principles of Economics, London Macmillan.

Midelfart-Knarvik K. H., Overman H. G., Redding S. J., Venables A. J. (2000). The Location of European Industry. European Economy-Economic Papers No. 142.

Peterson N., Mumford M., Borman W., Jeanneret R., Fleishman E., Levin K., Campion M., Mayfield M., Morgeson F., Pearlman K., Gowing M., Lancaster A., Silver M., Dye D. (2001). Understanding work using the occupational information network (O*NET): implications for practice and research. *Personnel Psychology,* 54, 451-492.

Rauch J. (1993). Productivity Gains from geographic concentration of human capital: evidence from the cities. *Journal of Urban Economics*, 34, 380-400.

Wedemeier J. (2010). The impact of the creative sector on growth in German regions. *European Planning Studies*, 18, 505-520.

Wedemeier, J. (2015). Creative professionals, local amenities and externalities: Do Regional concentrations of creative professionals reinforce themselves over time? *European Planning Studies*, 23, 2464-2482.

Appendix

Table 1

Knowledge areas

Administration and management	Psychology
Clerical	Sociology and anthropology
Economics and accounting	Geography
Sales and marketing	Medicine and dentistry
Customer and personal service	Therapy and counseling
Personnel and human resources	Education and training
Production and processing	Language
Food production	Foreign language
Computers and electronics	Fine Arts
Engineering and technology	History and archaeology
Design	Philosophy and theology
Building and construction	Public safety and security
Mechanical	Law, government and jurisprudence
Mathematics	Telecommunications
Physics	Communications and media
Chemistry	Transportation
Biology	

Source: US Department of Labor, O*NET system.

Table 2

Agglomeration of employment in high-knowledge activities

Knowledge areas	Krugman index	Knowledge areas	Krugman index
Food production	1.9846	Therapy and counseling	0.8097
Sociology and anthropology	1.9439	Law and government	0.7591
Telecommunications	1.9418	Philosophy and theology	0.744
Physics	1.8728	Sales and marketing	0.732
Foreign language	1.8088	Biology	0.716

Transportation	1.7483	Administration and management	0.661
Personnel and human resources	1.7475	Mechanical	0.652
Fine arts	1.642	Psychology	0.6223
History and archaeology	1.6063	Computers and electronics	0.5865
Geography	1.6001	Production and processing	0.5756
Communication and media	1.3706	Engineering and technology	0.5408
Economics and accounting	1.1762	Design	0.526
Chemistry	1.0694	Education and training	0.5187
Public safety and security	0.9835	Customer and personal service	0.4216
Building and construction	0.9402	Language	0.4147
Mathematics	0.9179	Clerical	0.407
Medicine and dentistry	0.9058		

Source: US Department of Labor, O*NET system and German SOEP data.

Notes: This Table displays Krugman concentration indices for employment in different jobs with high-knowledge requirements.

Table 3

List of planning regions, “Raumordnungsregionen”

Schleswig-Holstein Mitte, Schleswig-Holstein Nord, Schleswig-Holstein Ost, Schleswig-Holstein Sued, Schleswig-Holstein Sued-West, Hamburg, Braunschweig, Bremen-Umland, Bremerhaven, Emsland, Goettingen, Hamburg-Umland-Suued, Hannover, Hildesheim, Lüneburg, Oldenburg, Osnabrueck, Ost-Friesland, Suedheide, Bremen, Aachen, Arnsberg, Bielefeld, Bochum/Hagen, Bonn, Dortmund, Duisburg/Essen, Duesseldorf, Emscher-Lippe, Koeln, Muenster, Paderborn, Siegen, Mittelhessen, Nordhessen, Osthessen, Rhein-Main, Starkenburg, Mittelrhein-Westerwald, Rheinhessen-Nahe, Rheinpfalz, Trier, Westpfalz, Bodensee-Oberschwaben, Donau-Iller (BW), Heilbronn-Franken, Hochrhein-Bodensee, Mittlerer Oberrhein, Neckar-Alb, Nordschwarzwald, Ostwuerttemberg, Schwarzwald-Baar-Heuberg, Stuttgart, Suedlicher Oberrhein, Unterer Neckar, Allgaeu, Augsburg, Bayerischer Untermain, Donau-Iller (BY), Donau-Wald, Industrieregion Mittelfranken, Ingolstadt, Landshut, Main-Rhoen, Muenchen, Oberfranken-Ost, Oberfranken-West, Oberland, Oberpfalz-Nord, Regensburg, Suedostoberbayern, Westmittelfranken, Wuerzburg, Saar, Berlin, Havelland-Flaeming, Lausitz-Spreewald, Oderland-Spree, Prignitz-Oberhavel, Uckermark-Barnim, Mecklenburgische Seenplatte, Mittleres Mecklenburg/Rostock, Vorpommern, Westmecklenburg, Oberes Elbtal/Osterzgebirge, Oberlausitz-Niederschlesien, Suedsachsen, Westsachsen, Altmark, Anhalt-Bitterfeld-Wittenberg, Halle/S., Magdeburg, Mittelthueringen, Nordthueringen, Ostthueringen, Suedthueringen

