2 Innovation-based regional change in Europe – challenges and policy frameworks in different regional contexts

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2.1 Problem and objectives

A central policy task of European and national regional policy in the field of structural, social and spatial economic development lies in reducing regional disparities and supporting structurally weak regions in their structural change. Economic divergence is seen as a threat to economic progress in the EU (European Union 2017, p. 2). Reducing divergence at the national and regional level is a major challenge for the European Commission and EU Member States. Structural weakness as a cause for divergence cannot be defined uniformly, because the reference to what is structurally strong always depends on the context in which 'weak' and 'strong' are oriented. In addition, there are different degrees of structural weakness, which may relate to certain areas of a regional economy (with corresponding socio-economic effects) but may not affect all sectors and economic activities equally. In the perspective of European diversity, there are various political, economic, cultural, geographical and historical reasons for the different development paths of nations and regions and thus for the development of structurally strong and structurally weak regions. This is closely related to the possibilities of influencing socio-economic development paths, creating potential for new paths and thus contributing to structural change and reducing regional structural weaknesses (Trippl and Frangenheim 2018, pp. 54-56).

Empirical studies have shown that specific measures are needed to address regional structural change (e.g. Tödtling and Trippl 2005). At the level of European regional policy, the term "place-based policy" was coined, according to which regional structures, problem situations and circumstances should be reflected in both measure development and the implementation processes involving regional stakeholders (Barca 2009, p. 5). On the one hand, this specific feature excludes the derivation of support measures that have proven successful in other regions. On the other hand, knowledge from other regions or types of regions can be adapted to the own regional conditions. This may avoid mistakes and integrates best practices into the regional mix of measures.

The **aim of this paper** is to analyse different approaches and experiences in addressing regional structural change depending on existing potential factors and institutional paths in different types of European regions. It is based on a typology of regions according to

the characteristics of regional innovation systems (low number of actors, fragmented regional economies and systemic gaps, regions with (highly) developed and complete innovation systems) and according to the technological basis (mature or modern). Instead of individual regions, types of regions are deliberately considered in order to counter the objection that individual regional development strategies cannot be transferred to other regions.

For each of the five types of region identified, the **problem structures** and specific challenges are first analysed, followed by an **outline of key strengths/opportunities** and **weaknesses/risks**. The **description and analysis of policy strategies, programmes and measures** or the policy mix concludes the respective analysis. The five analyses are then compared (synopsis) and implications for structural change in East Germany are derived.

2.2 Theoretical background: growth and regional development

There is neither a uniform definition nor a uniform understanding of (regional) structural change. Encyclopaedias define regional (structural) change as a change in the economic structure of a region (or nation) with the consequence of changes in the regional structure (e.g. Geigant et al. 1979, p. 643). Other authors understand regional structural change as a process that changes potentials, competencies and abilities as well as interrelationships and infrastructures within a region (Iwer et al. 2002). According to Rampeltshammer and Kurtz (2011), structural change is a political concept aimed at regaining, maintaining or enhancing locational advantages with the goal of economic efficiency, innovation, employment, income and social cohesion. Sectoral changes, on the other hand, are shifts in the sectoral economic structure because of different growth rates in individual economic sectors. Depending on the way you look at it, **structural change can be measured** with different indicators. From an economic point of view, changes in the shares of economic activities or sectors in the regional economy (employment, gross value added), growth rates of per capita income, changes in the unemployment rate and growth in research and development (R&D) and innovation expenditure are common indicators. However, these only show quantitative changes over time. An additional qualitative interpretation is necessary in order to be able to conclude that there has been a change in both positive and negative directions over time. In extended socio-economic or socio-cultural analyses, poverty indicators or changes in participation rates (e.g. on infrastructure, education, etc.) offer further measuring possibilities.

Theories represent a possibility to derive knowledge about a certain subject area from empirical experiences (induction) or other generally valid knowledge (deduction) under

the assumption of certain basic conditions (premises). In relation to structural change, there are different theories and theoretical arguments dealing with regional growth (e.g. neoclassical theory, new growth theory), with regional inequality (e.g. post-Keynesian growth theory, polarisation theories), or with changes in the sectoral structure of a region (stages of economic growth theory, export basis theory). However, there is no closed theory of (regional) structural change.

The **aim of theories** is to derive conclusions about the change of structures and processes based on the respective knowledge background. This makes it possible to formulate political measures not only on the basis of a single case, but also on a theoretically justifiable basis. In addition to current empirical evidence, a look at theories and their implications for action is therefore helpful for assessing the possibilities available for influencing regional structural change through political action. Since not all relevant theories can be presented in the context of this paper, individual theories and their innovation policy conclusions are briefly presented as examples.

The **neoclassical theory** (Borts and Stein 1964) postulates that, assuming full employment, perfect competition, free mobility of production factors and a lack of interregional transport costs, interregional income disparities are offset in the long run by factor migration (labour, capital). Regional structural change and the adjustment of a new equilibrium stage are the result of market forces. Intervention through regional policy measures is not necessary.

This position is contrasted with the statements of **polarisation theory** (e.g. Myrdal 1957). Its central finding is that cumulative socio-economic processes and the emergence of agglomeration advantages in individual locations/regions exacerbate a regional imbalance (e.g. triggered by historical coincidence). Regions are favoured that have a positive basis for growth (infrastructure, human capital, knowledge). Positive growth processes in one region lead to backwash effects and affect other regions, which thereby lose growth and development potential. According to this theory, market forces, for example due to rising labour costs and infrastructure congestion, can also lead to spatial balance if corresponding spread effects exceed the effect of backwash effects. Unlike in neoclassical theory, such a development can occur, but it does not have to. From a regional policy perspective, this means supporting the emergence of conurbation disadvantages (for example through taxes or infrastructure taxes) and promoting the mobility of production factors to other regions.

Theories summarised under the concept of **new economic geography** (such as the new trade theory, the new growth theory and evolutionary theories of path dependency

and path design) show that knowledge and appropriately trained human capital are central growth resources. Innovations resulting from knowledge generation are drivers of competitiveness and prosperity. According to this view, regions with a higher human capital stock are growing faster than regions with a lower stock. Through knowledge diffusion (spillover effects), regional growth is based not only on its own human capital stock, but also on knowledge outside the region. Due to the distance dependency of knowledge spillovers, there are mainly proximity effects with neighbouring regions. Depending on the intensity of spillover effects and the extent of factor migration, both convergent and divergent developments are possible. Through the binding of knowledge to persons (implicit knowledge), this kind of knowledge is never completely mobile due to obstacles to the mobility of scientists. Regions in which new knowledge is generated always have a temporary advantage (Koschatzky 2018, p. 12). The innovation policy implication of these findings is to create framework conditions and opportunities to generate new knowledge in science and industry (e.g. expansion of the science infrastructure, research funding in science and industry, development of creative laboratories). Additionally, the possibilities for using knowledge in order to provide a region with growth advantages should be improved and new development paths established in order to promote structural change.

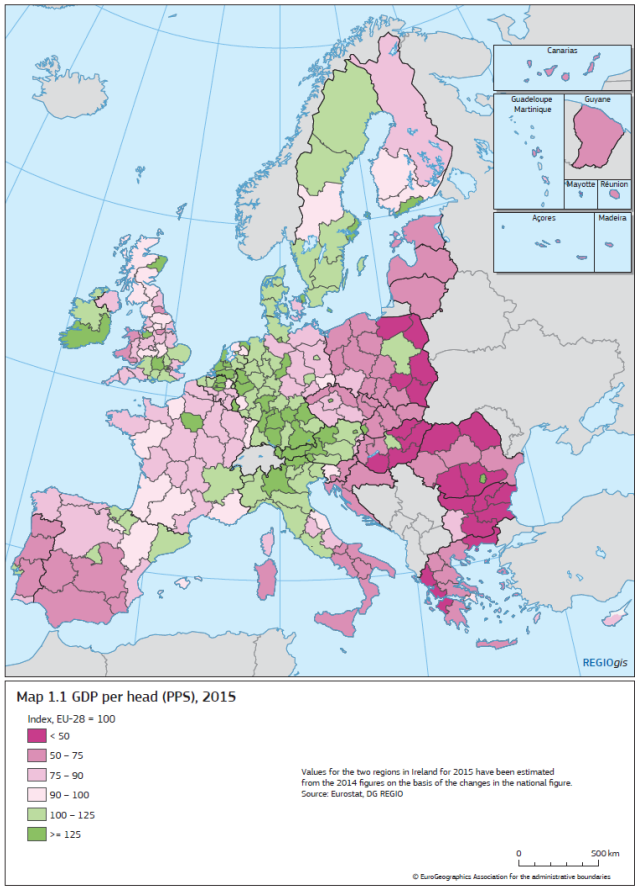
The **concept of innovation systems** (e.g. Cooke 1992 for the regional perspective; new elements in Warnke et al. 2016) offers a further opportunity to look at regions and to derive policy recommendations. The importance of systemic interaction within a country or region for economic development is emphasised here. (Regional) innovation systems consist of different organisations such as companies, research organisations, intermediaries, and other groups of actors (e.g. financing organisations, clusters, civil society organisations) that interact with one another regionally and nationwide through value chains or innovation networks and thus create added value that cannot be achieved by individual organisations. Growth and regional structural change will be driven forward sustainably by the orientation towards innovation. The conclusion for innovation policy is to intensify networking between organisations and to strengthen the research and innovation orientation of interactions. The basic characteristics of the concept of regional innovation systems are used to derive the typology of regions (cf. section 2.4.1).

