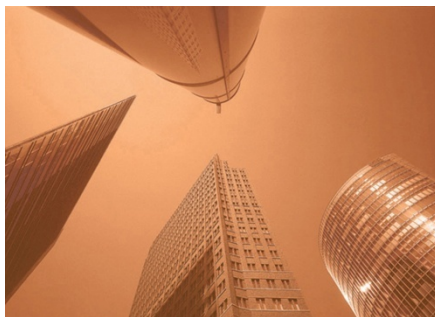


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Henning Kroll
Knut Koschatzky

Potentials and role of peripheral or weakly
structured regions in national innovation
systems



Fraunhofer
ISI



Contact:

Fraunhofer Institute for Systems
and Innovation Research ISI
Competence Center "Policy and Society"
Breslauer Strasse 48
76139 Karlsruhe, Germany

Phone: +49 / 721 / 6809-551

Fax: +49 / 721 / 6809-176

E-Mail: magdalena.groth@isi-extern.fraunhofer.de

URL: www.isi.fraunhofer.de

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1 Objectives and research questions

Innovation was made an important starting point for addressing the Lisbon objectives already since the 7th European Framework programme (Barca 2009; Koschatzky and Stahlecker 2010). Both in so-called "competitive and employment regions" and in "cohesion regions" structural funding should be directed to a certain extent to encouraging innovation, entrepreneurship and the growth of the knowledge economy by supporting regional research and innovation capacities. Also in the following years, the smart specialisation approach included elements of innovation promotion because regions should specialize in those fields in which they had a competitive advantage, namely where they were more innovative than other regions (Foray 2014; Capello 2014).

Nevertheless, what we still observe is a highly concentrated spatial pattern of innovation activities within the EU and within many member states (European Union 2017). There might be certain deconcentrating effects, because less developed regions exhibit a faster productivity and employment growth compared to the European average, but there is still the need to support structural change and the improvement of innovation capabilities in weakly structured regions outside the economic agglomerations.

In general, it can be said that regional change and especially an innovation-oriented regional change still is a major challenge at the supra-national, national, and regional level (Stahlecker et al. 2019). Innovation in this respect should not be understood as technological innovation only, but in a broad understanding of change and the generation of new ideas regarding technical, non-technical, organisational, social and other aspects for the improvement of living conditions, income and wealth (Warnke et al. 2016).

In the complex fabric of a national innovation system (Lundvall 1992; Asheim and Gertler 2005), sub-national spatial entities like regions or cities play manifold, but often different roles. Major agglomerations usually are the national growth engines with a high innovative potential, while peripheral, often rural areas are expected to play minor, e.g. supplementary roles in national and international value added chains. They lack public and private research capacities and thus the critical mass for invention and innovation (OECD 2016). On the other hand, creative capabilities can be found in many places, not only in cities, especially since advances in information technology and related infrastructure make connections within and between regions more easy and lead to a reduction in the importance of transportation and transaction costs (Schmidt et al. 2017). In this understanding, regional innovation policy approaches should be placed-based, i.e. they should reflect the initial conditions in regions (Barca 2009). We raise

the question whether so far weakly structured regions exhibit potentials that could be made the starting point for policy measures of innovation support and stimulation. The objective behind this understanding is to develop these regions so that they are able to play more active roles in national innovation systems.

It is the objective of this paper to analyse the role innovation policy could play in the promotion of regional change, using Germany as a case study, and to develop a typology of structurally weak regions for tailored and regionally specific policy interventions.

2 Theoretical framework

Regional change, i.e. the decline of formerly more successful and the rise of new regions, was and is an empirical fact at different times (cf. Liefner and Schätzl 2012). Innovation-based regional change describes the change in the innovative capacity and competitiveness of regions over time (Koschatzky 2018). It is a central aspect of regional change processes in the national and international division of labour as well as in technology and knowledge competition. Reasons are technological progress and political and social processes that trigger a shift in research and innovation activities.

Structural change in the classical sense is connected with the idea that the factor supply structure, factor costs and the demand structure for goods are no longer in equilibrium and that structures arise (economic, sector and spatial structure), which are not competitive and lead to structural weaknesses. The political starting point here is structural policy. It tries to adapt the factor supply structure and the demand structure (Geigant et al. 1979). Approaches are labour market policy measures, investments, for example in infrastructure and commercial spaces, as well as tax incentives.

In economic geography and the more economically based New Economic Geography numerous location and spatial economic theories are used as theoretical platform that deal with different facets of spatial structural change (Schätzl 2001). These theories deal primarily with the development of location and spatial structures depending on economic factors such as demand, product price and transport costs. However, they also provide information on how structures can change when these factors change (e.g. decreasing transportation costs due to technical progress or infrastructure expansion with corresponding implications for industrial site selection). In particular, these theories form the basis for the development of spatially differentiating factors in accordance with the spatial economic theory outlined by Edwin von Böventer (v. Böventer 1962; 1964):

- agglomeration factors defined as internal and external returns (localisation and urbanisation advantages)
- transportation costs
- economic dependence on the production factor land.

In line with the spatially differentiating factors of spatial economic theory, the New Economic Geography reveals the following factors that influence regional development and structural change (Koschatzky 2001, 82):

- the human capital stock of a region,
- economies of scale in production,
- positive and negative external effects from knowledge and learning (agglomeration effects, spillover effects),
- the productivity of the research sector resulting from human capital, knowledge production and learning and the closely related level of (temporary) monopoly rents,
- the speed of knowledge diffusion with the possibility of imitating or adapting new products, and
- the interactivity of a region, i.e. its openness to new knowledge.

From an innovation economics point of view, innovation is an evolutionary, cumulative, interactive and feedback process of transferring information, implicit and explicit knowledge into innovations of a technical, social and organisational character. This process is characterized by uncertainty, information search, information coding and decoding, and mutual learning. Socio-cultural factors decisively influence the ability, type and intensity of interaction between the different actors in the innovation process (Koschatzky 2001). As a result, innovation processes can have very different forms and innovation activities can differ in their orientation and success between nations and regions.