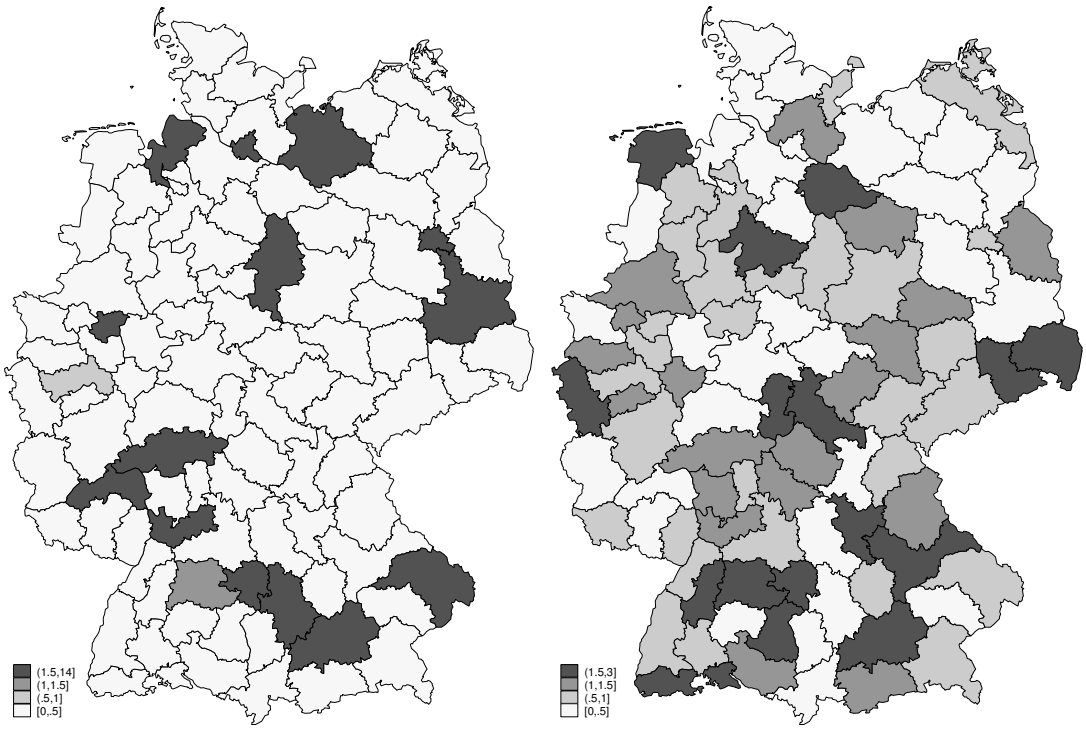

Figure 1

Regional distribution of employment in jobs with high knowledge in communications and media (left depiction) and in jobs with high knowledge in computers and electronics (right depiction)

Source: BBSR, author's own illustration.

Note: Regional Balassa indices are depicted on a scale ranging from low (light color) to high (dark color) values.