The briefly presented theories show that regional growth and structural change processes are possible and which measures appear to be particularly suitable from the respective theoretical position. Due to the generally valid character of the theories, policy recommendations can only be of a general nature, roughly outlining a direction. The policies derived from the analysis of the types of regions also offer a more concrete approach that reflects specific regional starting conditions and structural characteristics.

2.3 Regional structural change in Europe: disparities, convergence and divergence

The Seventh Report on Economic, Social and Territorial Cohesion of the EU Commission of 2017 states that in 2015 more than a quarter of EU citizens (27%) lived in a (NUTS 2) region with a per capita income (measured in purchasing power standards) of less than 75% of the EU average (European Union 2017, p. 2). Excluding the London region, which reaches the income index value 580 (EU 28: 100), the regional income disparities in the EU range from about 1:7 to 1:8. Bulgaria's poorest region has an index value of 30, the richest regions in Belgium and Germany of just under 210, Luxembourg of just over 260. As a result, the European Union will continue to be characterised by considerable regional income disparities.

Figure 2-1: Regional per capita income in the EU 2015



Source: European Union (2017, p. 3)

In addition to this static view, however, it is also evident that the growth rates in regions with below-average per capita income are above average. This indicates a conversion trend. The report confirms that there are first signs of a reduction in regional disparities

in the EU. Although regional disparities in employment and unemployment rates have increased in line with GDP per capita since 2008, employment disparities have begun to narrow again since 2014, followed by differences in GDP per capita since 2015. Per capita income and employment rates were still lower in many regions than before the 2008/2011 crisis (European Union 2017, p. xi).

In summary, the regional development pattern in the EU is as follows (European Union 2017, p. 1):

- Less developed regions are approaching the EU average in per capita income through faster productivity and employment growth.
- Regions with high per capita incomes have grown faster than the EU average due to agglomeration advantages and close links with the surrounding regions.
- Regions with a per capita income between 75% and 120% of the EU average are caught in a "middle income trap". Their growth remained well below the EU average. Their manufacturing industry is smaller and weaker than in regions with lower or higher per capita income. The respective innovation system is not solid enough to be able to keep up with global competition.
- Innovation activities remain highly concentrated in the EU. Central European, English and Scandinavian regions record high innovation performance. While surrounding regions in the north-west of the Union benefit from the proximity to innovative regions, in southern and eastern EU countries the most innovative regions are not strong enough to transfer development impulses to neighbouring regions.

Overall, a differentiated picture of structural strengths and weaknesses emerges in the EU. This is linked to different contributions to regional cohesion and to regional structural change in the direction of increasing innovative capacity. This regional heterogeneity feeds the regional typology, which we present in the following chapter.

2.4 Typology and analysis of regions with structural deficits

2.4.1 Using typologies as a conceptual framework

In order to address the above-mentioned research questions and to derive overarching findings, this book chapter proposes a typology of European regions. With the exception of regional groupings, defined on the basis of economic indicators (European Union 2017) or the level of innovation activities (see Innovation Scoreboard; European Commission 2017), few existing classification reflect the diversity of challenges related to structural change among European regions leave alone the even greater diversity of relevant policy responses.

So far, a number of case studies have been published which, however, tend to pursue very specific questions and accordingly, produce non-generalisable findings. These include, for example, the contributions of Goddard et al. (2012) on the North East of England, of Rehfeld (2004), Rehfeld and Ziegler (2015) on the Ruhr area, of Gloersen et al. (2005) on the northern European regions (North and East Finland, North Sweden), from Blazek and Csank (2016), on Prague and South Moravia, on Centro and Norte in Portugal from Belussi et al. (2010) on Emilia Romagna, from Nuur and Laestadius (2010) on peripheral regions in Sweden or from LaBianca et al. (2016) on Apulia.

With the aim of illustrating the diversity of regional structural change in Europe, the authors of this article have drawn on the typology of Tödtling and Trippl (2005) and developed it further on the basis of recent findings in innovation system research (Warnke et al. 2016). On the one hand, studies find that the level of endogenous technological capacity of a region represents a central influencing factor for technological change and the production of innovations. On the other hand, other contributions point to success factors of regional innovation systems such as "institutional density", "number of actors" and "degree of networking" (Cooke 1992; Koschatzky 2001; Asheim et al. 2011) and in this context stress the advantages of orchestrated innovation-based regional development, based on synergies between regionally coupled actors. Warnke et al. (2016) have taken up this basic idea and depicted current observations of regional orders (such as differentiation of the actor landscape of "mature innovation systems") and changes in the innovation process (e.g. increasing openness and demand orientation) as new elements of innovation systems. Regarding the dimension of technology base, the two categories the poles "mature technology base" and "modern technology base" emerge. As far as the dimension actor population/networking is concerned, the two extremes "thin actor population" vs. "dense/complete system" can be named accordingly (see Figure 2-2).

Against this background, regions were in a first step assigned according to two main dimensions "quality of technological base" and "actor density". In a second step, more precise characterisations were added, such as dominant economic sector, location (peripheral, central), appropriation of technology and production efficiency.

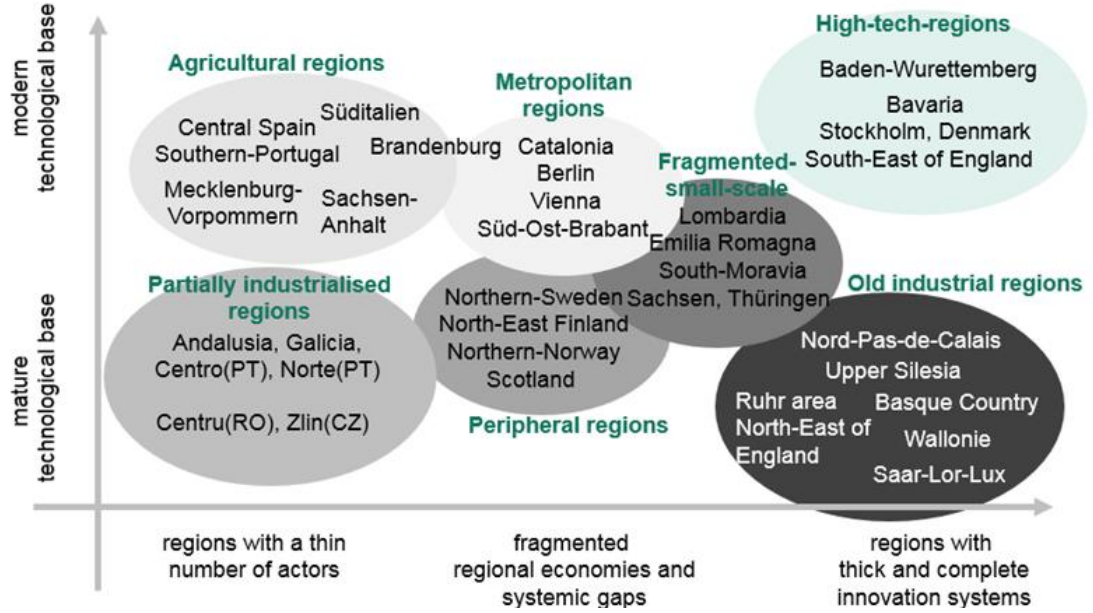
Overall, this results in the following seven types of regions, form which six form the basis for further structural and policy analyses:

1. ***Agricultural regions with technological "islands"***: characterised by high R&D expenditures by national standards, that is, however, concentrated on a few actors; activities tend to be focused on selected new technologies, and to a very limited extent embedded in a regional innovation system;
2. ***Metropolitan regions with systemic weaknesses***: characterised by above-average R&D intensity, supported by the public sector due to a high density of

universities and research institutions; due to internal fragmentation, however, there are systemic gaps and below-average cluster and network effects;

3. ***Partially industrialised regions with inefficient production facilities***: characterised by low R&D activities, production facilities controlled from outside the region or financed from abroad as "extended workbenches"; the local technology level is often rather low, as is innovative output;
4. ***Regions with fragmented, small-scale industrial structures***: characterised by below average private R&D expenditure, significant disadvantages due to small size and fragmentation, companies with innovation capacities usually pursue niche strategies on national or international markets;
5. ***Peripheral-fragmented, mono-structured regions with adopted technologies***: characterised by path-continuation and -extension through the adoption of external technologies and a focus on process innovations, public R&D intensity is low, often time monostructured in mining, raw materials or early-stage processing;
6. ***Mono-structured old industrial regions (coal and steel based)***: characterised by below-average R&D expenditures, a dominance of large enterprises, a "mature" technology base and attempts at modernisation based on diversification as well as new-path creation at the interfaces between old and new industries or technologies;
7. ***International leading high-tech regions:*** above-average R&D-expenditure, highly-competitive business sector with partially dominant industries (e.g. automotive and mechanical engineering clusters in Baden-Wuerttemberg).

Figure 2-2: Typology of European regions in structural change



Source: own concept based on Warnke et al. (2016) Tödtling and Trippl (2005)

It should be noted that a non-overlapping classification is not always possible, since despite all structural similarities between the regions of a type, region-specific peculiarities can be observed in individual cases, which stand in the way of an unambiguous classification.

2.4.2 Description and analysis of the regional types

The following chapters deal with the six types of regions, starting with the respective initial situations and followed by the priorities of innovation-oriented regional policy addressing structural change.

2.4.2.1 Agricultural regions with technological islands

Starting position

Comparable to the situation in some North and North-East German federal states, the agricultural sector dominated many rural regions of the European Union for a long time. In these sparsely populated regions, only limited production facilities emerged during the age of industrialisation so that the – unlike regions rich in raw materials – hardly ever developed supra-regional significance. Before individual means of communication were available across the board, they were largely cut off from technological development processes at national, let alone international level and could generally only adapt them by catching up later. Local industries predominantly followed the state of the art already existing in other locations with a certain delay, without them generating supra-regional, let alone international impulses in the development of new products or process technologies (Schneider 2010; Heinrichs 2010).

In addition, due to the generally low number of employees in industry (industrial population) and the lower population density, these rural regions typically did not develop contiguous clusters or localised value chains (Herrschel 1997). Most industrial enterprises are locally isolated in their sector and, instead of being integrated into local networks, are predominantly integrated into supra-regional value and supply chains (Schneider 2010; Bathelt 2009). The regions described in this section therefore often do not have a historical core of industry-specific skills and social capital from which to develop new economic policy approaches (Dybe 2003).

The only exception to this rule is in many cases the agricultural sector. Although this sector has in various regions been deprived of efficiency and effectiveness by unsuitable economic systems (centrally planned economies) in recent history, it still represents a central point of reference for social relations and socio-economic interactions. Especially in rural regions, the density of social relationships ('social capital') and the perceived

attachment to the location as such is therefore often even higher than in urban regions. However, it is often not oriented towards industrial activities that could contribute to the regional development of new products or process innovations.

The assumption that rural regions were resistant to change, as often readily suggested, can empirically not be substantiated in general terms. Although the inhabitants of these regions like to stick to established business models, they are often open to necessary changes for pragmatic reasons, if only as these open up options to remain economically active in the region to which they feel connected. Then again, the demographic and qualification challenges facing regions of the type described are undoubtedly proven and presented in a differentiated manner in empirical reports on the status of German unity (BMWi 2018) and European cohesion (European Union 2017). The generally low industrial population results in a generally low supply of (qualified) jobs, which leads to the out-migration of qualified workers, whose absence has a negative impact on future efforts to attract businesses. Fragmentation and the lack of localised value-chains among the few industrial enterprises have led to an increased dependence of internal decisions by boards external to the region. Political actors in the region have limited influence on planned relocations, or can only influence them with very classical, monetary means. In addition, many rural regions continue to suffer from insufficient and slow broadband coverage, the central means of communication of the coming decades.

In the European Union, different examples of regions with these characteristics can be found, especially in central Spain (Borrás and Jordana 2016), parts of central France, southern Portugal (Cooke 2016; Santos and Simões 2014), large parts of central and eastern Poland (Dziemianowicz et al. 2017), southern Italy (Labianca et al. 2016; Clo et al. 2018) the Greek islands (Komninos et al. 2014), southern Hungary (Lengyel et al. 2016), north-eastern Romania (Constantin et al. 2011) and north-western Bulgaria (Simeonova 2006). In Germany, regions of this type are most frequently found in Mecklenburg-Western Pomerania (Heinrichs 2010; Dybe 2003) as well as some areas of western Lower Saxony (Schneider 2010), northern Brandenburg and northern Saxony-Anhalt (Berger et al. 2017).

In summary, the following strengths and weaknesses can be identified for the regions described:

Strengths and opportunities:

- high social capital, dense personal networks,
- strong identification with the region,
- established competencies in the areas of agriculture, agribusiness.

Weaknesses and challenges:

- low number of actors, lack of critical mass,
- lack of link between existing industrial activities,
- out-migration of human capital and ageing,
- lack of tradition in the field of independent innovation.

Political approaches

There are different approaches to strengthen the innovative and economic capacities of rural regions and to overcome their abovementioned weaknesses:

First, various attempts have been made to improve the economic situation of rural regions by locating leading scientific institutions that do not require direct economic integration (Addie et al. 2018). Examples of such projects are the ELI in Szeged (Lengyel et al. 2016), the Wendelstein reactor near Greifswald, the Forschungszentrum (research centre) Jülich and, to a certain extent, the ESS in the southern Swedish region of Skåne (Nilsson and Moodysson 2015). In principle, these approaches can be regarded as successful regarding the functionality of the facilities achieved, but they find their limits in precisely those conditions that were the motivation for their establishment in the first place. For lack of relevant partners, the new facilities interact to a rather limited extent with their environment and hence fail to initiate further development processes.

A further approach lies in the promotion of selected technology companies. These are, for various reasons often associated with the initiative of specific people. Such individual "hidden champions" can be found e.g. in Greece (Komninaki 2015), North East Romania (Healy 2016) and Mecklenburg-Western Pomerania (Biocon Valley 2013). However, this approach, often driven by technology parks, can only have a limited structural effect because the in so far isolated companies are necessarily mostly active on national and international markets. In some places, however, new technological clusters, have been successfully developed, even in regions previously shaped by agriculture. Examples of this are the creation of technological development poles in Andalusia (Fernández-Esquinas et al. 2016) or the development of biotechnology clusters in Mecklenburg-Western Pomerania (Biocon Valley 2013).

In some regions, e.g. the Greek islands or southern Portugal, it also makes sense to focus on modernising the (tourism) service sector as a central driving force for regional development (Komninos et al. 2014; Pinto et al. 2012). Although this strategy often seems obvious, its structural weakness lies in the low quality of most jobs thus created in the service sector, which often come with comparatively low individual incomes and low regional value added. A complete concentration on tourism-oriented strategies is

therefore only advisable where the natural conditions lend themselves readily to tourism and a specific, Europe-wide unique selling point clearly exists.

The most convincing approach, finally, is to use established strengths of the regions in the agricultural and agricultural technology sectors to their advantage and to further develop them on a technology-driven basis. Due to its seemingly traditional orientation and therefore relatively low political attractiveness, however, it was only pursued to a very limited extent for a long time. Only in recent years has it regained importance under the headings "bio-economy" and "agri-food sector". Initiatives in this context include the development of modern agricultural technology (agriculture 4.0) on the one hand, but also the development of new products based on biotechnological processes on the other, e.g. in the field of renewable raw materials. What they have in common is that they aim to dissociate rural regions from their traditional, technologically catching-up role and place them in a position of leading technology developers in selected areas central to a resource-efficient economy.

2.4.2.2 Metropolitan regions with systemic weaknesses

Metropolitan regions can be regarded as special cases of regional innovation systems that are characterised by a particular density of companies (often also corporate headquarters), research institutions, universities and colleges, (qualified) labour, communication and transport infrastructures, institutions as well as technology and innovation potential. Due to their excess significance for the surrounding area, respectively their interregional supply and control functions, metropolitan regions also have an attraction effect for workers (commuters), tourists and private and commercial customers. For Kulke (2004), "global cities" in particular are regarded as the control and monitoring centres of global economic activities.