Depending on the type of innovation (radical innovation or incremental improvement) and the combination and development of these characteristics, different spatial characteristics of the innovation process are possible. The spatial implications of innovation processes are determined by the regional endowment of innovation-relevant production factors (such as the human capital stock, research institutions and R&D-active industrial and service firms), the specialisation and quality of the existing innovation infrastructure, as well as the type and intensity of networking and social interaction between innovation actors. In recent years, new forms of innovation such as user innovation (von Hippel 2005), social innovation (Howaldt and Schwarz 2010) and collaborative innova-

tion (Benkler 2013) emerged, often based on IT-based platforms and exchange processes as well as on the increasing digitization of production and services. This is followed by a loss of spatial contexts, which represents a countertrend to the relevance of proximity effects, according to which spatial proximity is particularly important when innovation projects involve a particularly high degree of uncertainty, especially in the early phase of innovation processes (Carrincazeaux and Coris 2011). The differentiation of innovation processes goes hand in hand with the emergence of new groups of civil society actors and initiatives that develop and test new, often low-threshold innovations in creative groups (crowd innovation, frugal innovation; cf. Kroll et al. 2016).

Although knowledge resources and critical masses for complex technological development and innovation processes are often lacking in structurally weak regions, these new forms of innovation represent opportunities for individuals, groups, initiatives and firms to develop innovative solutions in these regions without high expenditure on resources and research. Therefore, innovation processes are possible in these regions, they can (but do not have to) have a different character and level than in regions with strong knowledge potential. In addition, they can be carried out together with partners in other regions, or they can be complementary or more advanced in the sense of incremental improvements and adjustments (Koschatzky 2018).

The cooperation between partners is an essential feature of the innovation process. In an economy based on the division of labour, innovations can no longer be implemented exclusively by a single actor, e.g. a firm, but only in cooperation with and interaction between different actors. Systemic and networked approaches to division of labour processes are required. Heuristic models that address the need for interaction deal with national and regional innovation systems (Lundvall 1992; Cooke 1992). In an innovation system, organisations act and shape it through their mutual interactions and their interdependencies with other innovation systems. Key elements of an innovation system are small, medium-sized and large enterprises, universities, non-university research organizations, technology transfer agencies, consultants, further education organizations, public and private funding organizations, networks, clusters, business clubs and other organizations involved in innovation processes that generate innovations or influence their emergence and diffusion (Warnke et al. 2016). The relationships between these elements can be strong and weak ('strong ties, weak ties'), regular and irregular, intense and loose, hierarchical, heterarchical, polycentric and dualistic (Cooke et al. 1997, 478).

The concept of innovation systems allows innovation policy conclusions (Lindner 2012) that are also relevant for an innovation-based regional change and for weakly structured regions. In this respect, some specific aspects need to be considered. Innovations are something new, but the framework within which this new aspect is considered must be defined. Regional innovation policy in particular is not about new concepts and the generation of innovations that have not yet existed worldwide, but about creating inventions and implementing concepts that are new in the regional context. It is also not a matter of generating scientific knowledge or technical solutions that are novelty in the world, but of developing approaches that deal with scientific, technical, social, organisational, economic or cultural topics. Innovation should be understood at the regional level as a relative construct intended to promote regional or sometimes national objectives, but not global novelty. On the other hand, this conceptual openness should not lead to the use of the concept of innovation for all purposes and to label all activities as innovation. This only creates ambiguity and does not do justify the objective of awakening potentials for new ideas.

The aim of promoting regional change within the framework of innovation policy should therefore be to prevent regions from failing in future to meet the challenges of innovation-based regional change. A large number of regions as possible should remain in a position to compensate for their economic and innovative performance, which is expected to disappear in certain areas, with new skills and to enable regions with innovation potential that has so far been underdeveloped to improve their innovation performance. However, since the transition that occurs in the context of such a shift entails considerable adjustment costs, regions themselves start to face structural change quite late and reactively. This problem situation should be prevented by promoting structural change within the framework of innovation policy. Against this background, innovation policy interventions to strengthen regional capacities to cope with structural change appear justified in three respects (Koschatzky and Stahlecker 2019, 3):

- in order to maintain the necessary human capital and knowledge base,
- to resolve sectoral or technological lock-in effects within the region,
- to resolve regional lock-in effects within key sectors of the economy.

In regional innovation policy, a distinction can be made between "top-down" (regionalised innovation policy) and "bottom-up" (regional innovation policy) approaches. Region-specific approaches ("place-based approaches" according to Barca 2009) are important for the success of support measures, i.e. no "off-the-shelf" instruments and programmes, as the respective framework conditions can differ markedly from one an-

other in some cases (Tödtling and Trippel 2005). At the same time, policy must also be oriented to specific target groups, since problems are different in firms, research institutions and intermediaries. When assessing impacts, it is important to take into account that regional innovation policy (as well as other regional policies) is embedded in superordinate policy levels and that regions are part of a multidimensional economic system (and not isolated containers). While national support programmes are generally well funded, there are usually significant financial restrictions on the implementation of regional measures. For this reason, particular attention must be paid to the fit between financial resources and appropriateness with regard to the regional structural characteristics.

The target group for innovation policy measures aimed at maintaining the ability to cope with regional change should primarily be regions in which, due to (over)specialisation in certain sectors of the economy, there is a high probability that it would set back a noticeable change in the technological structure or in the area of the international division of labour. This concerns a large number of regions and not only those with an already developed innovative basis. Measures for innovation-based regional change should primarily be oriented towards opportunities and potentials that need to be stimulated and exploited. SWOT analyses (to identify strengths, weaknesses, potentials and challenges) can provide an important basis here, analogous to the process of developing an intelligent specialisation strategy (Foray and Rainoldi 2013).

As the previous remarks have shown, it is not only necessary to distinguish between different innovation policy measures to promote regional change, but also the group of structurally weak regions differs in terms of the potential and possibilities to initiate and promote structural change through innovation policy approaches. Before a typology of structurally weak regions is developed in Chapter 4, the following Chapter 3 briefly deals with the situation of support for structurally weak regions in Germany.

3 Promotion of regional change in Germany

Support for structurally weak or peripheral regions is an important political issue both at the level of the European Union (regional policy, cohesion policy) and in many individual countries. The reason why the following focus is on Germany lies in the planned integration of regional and innovation policy measures at the national level.