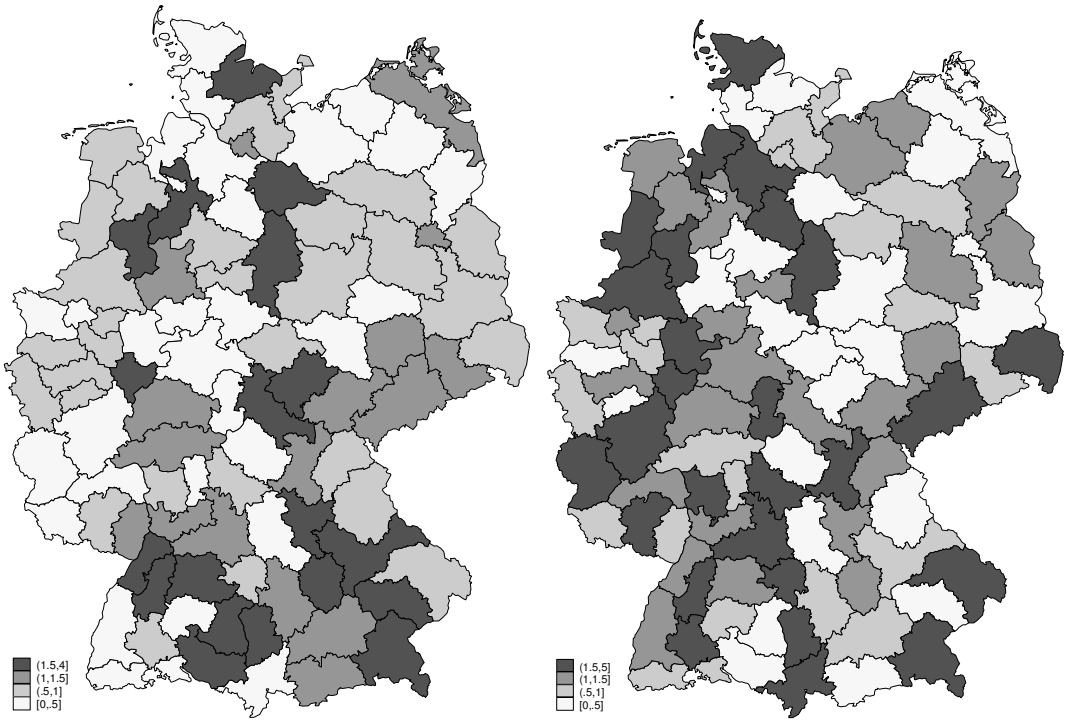

Figure 2

Regional distribution of employment in jobs with high knowledge in engineering and technology (left depiction) and in jobs with high knowledge in mechanical tasks (right depiction)

Source: BBSR, author's own illustration.

Note: Regional Balassa indices are depicted on a scale ranging from low (light color) to high (dark color) values.

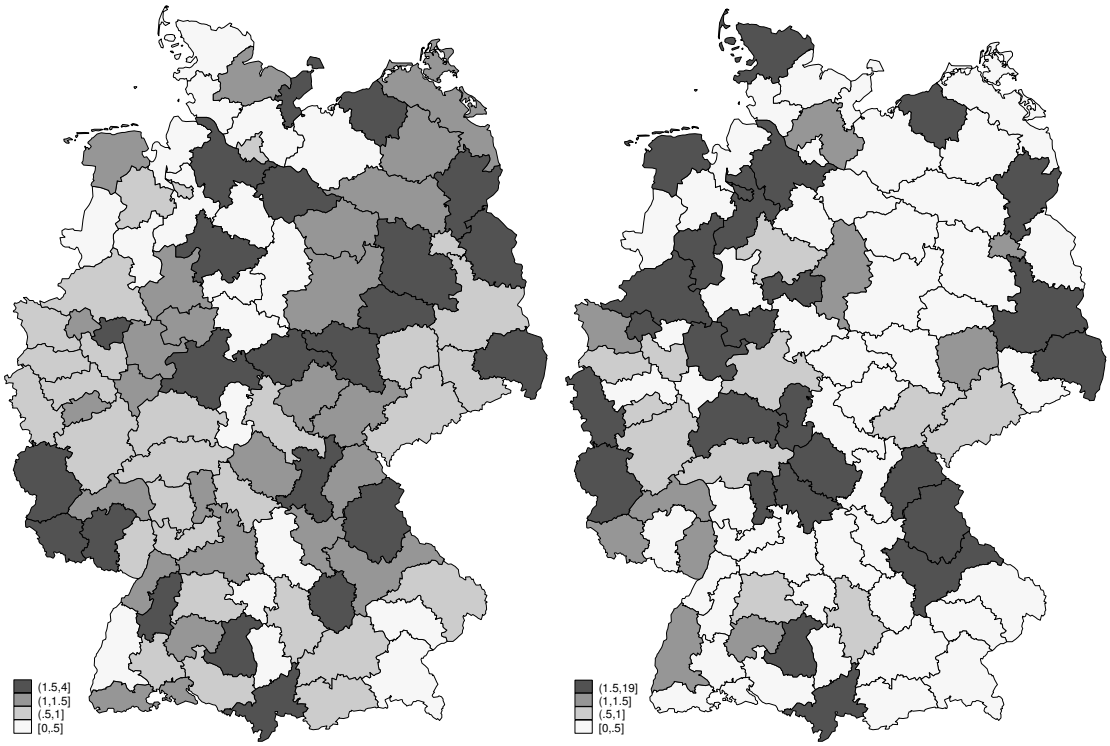

Figure 3

Regional distribution of employment in jobs with high knowledge in education and training (left depiction) and in jobs with high knowledge in public safety and security (right depiction)

Source: BBSR, author's own illustration.

Note: Regional Balassa indices are depicted on a scale ranging from low (light color) to high (dark color) values.