For Fischer et al. (2001), metropolitan regions are important areas of industrial innovation that benefit from knowledge externalities and agglomeration effects. The spatial, technological and institutional proximity between companies in metropolitan regions and the existence of specialised service companies and research institutions are regarded as particularly conducive to innovation. According to Fischer et al. (2001), the networking of actors promotes the generation and diffusion of knowledge and, in this sense, establishes a system context.

In spite of these theoretical advantages, given by the infrastructure and networking advantages, not all metropolitan regions are among the most innovative regions in their respective countries, or even in an international comparison. According to Tödtling and Trippl (2005), urban areas like Vienna, Frankfurt or South-East Brabant in the Netherlands are characterised neither by having a high and dynamic technology profile nor by

the existence of dynamic and innovative clusters. Despite the local presence of universities and research institutions as well as dense networks of knowledge and technology transfer institutions, they perform worse in (technology-intensive) business start-ups than would be expected according to their potential and positioning in the spatial hierarchy. Berlin also belongs to this type of region, as there are pronounced weaknesses in the area of private R&D and innovation (Senatsverwaltung für Wirtschaft, Energie und Betriebe 2018).

For Tödtling and Trippl (2005), the problem of fragmentation in this type of region manifests itself in the absence of networks, regionally embedded value chains or gaps in existing networks. These systemic weaknesses prevent or obstruct interactive learning between the actors, so that no noteworthy synergies arise. Essentially, the various subsystems (private sector, public research) are de-coupled, i.e. the process of generating and applying knowledge is hampered by weak links between business and science, or links that lag far behind the possibilities.

In addition to the problem of fragmentation, these cities exhibit similar structural change characteristics as entire regions, for example with regard to the relocation of companies as a result of an industry recession, job losses, tax losses and population decline, problems in attracting investors and businesses locating there (Friedrichs 1993). Gaebe (2004) emphasises that the deindustrialisation of metropolitan areas does not necessarily lead to a long-term crisis if the economic structural change from production to services is successful. However, changes in value added and distortions on the labour market cannot be ruled out in these cases either. In terms of a successful structural change in cities, Gaebe (2004) mentions characteristics such as innovativeness, creativity, flexible and knowledge-intensive production systems, knowledge-intensive and business-oriented services, economic and financial services, efficient infrastructures (transport, communication and educational facilities), strong international interdependencies, but also "soft" location factors such as residential, leisure and environmental quality.

In summary, the following strengths and weaknesses can be identified for the region type of fragmented metropoles:

Strengths and opportunities:

- high density of innovation- and technology-relevant potentials,
- large local market for private and commercial customers, opportunities for personal interactions and for the development of cooperation and networks,
- often a culture of openness and experimentation, a testbed for something new, economic, ecological and societal-social challenges as drivers of innovation.

Weaknesses and challenges:

- fragmentation and under-exploitation of synergy potentials, underdeveloped cluster dynamics and innovation-relevant networks,
- lack of headquarter functions and dominance of public institutions,
- danger of not assigning enough importance to the innovation theme compared to other specifically metropolitan themes competing for political attention.

Political approaches

Innovation policy approaches to overcome the systemic weaknesses of this type of region often include instruments that are also applied in other regions facing similar challenges. However, there are a number of special features in metropolitan regions that directly influence the measures' design. These include, for example, problem areas such as transport, environmental pollution, (cheap) living space, a lack of green spaces or recreational areas, (contaminated) wasteland in suburban areas or social problems in general, which are often particularly marked in conurbations.

With a view to improving the technology- and innovation-oriented infrastructure, this type of region is characterised by a special concentration of innovation, technology and start-up centres, the development and expansion of which represents a corresponding focus of these regions. For example, the Science and Technology Park Berlin-Adlershof or the BiotechPark Campus Berlin-Buch have for some time been an important infrastructure measure in Berlin to promote future industries. In addition, the technological focal points of the facilities are oriented towards the priority clusters to be supported, such as photonics and optics, microsystems and materials, information technology, biotechnology and the environment, as well as photovoltaics and renewable energies. The close integration of the centres with Berlin's technological potential is also reflected in the equipment of the centres and the consulting services offered. Similar to Berlin, Vienna's Seestadt Technology Centre offers state-of-the-art infrastructure at the interface between technology promotion and intelligent urban development. In the sense of an "urban lab", the needs of Viennese companies in the area of Industry 4.0 are to be addressed, with a focus on automation and manufacturing technology.

On the supply side, many cities of this region type continue to focus on improving the transfer and exploitation of research results from the typically numerous universities, research institutions and colleges, for example by setting up transfer points at public institutions or patent brokerage firms.

With a view to addressing systemic gaps, the promotion of clusters and networks plays an important role to develop specialisation advantages, generate synergy effects, increase international visibility and as an instrument for promoting start-ups in fragmented metropolitan regions. For example, for a number of years now Vienna has been focusing specifically on the promotion of clusters, with a number of clusters being coordinated and supported by the Vienna Business Agency (partly co-financed by the EU), as well as clusters active nationwide located in Vienna (bmwfw 2014). As part of the Joint Innovation Strategy with Brandenburg (innoBB), Berlin also focuses on the establishment and expansion of clusters. On the one hand, five cross-federal-state clusters are being set up (e.g. health industry, ICT, media and creative industries), and on the other hand four cross-sectional themes have been defined which support the innovation processes in the clusters as cross-sectional and key technologies.

In principle, cluster and network funding can make an important contribution to institutional stabilisation of the existing or to be established actor communication and integration and can counteract fragmentation. As the example of Berlin/Brandenburg shows, further synergies can be exploited by building up targeted city/regional relationships and integrating peripheral potential.

In addition to setting up infrastructures and networks, all regions of this type have set up their own R&D and innovation funding programmes, focusing not only on cluster-specific topics but also on social and environmental problems (e.g. environmental pollution). The focus here is on integrated strategies to tackle the most serious risks of poverty and exclusion, as well as measures to improve the environment (measures to protect the climate and reduce CO2 emissions). Investment priorities include, for example, promoting energy efficiency and the use of renewable energies in businesses, public buildings or housing, strategies to reduce CO2 emissions, promoting research and innovation in low carbon technologies and their use (e.g. or measures to improve the urban environment, revitalise urban centres, clean up and decontaminate brownfield sites, reduce air pollution and promote noise abatement measures).

In terms of addressing these urban-related problems, innovation policy can make a significant contribution, since directly application- and problem-related funding (as a primary objective) can be combined with an improvement in systemic competitiveness (as a secondary objective) and, in this sense, urban pilot and model projects can assume a lighthouse function both internally and externally.

2.4.2.3 Partially industrialised regions with inefficient production facilities

Starting position

In almost all the Member States of the European Union there are a number of regions which were partly industrialised in the past, but which have never attained industrial and technological leadership. This distinguishes them from regions in which there is almost no industrial base (and never was), but at the same time they are no classic old industrial regions which once played a leading role (but have since lost it). What they have in common with the latter, however, is that the majority of companies currently based there do not produce truly competitive products and the production processes they use often do not meet current standards.

The reason for the lack of competitiveness of locally based enterprises can be, on the one hand, a late industrialisation and/or a lack of dynamic industrialisation, which can be observed in parts of southern Europe. On the other hand, it can be the result of transformation processes, which deprived industrial cores developed in state-socialist system of their economic basis and led to the closure or qualitative decline of existing production facilities (Herrschel 1997). Finally, technological developments can decouple an industry that was previously embedded in international value chains from further development if the contribution it makes is no longer needed, or no longer needed to the same extent, due to systemic transformations.

In contrast to predominantly rural regions, partially industrialised regions are equipped with industry- and technology-specific human capital and a display a certain level of localised value chains. In many cases, supplier structures and local clusters have established themselves to a certain extent in the vicinity of selected large enterprises, although the technological dynamics in the area of small and medium-sized enterprises are often limited (Bathelt 2009). In addition, industrial history has generally led to the establishment to a certain extent of topic-specific education and training institutions, albeit not necessarily supra-regionally visible universities.

The path dependency of all socio-economic and political relations in partially industrialised regions is, however, in many cases far less significant than in classic old industrial regions. Although industrial history has left its mark on the local constellations of politics and interest groups, the economic developments described here call the basic societal structure of the region into question to a much lesser extent.