Already in the year 2013 the German federal government and the governments of the federal states of East Germany agreed to develop an all-German support system for

structurally weak regions when the Solidarity Pact II for the support of East Germany expires in 2020 (Federal Government 2013). The agreement states, "from 2020 onwards a further developed system of support for structurally weak regions will be necessary. Such a system must concentrate on the structurally weak regions in the respective 'Länder' and therefore eliminate the differentiation between East and West" (ibid., p. 23). As a result, a working group consisting of representatives from different ministries and the Federal Chancellery drew up the cornerstones for an all-German system of regional development (BMW i 2017, p. 2). The following key points were agreed:

- Further development of the regional support measure GRW (Joint Task for the Improvement of the Regional Economic Structure), programmes to promote economic strength, programmes for enterprise- and region-oriented innovation promotion.
- Measures for broadband expansion and rural development, increasing urban attractiveness, ecological upgrading and adaptation to the consequences of climate change.

It was agreed that a new support system "...should offer an integrated approach for the future support of structurally weak regions by the federal government" and that the instruments "...would either be geared exclusively to structurally weak regions, show support preferences for structurally weak regions or that the result of the support would be an over-proportional use of funds in structurally weak regions" (ibid.)

Parallel to these discussions, the Ministry of Economic Affairs and Energy (BMW i) commissioned a study entitled "Tasks, structure and possible design of an all-German system for the promotion of structurally weak regions from 2020", which was published in May 2016 (Untiedt et al. 2016). This study is based on the experiences of the "Joint Task for the Improvement of the Regional Economic Structure (GRW)" and attempts to develop an integrated funding approach with the GRW as a central instrument for the promotion of development and structurally weak regions, through which growth and employment in developmentally weak regions can be supported.

A three-circle model (Karl und Untiedt 2018, p. 195ff.) is the central approach for the reorientation towards structurally weak regions in all of Germany. The inner circle is defined by the authors through economic support programmes that are exclusively geared to structurally weak regions (e.g. GRW, European Regional Development Fund ERDF, European Social Fund ESF). The Ministry of Education and Research (BMBF) "Entrepreneurial Region (Unternehmen Region)" programme will also be included in the inner circle. With a funding volume of approx. 2 billion euros, it is now geared exclusively to structurally weak regions (specifically East Germany) and with most of the

programmes closely linked to industry and science. In the middle circle, there are funding programmes which primarily aim at overall economic growth and the strengthening of innovation performance (e.g. support for SMEs from the BMWi, support for research and innovation from the BMBF) and which can have positive effects in structurally weak regions. The outer circle contains support programmes that are not directly related to industry, such as the European Agricultural Fund for Rural Development (EAFRD) or urban development support. This combination of funding approaches makes it clear that in future a mixture of programmes for regional structural funding can be used that explicitly include innovation-oriented measures.

These political discussions and developments have given concrete shape to the outlines of a new support system for structurally weak regions in Germany. It is to contain different thematic orientations and in future be more innovation-oriented than the previous regional structural funding. In August 2017, the BMBF published the funding guideline for the programme "WIR! - Change through Innovation in the Region" as the first programme of the programme family "Innovation & Structural Change". This programme family now addresses both East and West German structurally weak regions (BMBF 2018a). WIR! is initially aimed at the eastern federal states, whereby project cooperation with partners from the western federal states is possible. In the medium term (from 2020 onwards), it is planned to extend it to West German regions.

The High-Tech Strategy 2025, which was published in September 2018, lists the "Framework Concept for Innovation and Structural Change" as a new research and innovation policy initiative for the period 2018 to 2021 under the societal challenge "City and Country", with which "...sustainable, innovation-oriented development paths in structurally weak regions in East and West Germany are to be paved" (BMBF 2018b, p. 28). In September 2018, a commission headed by the Ministry of the Interior, Building and Community (BMI) started work on the topic of "Equivalent Living Conditions". Its task is to draw up recommendations for action with regard to various regional developments and demographic change. One of six working groups is dealing with the topic "Economy and Innovation" (BMI 2018).

Additional political activities result from the Commission "Growth, Structural Change and Employment", whose task was "...to establish a broad social consensus on the shaping of structural change in Germany based on energy and climate policy" (BMWi 2019, p. 2) and which presented its final report in January 2019. The Commission has drawn up conclusions and recommendations specifically for the Helmstedt, Lausitz, Rhineland and Middle German coal areas, which are predominantly structurally weak and dependent on lignite and hard coal mining. For example, in addition to expanding

the digital infrastructure, it is recommended "...that the lignite mining areas should become innovation regions for coping with structural change" (ibid., p. 96), that real-world laboratories should initiate pioneering projects, that tax incentives for R&D should be introduced on a pilot basis, and that the WIR! programme "...will be extended over the duration of the entire process and enlarged towards the Rhineland coal area" (ibid. p. 104).

In May 2019, the Federal Government published the "Key elements for implementing the structural policy recommendations of the Commission 'Growth, Structural Change and Employment' for a structural strengthening act for coal regions" (Federal Government 2019). According to these key elements, the Federal Government will make up to 14 billion euros available to the Länder for the coal regions by 2038. These funds will flow into priority projects in the federal states of Brandenburg, Saxony, Saxony-Anhalt and North Rhine-Westphalia. In addition, further promotional activities amounting to around 7.2 billion euros are planned.

Against this political background, a typology of structurally weak regions in Germany and their characteristic features will be developed in order to identify starting points for targeted measures of innovation-oriented regional structural support.