A central problem of the type of region described is the shortage of qualified workers caused by the decline or disappearance of historically existing industries. Although they

continue to be qualified through the region's education and training institutions, they often already begin to orient themselves towards the outside world during their training in view of the limited (quality of) employment opportunities in the region. Local clusters are also threatened by disintegration, as those companies able to maintain an up-to-date technological standard are forced to orient their supplier and customer relationships more and more outside the region. This constellation can occur both in the form that OEMs cannot find suitable local suppliers and in the form that qualified suppliers can no longer find suitable end customers in the former regional cluster context.

Another problem is that industries that have "fallen out" of high-quality areas of international value chains may find it difficult to reconnect due to a lack of exposure to new technological developments. In the medium term, the system of local intermediaries, i.e. chambers and cluster organisations, also threatens to lose contact with international trends and its ability to identify opportunities for developing promising business models. Should this downward spiral continue, a region could become almost completely deindustrialised, thereby then sliding back to the state of an agricultural region with a few technological islands (see above).

In the European Union, there are many such regions which were partly industrialised for some time but in recent years increasingly faced the challenge of keeping pace with industrial development. These include, for example, Andalusia (Quesada Vazquez and Rodriguez Cohard 2014) and Galicia (Vence 2010) in Spain, the regions Centro and Norte in Portugal (Bateira and Ferreira 2002), parts of central Italy as well as regions affected by system transformation such as Centru in Romania (Serbanica et al. 2015) or Zlín in the Czech Republic (Hajek et al. 2011). In Germany, such regions can be found above all in North Rhine-Westphalia, where technological change induced a decline in the textile industry (Smitz and Brinkmann 2000), or in the Nuremberg-Erlangen region, which, for similar reasons, recorded a loss of major employers in the telecommunications sector.

The strengths and opportunities of such regions lie:

- in an industrial human capital base and relevant educational institutions,
- the fundamental existence of local value creation networks,
- in some, still (or again) globally competitive lead companies.

Weaknesses and challenges:

- the out-migration of qualified workers, which is often already underway,
- the out-migration of firms and the disintegration of existing clusters,
- a lack of qualified intermediaries,
- the danger of losing touch with technological developments.

Political approaches

There are various approaches to preserving the remaining innovative and economic power of the regions described and to revitalising competencies currently lying fallow:

Some countries such as Spain (Quesada Vazquez and Rodriguez Cohard 2014) but also Poland (Rogut and Piasecki 2011) have in the past made conscious decisions in the interest of peripheral, but already partially industrialised regions when it comes to relocating large companies. The development of secondary industrial development cores should be strengthened by means of such relocations, in conjunction with the establishment of supplier parks and other relocation-promoting activities. In principle, these initiatives have had considerable success in the past, but in market-economy contexts there is only seldom an opportunity to become directly active as the state in this way.

Another possibility is to pursue traditional strategies to attract businesses based on infrastructure development. This approach is based on the expectation that business' relocation to regions with an industrial history are based on more comprehensive considerations than those in rural regions. Particularly in regions with considerable ERDF regional budgets, e.g. in southern Spain, central and northern Portugal (Cooke 2016), eastern Poland, the Czech Republic (Zitek and Klimova 2016) and parts of Romania (Healy 2016), considerable investments were made against this background in classical infrastructure, technology parks, but also in possibilities for connection to local education and research institutions. In terms of content, it was not uncommon for high-tech companies to locate there. In some cases, this strategy was quite successful, in others the hopes placed in (often foreign) investors proved to be inflated to the extent that they were not really interested in embedding themselves in regional innovation system but primarily in taking advantage of wage cost advantages and subsidies as such. Moreover, it is in many cases difficult to put genuinely new and different priorities into fruitful relation with existing local competences.

A further approach aims not to not fundamentally reposition the industrial sector, but to build on still existing or re-established competences of lead firms, to modernise the surrounding enterprise sector. The objective of such measures is decidedly not to keep obsolete industrial structures alive. To the contrary, it seeks to transfer learning from successful transformation experiences and to renew business models and production processes on this basis. Ideally, this will help create qualified jobs for local graduates and encourage the return of skilled workers who have already left. In addition, support based on existing skills can lead to a stop being put to the increasing fragmentation of local value-added relationships and enable the emergence of new, sustainable clusters. As a rule, this requires not least the professionalization of local intermediaries to improve the

international networking of existing industrial enterprises. Although the suitability of this approach is obvious, it still meets reservations because of the apparent backward-looking nature of its concern. However, these are often found more at the political than at the entrepreneurial level. In this context, initiatives by Romanian regional development agencies, chambers of commerce and companies can be cited as examples of how regional actors have been able to position themselves directly and successfully against a science-push policy promoted central government.

Furthermore, it should be pointed out that efforts to modernise industry in regions with ultimately still relatively limited industrial base alone can hardly reverse economic trends. Finally, those measures that were already presented in detail in the section on rural regions may be necessary or at least useful for these regions as well.

2.4.2.4 Regions with fragmented, small-scale industrial structures

Starting position

In studies such as the Regional Innovation Scoreboard (European Commission 2017), a number of regions in the European Union are regularly assigned to one of the leading groups because they generally have considerable potential in both the research and business sectors. However, they suffer from structural weaknesses in the composition of its corporate sector, which impair their technological and economic agility and hamper further, future-oriented development of local economic structures.

The core of the problem in this regional group, often illustrated with the example of Northern Italy ("Third Italy") (De Marchi and Grandinetti 2017; Aydalot 1986), is a business structure characterised by an above average number of smaller businesses, often resulting from handicraft traditions. On the one hand, such a structure enables entrepreneurial dynamism and a flexible development of the regional economy driven by creative individual actors. On the other hand, it creates coordination problems and limits the ability to adapt existing technologies and further develop existing business models (Camagni and Capello 2013; Pietrobelli and Rabelotti 2007).

Fundamental problems in the so-called "Third Italy" result on the one hand from a more traditional orientation of widespread business models and, on the other hand, from general obstacles that small and medium-sized enterprises face in the area of business development. A lack of equity limits their ability to finance development projects and low overall employment prevents individual employees from concentrating fully on research and development. Hierarchies in family businesses are often permanent and can make it difficult to make the necessary organisational changes.

In addition, a culture based on small business and handicraft traditions often leads to a perceived distance between engineering science faculties in the centres and practically thinking, short-term planning companies outside. Scientific contributions to technology and product development in companies are therefore often considered as unnecessary or useless. Even institutions such as chambers of commerce or associations that tend to mediate in their mission often reaffirm this basic attitude rather than helping to overcome it. This further complicates the already technically difficult development of future-oriented cooperation between science and industry due to the high degree of fragmentation of the economy.

In the field of qualifications, the corresponding challenge is that employees in technologically well-positioned small and medium-sized enterprises typically do not need a university degree, but are on the other hand no longer sufficiently equipped for the increasingly complex processes in current production processes with somewhat more than initial vocational training. Many European regions with small-scale fragmented company structures at this point lack an offer that serves the needs of smaller companies in a suitable manner and helps to promote their systematic further development. Not least the absence of such an offer has in some regions contributed to aggravating the communication problems between science and industry.

On the other hand, the relatively low dependence on individual lead firms in the regions described here can be viewed positively. Although the relocation of large enterprises can lead to considerable distortions in these regions as well, laid off employees find related jobs of comparable quality much easier than in less industrialised regions. In addition, the technological qualification level of most companies located in these regions is high and their diversified industrial sectors offer ample alternative employment opportunities and are able to compensate for economic losses relatively soon after single companies relocate or close.

Examples of such regions can be found in the European context as mentioned in the Third Italy, i.e. Lombardia, Emilia-Romagna (López-estornell et al. 2013) and parts of Tuscany, but also in rural parts of Catalonia (OECD 2010). In addition, there are some eastern European regions such as the South Moravian region of the Czech Republic (Blazek et al. 2013) and Slovakia (Hudec and Prochádzková 2018), some of which have succeeded in successfully transforming their systems to such an extent that they can no longer be classified as partially industrialised regions with technological weaknesses. In Germany, comparable structures can be found in most prominently in some regions of Thuringia (Hendry et al. 2003) and Saxony (Plum and Hassink 2013; Bathelt 2009) outside the urban centres, where a business landscape made up of extremely small firms provides a far greater contribution to regional economic life than is the case in other

federal states but is also repeatedly hampered by factors that are particularly significant for small businesses (succession, financing, long-term development).

The strengths and opportunities of this type of region can be described as follows:

- dynamic, technologically qualified corporate landscape,
- dense regional firm structure, resilient to out-migration,
- capacities in research and development are in principle available.

Weaknesses and challenges:

- fragmentation, typical, individual weaknesses of small businesses,
- lack of organisational ability, partly resistance to change,
- only partially suitable qualification offer,
- little exchange between science and business.

Political approaches

Approaches to overcoming these challenges can be identified in the regions mentioned, both in innovation and industrial policy areas themselves and in related policy areas such as research and education policy.

A common type of measure aims at providing resources for dedicated research and development in smaller companies (Kroll et al. 2016; Bosco 2007) that they cannot raise themselves. Measures in this area primarily include suitable offers for SMEs to finance innovation and growth, but also measures aimed directly at enabling the recruitment of new employees, such as various variants of innovation assistant programmes and 'voucher schemes' through which smaller companies can buy innovation-related services free of charge (Garofoli and Musyck 2003). The aim is not only to lower factual thresholds for innovation, but also to promote a regional innovation culture that tends to be weaker in these regions than elsewhere.

In addition, many regions take measures or support participation in national funding schemes aimed at pooling resources and skills of small enterprises whose capacities are not sufficient in themselves to implement relevant preliminary research and innovation projects (Kroll et al. 2016; Bosco 2007). Examples of this include activities within the framework of the AiF/IGF (German Federation of Industrial Research Associations) and numerous efforts to establish demonstrators and pilot development environments in northern Italy (Pietrobelli and Rabelotti 2007). Partly with the involvement of regional research institutions, these enable smaller firms to use testing equipment and current technologies to which they on their own could not gain access.

In a similar way, universities with applied education and research orientation as well as business-oriented research institutions play a special role in strengthening the traditionally weak relations between science and industry in these regions (Kroll et al. 2016; Bosco 2007). Classical universities and public research institutions in the regions described are often unable to establish broad-based relationships with small and medium-sized enterprises because of their disciplinary orientation, but also because of considerable cultural and cognitive distances. As a result, in many of the regions mentioned, political decision-makers have sought to set up and expand such research institutions (in Germany, for example, universities of applied sciences and regional industrial research institutions).

In addition, the generation of impulses to bridge existing fragmentation in the corporate landscape as well as the often considerable gap between pragmatically oriented SMEs and the regional research landscape, cannot generally be achieved by these actors themselves. Against this background, the creation of suitable intermediaries like clusters, technology centres or public coordination agencies like ASTER in Emilia-Romagna (ASTER 2017) is of particular importance. Certainly, it is true that their establishment is more difficult than elsewhere under the framework conditions described above and may produce less immediate visible results. However, it is precisely in these regions that their fundamental function for changing local networks and patterns of thought cannot be overestimated. Often their successful establishment makes the difference between those regions, e.g. in Northern Italy and Central Germany, which have become economically very successful despite these fundamental challenges, and those, e.g. in Southern and Eastern Europe, where fragmentation and other factors still represent a serious obstacle to development.

Finally, an orientation of the local education and training offer towards the needs of the local business sector constitutes challenge and opportunity at the same time. Where local education institutions fail to act as mediators to industry, highly qualified graduates will not find suitable employment and leave – perpetuating a less innovation-oriented corporate culture. Against this background, it is of particular importance that those responsible for vocational training in the region participate in the development of a forward-looking curriculum and maintain a continuous openness to assist firms with the changing demands of the modern workplace. In particular, this applies to polytechnics, practice-oriented universities and professional teaching institutions

2.4.2.5 Peripheral-fragmented, mono-structured regions with adopted technologies

Starting position

Peripheral regions are typically confronted with a whole series of challenges, which essentially arise from their geographical location far away from national capitals or others metropolitan areas with good transport connections, as well as from limited population density. Within the EU, areas can be described as peripheral if they have a peripheral location with respect to the core of Europe, situated either at an external border or coastline ("outer periphery"). Alternatively, the term can refer to regions that, although geographically central, are difficult to reach (e.g. mountain regions or islands) ("inner periphery"). The group of regions addressed here includes primarily those located on the northern and eastern periphery of the EU whose otherwise fragmented economy is characterised by certain mono-structures and whose technology base has tended to develop on the basis of the adoption of external technologies. Economic priorities of this type of region are the extraction and further processing of mineral and fossil raw materials as well as forestry and agricultural activities. In northern Europe, examples include northern and central Sweden, northern and eastern Finland, northern Norway (in the European Economic Area), Scotland and eastern Poland (Carpathian foothills, Lublin, Pomorskie, Warmia-Masuria).

Due to the settlement structure of this type of region as well as an overall thin population of companies, dynamic clustering processes remain the exception and value chains incomplete, with a focus on early processing stages (Tödtling and Trippl 2005). Despite some large enterprises active in raw material extraction (gas, oil, coal, iron ore) and in the energy sector, the remaining business population is dominated by small and medium-sized enterprises, often in the business- or technology-oriented service sector. Typically, the start-up dynamics of those regions are rather limited, on the one hand due to the lack of a supporting infrastructure for these companies, on the other hand due to the geographical distance to larger markets (OECD 2016).

Against this background, the overall regional innovation systems in this type of region are quite fragmented. Due to the lack of system-relevant actors, especially regarding supportive intermediary institutions, a quite thin network structure, both regarding value chains and complementary technology-related linkages, can be observed. In this context, Tödtling and Trippl (2005) speak of "organisational thinness", which in the systemic sense brings with it disadvantages and concerning funding policies means greater challenges. Along with the systemic weaknesses, the R&D and innovation activities of these

regions are at least in relation to the national average quite low or below average (Fritsch 2000).

Regional technological capacities – as measured by patent applications – remain below average as does technology-oriented cooperation between science and industry. Technology acquisition tends to take place within the framework of external cooperation structures or models, underlines importance of establishing supra-regional networks, especially regarding SMEs. Nonetheless, the technological basis of these regions can be relatively high in selected domains. Regions such as Scotland or northern Sweden are technological leaders in the raw material extraction and processing sector. For example, "smart mining", i.e. the use of digital technologies in mining, is widespread in central and northern Sweden (ore mining).

The educational infrastructure is relatively good, especially with regard to tertiary education in the north of Sweden, Finland, Norway and Scotland compared to for example regions at the Eastern periphery. With the exception of the larger Scottish cities of Glasgow and Edinburgh, the northern peripheral regions mostly host polytechnic colleges, but some are also universities (e.g. in Umea and Lulea in Sweden) and in Finland (Oulu, Kuopio, Joensuu, Rovaniemi). As the study by Gloersen et al. (2005) shows, these regions sometimes have a more favourable ratio between the number of students per inhabitant than the larger cities of Helsinki and Stockholm. As will be explained below, education policy efforts in these regions play a central role in regional structural change and the modernisation of the business sector.

Strengths/opportunities of this type of region can be described as follows:

- specialised equipment suppliers and service providers for mining operations, timber and forestry, bio-economy and the energy sector,
- opportunities for diversification and new path creation at the interface of embedded competencies and new technologies,
- comparatively high level of education and training,
- general political sensitivity regarding the challenges of these regions and implementation of appropriate measures.

Weaknesses and challenges:

- access to remote markets and technologies outside the region,
- thin business population, underdeveloped supplier scene and cluster dynamics,
- little exchange between science and industry and limited start-up activity,
- further infrastructure expansion, especially in the area of digital infrastructure.

Political approaches

Due to the lack of corresponding studies, the following description of the policy mix refers only to the peripheral regions of Northern Europe, i.e. the northern/eastern regions of Finland and the northern regions of Sweden and Norway ("sparsely populated areas"). Possible (absolute) competitive advantages of these regions vary and primarily include the areas of mineral resources and energy, fisheries and aquaculture, forestry, renewable energies and tourism (OECD 2016).

Central challenges in these regions arising at the general level from the combination of periphery/remoteness, low population density/settlement structural disadvantages and climatic disadvantages. Against this background, it should be noted that Finland, Sweden and Norway implemented the innovation system concept as the basis of national innovation policy many years ago (Suorsa 2007). For the peripheral regions of these countries this led to the insight that innovation-promoting agglomeration effects or external economies of scale cannot or only to a limited extent form the basis of innovation policy strategies or instruments. This is prevented by the lack of spatial proximity between suppliers of inputs and end customers, the lack of opportunities for "labour pooling" (i.e. the sharing of a common, qualified labour market) and the lack of localised information transfer between companies. In all three countries, however, the importance of the regional level in the implementation of innovation policy has generally increased since the beginning of the 2000s (Suorsa 2007). As a result, peripheral regions as well as national governments have placed high hopes on the regionalisation of innovation policy. The packages of measures initially consist of the establishment and expansion of technology-oriented infrastructures, including regional technology parks, as well as special technology and innovation promotion programmes that were/are explicitly designed for regional development.