4 Types of peripheral/developed regions in Germany

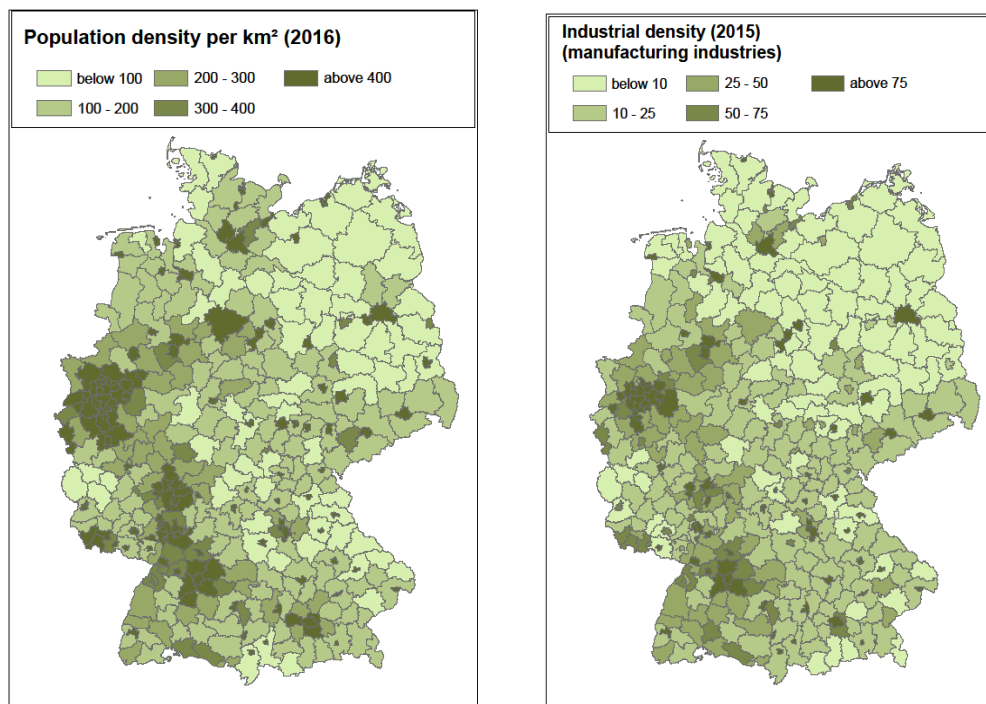
4.1 Introduction and Empirical Classification

Unlike those of northern or southern European countries, Germany's territory does not include genuinely remote areas. As Figure 1 illustrates, however, it does nonetheless feature substantial inner peripheries. In general terms, these can be summarised under the term "structurally weak" regions in the sense that they have either never experienced profound industrialisation or have permanently lost their industrial base as a result of the structural break following German unification. In contrast to traditional old industrial regions affected by structural change, their local economic structures are fundamentally problematic not only from a dynamic but also from a static perspective. What these regions have in common, despite all their diversity, is a low population density and a correspondingly low density of economic, especially industrial, activities. As Figure 2 additionally illustrates, structurally weak regions are characterised by a below-average proportion of university-educated workers and a low proportion of employed persons in scientific and technical occupations, aggravating the implications of a generally quite limited presence economic actors. This limited presence of qualified

workers is both a cause and a consequence of the fact most research and development in the business sector takes place outside these regions. If present at all, local investors tend to instead concentrate on production activities or, at best, those directly related to market development.

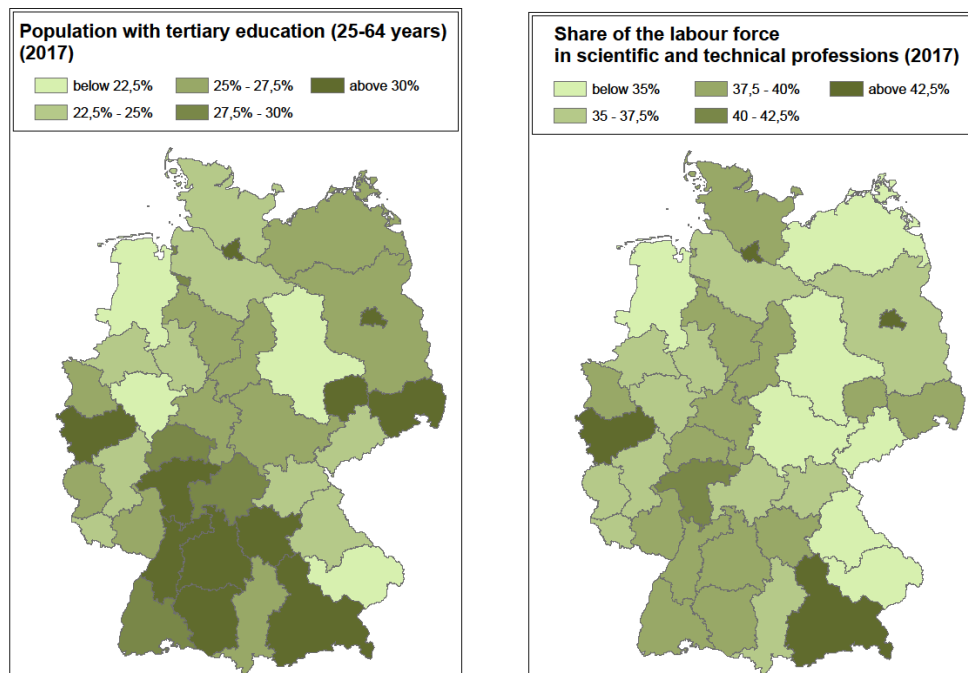
Overall, inadequate factor endowments as well as limited opportunities for local networking (absent any relevant local capacities) reduce the economic dynamism of structurally weak regions. Beyond that, however, structurally weak regions usually display a below-average ability to exploit technological innovations on the ground. Due to the limited availability of highly skilled workers as well as the absence of local development activities in the industrial domain, it is more difficult for these regions to benefit from novel technological trends and/or to maintain a favorable position in existing international value-chains and -networks. As a result, employment in many structurally weak regions is declining (Figure 3, left side). Due to the generally low level of economic activities, even single firm failures or plant closures can tear significant, difficult to fix gaps into the local economic fabric. While some regional policy-makers may still successfully attract private sector investment, few of the firms thus attracted will offer sustainable and attractive jobs. For example, several regions of the internal periphery tend to attract investments in the logistics sector due to their, in European terms, quite central location combined with low wage levels. Jobs in that sector, however, are poorly paid and usually come with short-term, temporary contracts. Moreover, most of these investments depend on corporate decisions taken in headquarters outside of the region. Due to the unattractive human capital environment basis and the lack of relevant local business networks, these may swiftly change to the detriment of the region once e.g. even lower wages become accessible elsewhere. With very limited exceptions, structurally weak regions lack the endowment with resources and actors that would be required to enable an organic growth of dynamic industrial clusters. Without the binding force of such clusters, however, their ability to sustainably tie external investment to the region will remain very limited.