The most important are the Centre of Expertise Programme and Regional Centre Programmes in Finland. The Centre of Expertise Programme aims to initiate regional research cooperations between universities, research institutions and companies and to provide the corresponding funding. It also supports the internationalisation of companies and the networking of high-tech companies in the northern regions of Sweden, Finland and Norway. The Regional Centre Programme is an association of regional centres in all 34 regions of Finland with the aim of supporting strengths, regional specialisation and cooperation through R&D and innovation projects.

In Sweden, VINNOVA has implemented the Regional Growth Programme and VINNVÄXT. The Regional Growth Programme currently identifies the priorities "innovation and entrepreneurship", "attractive environments and accessibility", "provision of

skills" and "international and cooperation". The focus is thus on creating favourable framework conditions for business development, such as financing (of innovations), provision of skilled workers, access to public and private services, education and training, and investment in information technologies and infrastructure. Within the framework of EU cohesion policy, Sweden receives substantial funding to promote territorial cooperation, for example with a view to strengthening cross-border innovation systems, strengthening the competitiveness of enterprises in border areas, developing cross-border natural and cultural regions, addressing energy, environmental and climate-related challenges and sustainable transport by strengthening planning, infrastructure and communication structures. VINNVÄXT is a competition to promote sustainable growth based on innovation and technology in regions. In contrast to the previous objectives (regional excellence and cooperation), the initiatives have to currently represent national and international excellence.

Finally, in 2007 the Research Council of Norway implemented the VRI programme, which is the central medium to support research and innovation in the regions of Norway. The main objective of VRI is on the one hand the promotion of regional cooperation between business, services, R&D institutions and public administration and on the other hand the establishment of networks with national and international measures such as the Arena Programme, the Norwegian Centres of Expertise (NCE) or the Regions of Knowledge Initiative. The NCE programme promotes regional clusters in various fields. The main features of the clusters are the establishment of systematic cooperation relationships and, at the same time, an orientation towards national and international markets. In peripheral, northern Norway, the aquaculture cluster was established, in which a number of companies and R&D institutions are organised, and which deals with regionally anchored competencies in the area of commercial fish farming and related topics.

2.4.2.6 Mono-structured old industrial regions (in particular coal and steel based)

Starting position

Old industrial regions, in particular coal and steel regions, represent another type of region which, despite considerable political efforts in the past 30 years, are still often burdened with great challenges. In Germany, the Ruhr area and Saarland have become synonymous for regional structural change as such. In other European countries, the classic coal and steel regions continue to include the north of England (North-East and North-West of England), Wallonia, Lorraine-Luxembourg (Saar-Lor-Lux), Upper Silesia, the Basque Country (Navarro et al. 2014; Morgan 2016; Moso and Olazaran 2002) and Nord-Pas-de-Calais (now Hauts-de-France).

The central problems of these coal and steel regions relate on the one hand to their biased sector and size structures, and on the other hand - associated with this - to their educational structure. This type of region is typically characterised by a high concentration of large companies and, as concerns the main sectors, by mining, in particular coal mining, and heavy industry processing raw materials or the iron and steel industry. Most of the companies were vertically integrated large companies in the coal and steel industry, around which a complex of supplier companies settled, which was strongly oriented towards the end users of the coal and steel industry (Lagemann et al. 2005). Small and medium-sized enterprises, on the other hand, were only weakly represented, as were – due to the mass character of the end product – the generation of innovations and the implementation of research and development.

In terms of innovation, these regions often follow "mature" technological paths (Tödtling and Trippl 2005). Innovations are usually incrementally developed further, radical innovations are not introduced. Furthermore, the focus is on process innovations, both related to coal extraction and following processing steps. Systemic efforts to develop and introduce (radical) innovations are, according to Tichy (2001) negligible. Knowledge generation and diffusion typically takes place within the framework of a system geared to the traditional or increasingly outdated core competencies of the region (Cooke et al. 2000). In this context, purely supply-oriented technology transfer structures were often set up – starting from the research institutions and universities located there (see below) – which, however, tended to be more directed towards the large companies of the mining and industrial complex than at SMEs diversifying themselves.

In addition to the structural "heritage", the age and educational structure of the population poses a considerable challenge for this type of region. According to Lagemann et al. (2005), the Ruhr area was already one of the largest metropolitan regions in the 1980s, with a traditionally rather low educational density and a comparatively old population – due to the labour-intensive production methods characteristic of the coal and steel industry. Despite significant policy efforts started as early as the 1960s with the establishment and expansion of the higher education landscape (e.g. in the Ruhr area, Wallonia or also in Northern England), many of these regions still show unfavourable framework conditions for the creation of human capital, both in terms of expenditure on school education and in terms of quality.

Another aspect that can be observed in a whole series of regions of this type relates to the close cooperation relations that have developed in the field of the coal and steel industry between the players in the coal and steel industry and economic policy (Funder 1996). In the past, relational assets, which had often been developed over many dec-

ades, initially appeared as a socio-political anchor of stability, since, for example, a socially responsible reduction in employment contributed to overcoming the crisis, but at the same time subsidy policies were promoted and the necessary process of adaptation and modernisation was blocked. In this context, Grabher (1993) and Hassink and Shin (2005) speak of various forms of "lock-in" and referring to functional, cognitive and political interlocks that can lead to a tendency of an institutional setup to reproduce and the dominant actors in business, trade unions and politics to work towards maintaining the regional structure. As Grabher (1993) showed inter-company networks in the Ruhr area are characterised by a certain degree of unity or rigidity, which means that new impulses or technological paths are only taken up to a very limited extent and in a delayed manner. Cognitive lock-ins, on the other hand, refer to similar perceptions of problem structures and the willingness to accept new developments. Political lock-ins, finally, can be observed where a close nexus between politics and the private sector has been established, for example in the context of organised interests of business (employers' associations), employees (trade unions) and labour market policy geared to specific voter clienteles. In the past 40 years, the combination of the various lock-ins and the close ties within existing regional networks ("strong ties") has often hindered the industrial restructuring process, which is still underway in many old industrial regions, in particular those formerly engaged in coal and steel.

Strengths/opportunities of this type of region can be described as follows:

- technological basis in principle conducive to new fields of application,
- establishment/relocation of universities and research institutions,
- major innovation and industrial policy efforts in the last 15 years, in particular with respect to the use of new instruments (clusters, structural policy, transfer etc.).

Weaknesses and challenges:

- mismatch between existing skills and demand for qualifications still persists,
- weakness regarding start-ups and transfers (absorptive capacity too low),
- mature technological basis,
- low level of R&D and innovation,
- institutional, structural and political interlocks still partially in place.

Political approaches

With the crisis of the coal and steel industry, which had already begun in the 1960s and continued to varying degrees of intensity in all affected regions until the 1980s, the overriding goal was initially to soften structural change via social and economic policy and to create new employment opportunities. In terms of economic structure, renewal took

place in almost all regions shaped by the coal and steel industry. Partially this happened through service-driven structural change, as shown by the example of the Basque Country which became a location for banks and IT companies, partially through the targeted retention of industrial production, supported by and resulting in the diversification of existing companies. At the same time, at the latest since the late 1980s, more and more impetus was given to technology and innovation policy, the foundations of which had been laid years earlier with the founding of universities, colleges and research institutions (the Ruhr-Universität was the Federal Republic of Germany's first newly founded university in 1962).

Taking the Ruhr area as an example, Lagemann et al. (2005) point out that significant opportunities for the future can lie in the establishment of new sectors entirely unrelated to coal and steel (e.g. the media industry). Furthermore, the authors point to the modernisation of parts of the steel industry as well as the diversification of the large energy and steel companies into more dynamic, technology-oriented areas. Finally, innovation policy pays more and more attention to single university/college locations, especially with regard to the formation of high-tech clusters.

As far as the challenges and weaknesses of this type of region are concerned a whole range of technological and innovation policy instruments can be observed, which are implemented to varying degrees and intensities depending on the concrete starting position and overall strategy (which also includes financial resources).