Figure 1: Population density and industrial density in Germany



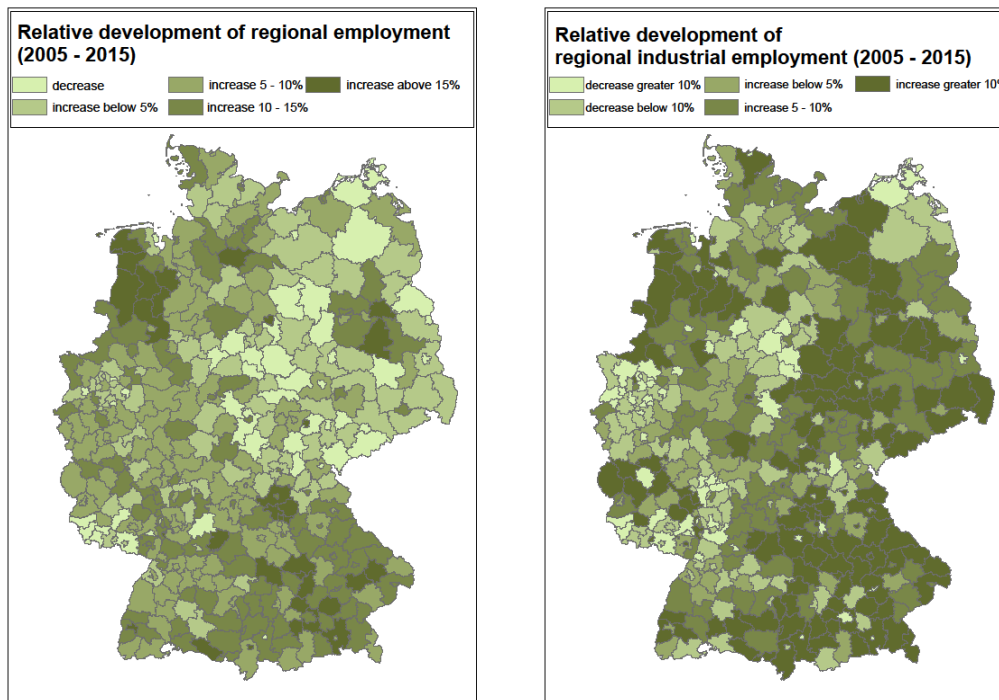
Source: own illustration based on Eurostat, cartography ESRI ArcMap

Figure 2: Level of education attainment and labour force share in scientific and technical occupations



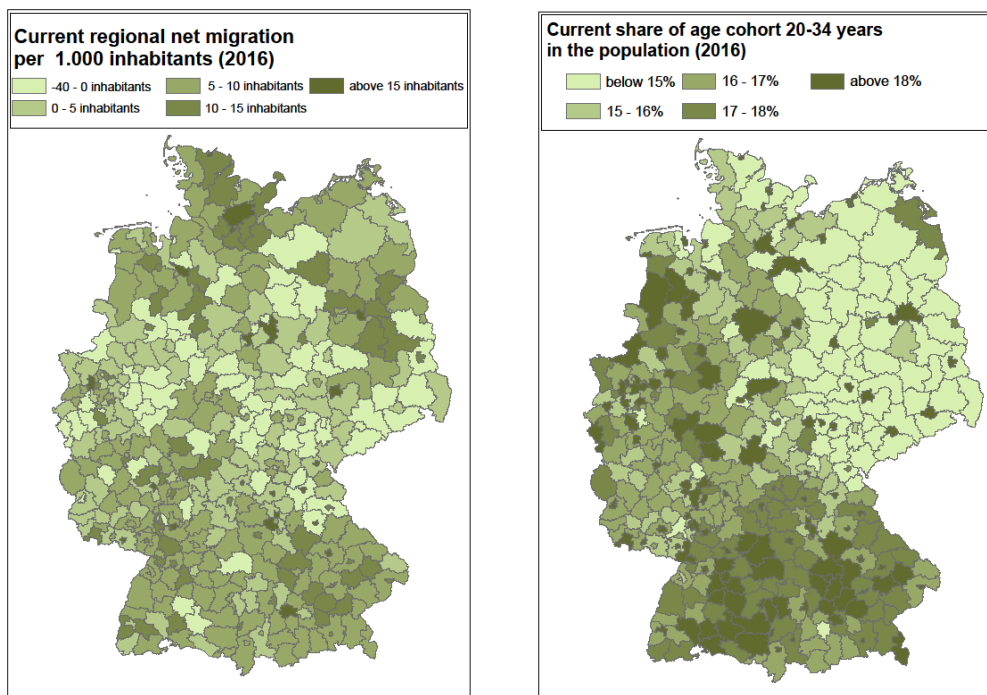
Source: own illustration based on Eurostat, cartography ESRI ArcMap

Figure 3: Development of regional employment



Source: own illustration based on Eurostat, cartography ESRI ArcMap

Figure 4: (Out)Migration flows and Consequences



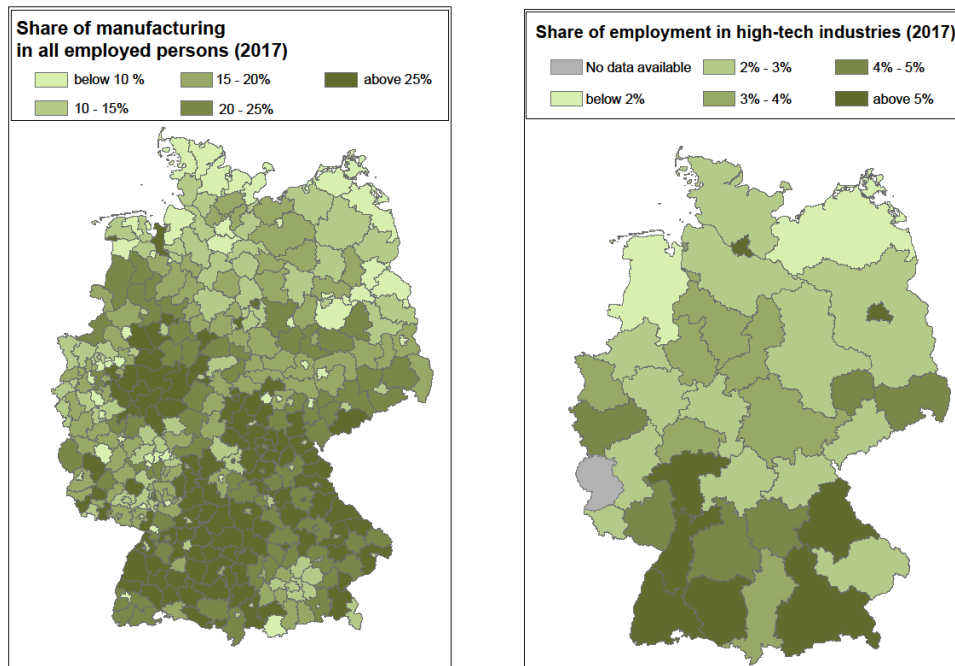
Source: own illustration based on Eurostat, cartography ESRI ArcMap

Importantly, the observed decline in employment is not predominantly attributable to negative developments in the industrial sector, which can more pertinently be used to empirically identify old industrial regions affected by structural change (cf. Figure 3, right side). Instead, the observed decline in overall employment can be more closely related (as both cause and as a consequence) to the considerable level of outmigration (Figure 4, left) affecting most structurally weak regions. After jobs are lost as a result of single firm failures or closures, further outmigration of skilled workers ensues on a regular basis. As a result the local skills based is weakened further, making a reversal of the trend is even more difficult. Eventually, the outmigration of not only young, skilled employees but also their spouses (Figure 4, right side) may result in a general decline of those cohorts of the population with the greatest prevalence to start families. In consequence, many structurally weak regions also display results over-ageing population and declining birth rates.

In principle, structurally weak regions do thus in many respects not offer an ideal environment for innovative activities. On the other hand, such future-oriented activities are about the only plausible means to bring about trend reversals in regions already affected by self-reinforcing negative developments.

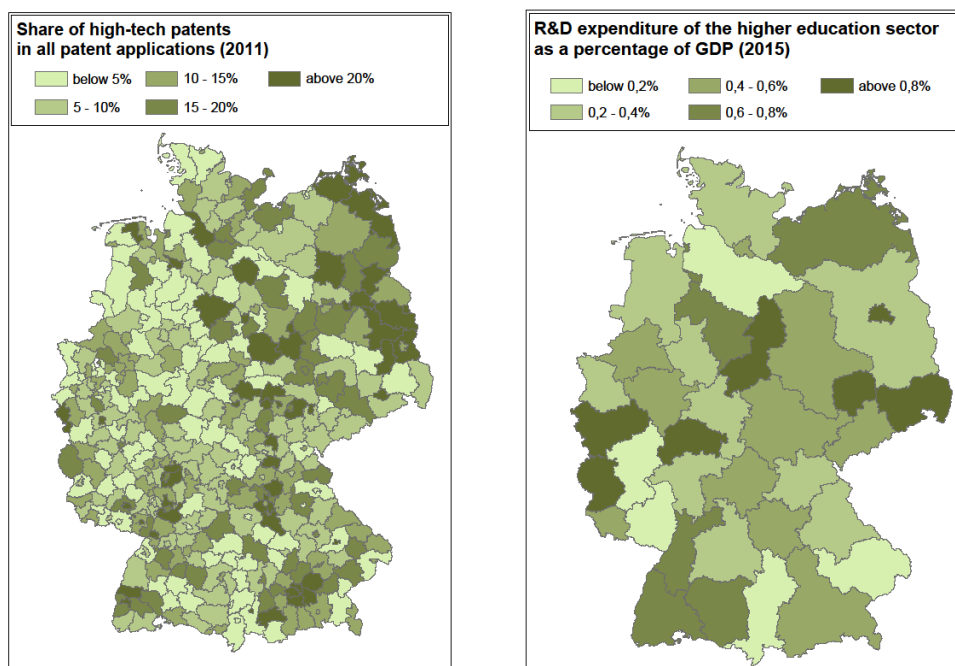
Furthermore, sparsely populated areas differ considerably with regard to their level of industrial development (Figure 5, left side). While, despite its low population density, the manufacturing sector accounts for a significant proportion of employment in Lower Bavaria, this far less the case in the coastal areas of northern and northeastern Germany as well as some western and south-western border peripheries. Even though the employment share of high-tech industries in structurally weak regions is with few exceptions lower than that in the industrial centres of southern Germany, there is considerable variance even between different sparsely populated areas. Finally, Figure 6 underlines that the relative share of high-tech patents in all patent applications and the university research and development intensity can in fact be particularly high in some peripheral regions. Both are undoubtedly relative effects, resulting primarily from the overall lower level of patenting and value creation in these regions. Nevertheless, they evidence an important aspect of many weak regions' economic systems: the existence and interregional relevant of "technological islands" or "hidden champions" in an overall less competitive economic environment.

Figure 5: Share of industrial employment and high-tech employment in total employment



Source: own illustration based on Eurostat, cartography ESRI ArcMap

Figure 6: "Islands of Technology" in the periphery (high-tech patents and public R&D expenditure)