In principle, it can be said that, from a strategic point of view, the encouragement of companies to open up new fields, paths and markets and, related to this, the stimulation of product and process innovations is a central concern of regional innovation policy. As a result, almost all regions of this type have programmes that aim at promoting individual or cooperative R&D. The aim here is to strengthen the local companies' innovative capacity and technology base. In these R&D projects, specific focusses are often put on addressing the particular problem structures of the regions, above all in connection with ecological redevelopment, revitalisation of urban districts or linking established sectors with the application of new technologies. Especially due to the dominance of "mature" sectors, the successful adoption of new technologies can result in an overall new technology base, whereby the resident universities – although not exclusively – can play an important role (endogenous modernisation).

In addition to individual company R&D funding and funding of collaborative research, many of the regions of this type have gained experience over the past 15 years in cluster funding and the promotion of innovation networks (the Basque Country was one of the first European regions to implement its own cluster policy in the early 2000s). The central

objective of cluster policy in these regions is to promote new fields of technology or their regional application, and generally to strengthen/renew regional value chains based on innovation and to create a climate of cooperation. Secondary objectives often consist of promoting new enterprises, attracting cluster-relevant direct investments and generally diversifying the economic structure. The concrete form of cluster policies in the regions appears to vary considerably, depending on strategy, initial conditions and budget, ranging from decentralised cluster offices as coordinating bodies to public-private partnerships with the financial participation of the private sector (see Catapult Centres in England) to loose, self-regulating alliances.

Furthermore, in almost all regions the local colleges, universities and research institutions form an integral part of the promotion of innovation, both in terms of the creation of structures (e.g. transfer offices, start-up support, entrepreneurship education, clusters) and the creation of incentives for cooperation with the regional economy. The regional funding programmes for collaborative research are designed accordingly.

Finally, it should be noted that various regions, such as Nord-Pas-de-Calais (Lille), the Basque Country (Bilbao), North-West England (Manchester) and the Ruhr area have made considerable efforts in the field of cultural policy not only to work on their image but also become more attractive for tourists/artists and creators of culture – to initiate a cultural renewal. Examples include the foundation of the Louvre-Lens on a former colliery site in 2012, the opening of the Guggenheim Museum in Bilbao in 1997, and Bochum as a location for the performance of musicals. As far as the Ruhr area is concerned, the International Building Exhibition Emscher Park should also be mentioned. From 1989 to 1999, it was a future project of the state of North Rhine-Westphalia and transformed the entire region of former heavy industry between Duisburg and Dortmund into a residential, cultural and leisure landscape which aimed to fulfil ecological standards.

2.4.3 Conclusion of the comparison of the regional types

The analysis of the various manifestations of structural change in Europe initially showed that even after many years of social, industrial and technology policy intervention, the respective starting positions are still very different. However, there are also a number of common features that can meaningfully be illustrated by a regional typology. Depending on the geographical location, dominant industries, degree of modernity and structure of the business sector as well as technological basis and innovation orientation, there is a range of regions which have to cope with structural problems. These include peripheral, sparsely populated regions in northern Europe, regions shaped by agriculture, systemically weak urban environment, classical coal and steel regions as well as those suffering from a particularly small business structure.

Innovation activities and their promotion can play a certain role in all types of regions, and within-group differences may well be substantial. Notably, there is no clear correlation between the classification of the European Innovation Scoreboard, which only assesses the absolute level of innovativeness, and the regional typology used for this paper. Both strong and weak innovators may be found in the same sub-groups as this chapter classifies be structure rather than outcome.

Regarding the (innovation) policy measures to address regional structural change, it should first be noted that a "standardisation" of the regional strategy process can be observed for the period 2014-2020, not least due to the ex-ante conditionalities as one of the central elements of the cohesion policy reform. This initially led to regions that had not previously practised a systematic approach in the innovation policy field setting up a corresponding process and to regions that were already "pioneers" now having to explicitly document their previously implicit procedures and approaches.

In addition to the strategy processes, a "convergence" of regional measures and instruments can in some cases be observed, but by no means the emergence of type-specific policy mixes. For example, almost all types of regions use programmes to promote R&D in individual companies, cluster measures or measures to promote cooperation between science and industry. In many regions, instruments aim to support supra-regional networking and, in most cases, the international orientation of innovation activities. Depending on the initial conditions, there are different needs for infrastructure development, with rural and peripheral regions in particular need of action. Concrete examples are the establishment/relocation of research institutions with regionally adapted profiles, technology and start-up centres or intermediaries such as patent brokerage firms. An important political focus in almost all types of regions is on promoting business start-ups and, in particular, the establishment of new businesses. For example, the "classic" coal and steel regions affected by structural change were faced with the necessity of providing new jobs within the framework of promoting the establishment of manufacturing companies following the collapse of the large employment aggregates.

If one can tend to speak of a cross-regional alignment of the measures and instruments developed to address (innovation-based) structural change, there are nevertheless many differences in the administrative and implementation processes as well as in the handling of regional socio-technical paths and the persistence of institutional orders. While many policy mixes can thus be regarded as similar at first glance there may still be substantial differences in the financial and material scope of the instruments, their relationship to one another, as well as the processes of implementation, that determine their actual contribution to structural change.

2.5 Implications of the different forms of regional structural change in Europe for East Germany

Based on the typology developed for this paper, it should first be pointed out that the East German Länder belong to three different types of regions. Thus, East Germany is characterised by notably different regional starting conditions for regional/regionalised innovation policy. The Free States of Saxony and Thuringia display similarities with the Italian regions Lombardia and Emilia Romagna due to their fragmented, small-scale structure while Berlin belongs to the group of fragmented metropolitan regions with systemic weaknesses. Finally, Brandenburg, Saxony-Anhalt and especially Mecklenburg-Western Pomerania have to master special challenges resulting from sparse population, weak industrial sectors and a location at the "inner periphery" – at least compared to West German conurbations.

In line with the heterogeneous starting positions of the East German federal states (Länder), it was and is the task of innovation promotion to develop regionally adapted strategies and to implement these accordingly in order to achieve sustainable effects. The innovation system approach, which has served as a blueprint for innovation policy action in all eastern German federal states since the mid-1990s, and later within the framework of "Unternehmen Region" (Entrepreneurial Regions) and the "Smart Specialisation Approach", has been the guiding principle to this day. As in many leading regions in Germany and Europe, the aim was to create a regional order characterised by the uniqueness of its profile and the simultaneous openness and closeness of its networks. Accordingly, an innovation-promoting set of instruments was developed which initially aimed at strengthening small-scale area potentials or attempted to preserve industrial cores and attract new companies to settle via large-scale projects. The InnoRegio programme is representative of this approach in addition to various state programmes. In the further course of the programme, the federal programmes "Industrielle Wachstumskerne" (industrial centres of growth) and "Zwanzig 20" (twenty20) increasingly used instruments that took an even closer look at the system context, which also included the interaction of the programmes and complementarities with other federal and state funding measures. Recently the regionally embedded innovation systems have been increasingly pushed towards opening up through the programme "WIR! – Wandel durch Innovationen in der Region" (change through innovations in the region), in which the integration of technology and innovation partners from outside the region, especially from nationwide locations, into the project consortia is planned as a fixed component.

In the sense of "policy learning", the regional comparison and typology showed that – at least on the basis of the available studies – no completely new instruments could be identified at the level of the instruments for addressing the various forms of structural

change that would not also be used in East Germany. On the contrary, innovation policy in the eastern German federal states (Länder) is characterised not only by 25 years of (practical) experience in dealing with structural problems – in the context of transformation and beyond – but also by the further development and adaptation of the instrument portfolio over time. This includes the expansion of the various science organisations and the establishment of institutes in eastern German federal states, as well as the establishment and expansion of universities and colleges. Thus, relatively early after reunification, publicly-funded research and science was already seen as an integral part of innovation-based regional development – entirely in line with the system approach. Other elements included technology and innovation-related infrastructure development (e.g. numerous technology and business incubators), R&D funding for individual companies and for networks, and, since the end of the 1990s, the establishment of innovation networks and clusters.

The above-mentioned measures in East Germany as a whole and in their combination ("policy mix") can only be found in very few regions when comparing the regions of Europe, both in terms of the sum of instruments and in financial terms. Initially, this does not say anything about the efficiency and effectiveness of implementation, but here too a wide variety of supporting and complementary measures such as evaluations, potential analyses or accompanying research are used in the eastern German regions.

In general, the differences or similarities in the policy mix are less to be found in the concrete measure or the use of instruments than in the interaction of the instruments, as far as their financial resources and, above all, the implementation process is concerned. The actual process of implementation often decides on the essential question of innovation policy, namely the question of the efficiency and effectiveness of the measures. In this respect, innovation research and policy is increasingly dependent on evidence accompanying processes in order to be able to present comprehensive analyses of policies.

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