Source: own illustration based on Eurostat, cartography ESRI ArcMap

4.2 Identification and classification of structurally weak regions

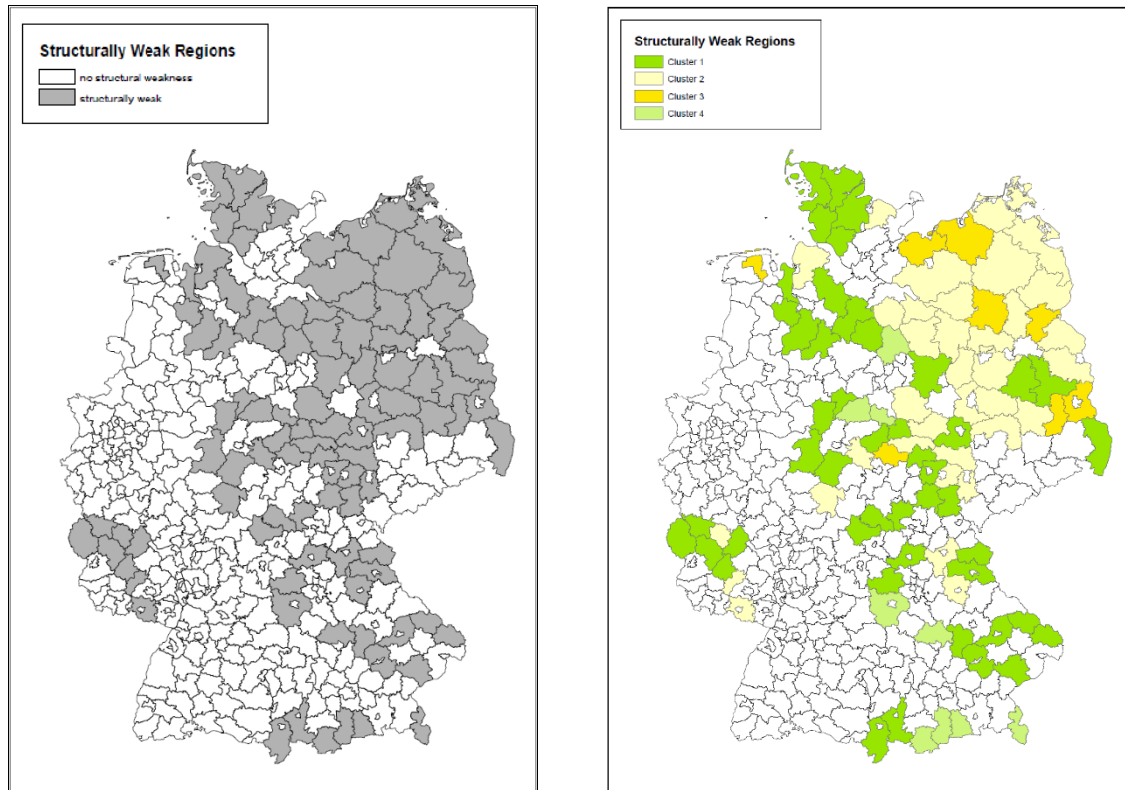
This paper is not primarily concerned with traditional old industrial regions affected by structural change, but instead with those characterised by a limited supply of production factors, a small number of actors, and weakly developed regional networks. Empirically, such regions can be identified because of their low population density and low industrial density. Figure 7 (left side) shows those regions in which both population and industrial density are less than a quarter of the nationwide average. In addition, it excludes regions in which the level of GDP per inhabitant is above the national average.

As described in the introduction, structurally weak regions thus defined can be found in large parts of eastern Germany outside Saxony's main agglomerations, in Schleswig-Holstein and Rhineland-Palatinate, as well as in relevant parts of rural Bavaria and Lower Saxony.

With a view to additional dimensions of analysis, however, a notable degree of internal diversity can be detected among these regions. Figure 7 (right side) shows the results of a cluster analysis that distinguishes four main groups of structurally weak regions based on six indicators¹ from the main areas of actor density, demography, economic structure and R&D orientation.

¹ Specifically, these indicators are industrial density and GDP per inhabitant (actor density), (out)migration and birth rate (demography), share of industrial employment in total employment, share of business R&D expenditure in total R&D expenditure (economic structure) and R&D expenditure per inhabitant and share of high-tech patents in all patent applications (R&D orientation).

Figure 7: Structurally Weak Regions in Germany, Sub-groups of Structurally Weak Regions



Source: own illustration based on Eurostat, cartography ESRI ArcMap

In summary, these types of regions can be characterised as follows:

1) Structurally weak regions with limited areas of competence

1 a) A first group has a comparatively high actor density (among the group of structurally weak regions), achieves average values with a view to demographic aspects and displays a comparatively high industrial share in the local labour force. Their research intensity, however, remains in the middle-field and the regional share of high-tech patents is low (cluster 1, dark green),

1 b) Conceptually closest to the above group is a further cluster in which regions display a comparatively high number of actors, positive values with respect to demographic aspects, an average share of industry in the local labour force and the lowest overall role of public research. Their research intensity reaches the highest values within the

group of structurally weak regions, although the share of high-tech patents in the total patenting hardly exceeds that of the first group (cluster 4, light green),

2) Structurally weak regions with considerable and broad capacity deficits

2 a) Clearly distinct from the above groups is a third one, which is worst positioned with regard to aspects of demography and displays the lowest overall number of actors. Likewise, the share of industry in these regions' overall employment is low, the general research intensity and the share of high-tech applications in overall patenting remain low. Absent business sector development activities, in contrast, the relative share of public efforts among overall R&D expenditures is high (cluster 2, light yellow),

2 b) With a view to this fundamental level of deficits, this last group is comparable to the abovementioned third one. While the number of actors is low and the share of industry in regional employment lowest overall, however demographic trends in this fourth group of regions are noticeably more positive. While the overall intensity of R&D in these regions is similarly low, the role of public research is significantly higher. Among all structurally weak regions, they are characterised by the highest share of high-tech patents in overall patenting. Apparently, the relative strength of public research in those regions does not seem to result solely from the absence of business sector activities but from genuine - if in absolute terms limited - expertise in certain areas (cluster 3, dark yellow).

With regard to the role of research and innovation, the internal differentiation of the two main groups thus provides clear indications that, under otherwise identical conditions, research and innovation can make significant contributions to attenuating and amending difficult initial situations or at least prevent the emergence of self-reinforcing negative developments.

In addition, an analysis of the mutual "proximity" of the groups shows that clusters 1a) and 2a), which differ greatly in terms of the basic number of actors, are comparatively similar (even more similar than the respective sub-groups), while clusters 1b) and 2b), which are more strongly characterised by research and innovation activities, show the lowest similarity of all. This underlines the considerable structural differences between contexts in which sparse research and innovation activities remain embedded in a business environment, albeit weak, and those in which such enterprises in the narrower sense are "islands" in otherwise low-activity environments.

The following Table 1 shows the assignment of the individual regions to the four groups.

Table 1: Regions according to the four groups

Group 1a) (by district)	Group 1b) (by district)	Group 2a) (by district)	Group 2b) (by district)
Freyung-Grafenau Kelheim Landshut, Landkreis Regen Rottal-Inn Straubing-Bogen Neustadt an der Waldnaab Tirschenreuth Bamberg, Landkreis Neustadt an der Aisch- Bad Windsheim Bad Kissingen Rhön-Grabfeld Ostallgäu Oberallgäu Dahme-Spreewald Teltow-Fläming Schwalm-Eder-Kreis Waldeck-Frankenberg Diepholz Holzminden Nienburg (Weser) Celle Rotenburg (Wümme) Heidekreis Oldenburg, Landkreis Wesermarsch Höxter Birkenfeld Rhein-Hunsrück-Kreis Bernkastel-Wittlich Eifelkreis Bitburg-Prüm Vulkaneifel Görlitz Börde Saalekreis Dithmarschen Nordfriesland Rendsburg-Eckernförde Schleswig-Flensburg Steinburg Eichsfeld Nordhausen Sömmerda Hildburghausen Weimarer Land Saalfeld-Rudolstadt Saale-Orla-Kreis	Berchtesgadener Land Bad Tölz-Wolfratshausen Eichstätt Garmisch-Partenkirchen Miesbach Ansbach, Landkreis Gifhorn Northeim Osterode am Harz	Amberg-Weizsach Bayreuth, Landkreis Elbe-Elster Havelland Märkisch-Oderland Oberhavel Oder-Spree Potsdam-Mittelmark Prignitz Uckermark Vogelsbergkreis Werra-Meißner-Kreis Mecklenburgische Seenplatte Vorpommern-Rügen Vorpommern-Greifswald Ludwigslust-Parchim Cuxhaven Lüchow-Dannenberg Uelzen Cochem-Zell Kusel Südwestpfalz Nordsachsen Altmarkkreis Salzwedel Anhalt-Bitterfeld Jerichower Land Burgenlandkreis Harz Mansfeld-Südharz Stendal Wittenberg Plön Kyffhäuserkreis Saale-Holzland-Kreis Greiz	Barnim Oberspreewald-Lausitz Ostprignitz-Ruppin Spree-Neiße Landkreis Rostock Nordwestmecklenburg Wittmund Unstrut-Hainich-Kreis

Source: own analysis based on Eurostat

5 Policy Conclusions

In light of the above said, this chapter's findings clearly suggest that both innovation and regional policy should take into account not only the differentiation between those regions that are structurally weak and those that are not, but also the - in many ways substantive - differences within this group.

In the perpetual process of structural change that affects all regions, strong and weak areas alike are continuously challenged to reposition themselves in changing socio-technical environments. Most important in this regard is to avoid falling behind current developments and to end up in a situation of organisational and institutional status from which the region will have difficulty to escape. In this respect, structurally weak regions do not face fundamentally different challenges than others. Peripheral regions with both some hidden champions and some good local colleges are generally not in immediate danger and may even contribute substantially to the overall national innovation effort.

Nonetheless, two things are particular about structurally weak regions in which there are less socioeconomic actors to start with and fewer localised linkages that are relevant for innovation. First, equilibria in and of sparser ecosystems are more vulnerable. While structural change is not as such more problematic for structurally weak regions, as long as these remain in equilibrium, the economic failure or closure of single entities affects them much more fundamentally, be they caused internally or externally. Second, the demographic fabric in these regions is thin and once a disequilibrium is caused, the situation may easily topple into a downward spiral. A sudden lack of suitable jobs triggered by major closures may prompt outmigration that induces a further loss of attractiveness as an investment location that in turn aggravates the availability of qualified job opportunities. Eventually, the outmigration of economically relevant age cohorts (and those prone to start families) will have reached a point at which the local socio-economic fabric comes close to a collapse.

Accordingly, responsible regional innovation policy should pursue two main ambitions to benefit the overall national innovation system: First, it should work to sustain and strengthen vulnerable equilibria around local areas of strength, where this is still possible. Second, it should offer those who can no longer draw on surrounding regional resources to connect with external networks and hubs of activity from their current physical location.

With a view to the analysis put forward above, this suggests that actors in *structurally weak regions with limited areas of competence* should be encouraged to strengthen their specific competences and connect them to national-level activities in the field. In

line with e.g. the long standing approach of the *Entrepreneurial Regions* support programme of BMBF in Germany, funding for such activities should be based on the premise that these regions indeed have to offer something - and thus on criteria-based, competitive application procedures. Although not necessarily leading edge, funding innovation projects and networks should be ambitious, seeking to prevent sectoral and regional lock-ins and keep local hidden champions and colleges abreast of current developments in their respective fields. Mostly, funding in these regions should at least attempt to take a localised systemic approach.

In *structurally weak regions with considerable and broad capacity deficits*, the approach has to be different, focusing more on individual actors and on inter-regional connectivity. While localised networking or collaboration in weak and genuinely peripheral regions can still be beneficial, it should not be made a general premise of policy support. Instead, regional support policies should focus on enabling those firms and organisations that are willing to stay to perform innovation activities that they can relate to and connect interregionally in sectoral networks. Different from the abovementioned approach for slightly more balanced regions, the criteria for those activities can be less strict, to e.g. allow for low-tech innovation (but must not be random). Ideally, broader activities will later develop around these initial cores. At the very least, the further out-migration of qualified labour will have been attenuated and the eventual collapse of the region's socio-economic fabric prevented.

Even in *very weak regions*, however, it is arguably better to support innovation activities rather than mere infrastructure investments or finance for expansion. These latter approaches are known to invite considerable free-rider effects, and do not necessarily contribute to any rebalancing or stabilisation of the regional economic system.

Instead of seeking to maintain local structures that may already be collapsing with considerable momentum, future-oriented regional policy should seek to enable actors in structurally weak regions to position themselves in the best manner possible in ongoing processes of change. A support that is directed towards maintaining and developing specific capacities can help to enable constructive contribution to the performance of the overall national innovation system - even if these come from somewhat unlikely places. In particular, not all structurally weak regions are by definition unsuitable to explore specific aspects of innovation. Even if their local socio-economic fabric is weak, for example, some peripheral regions may in fact be rather well positioned to explore specific aspects of sustainable energy generation or the modernisation of the agricultural bio-economy.

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