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Innovation-based regional structural
change – Theoretical reflections,
empirical findings and political
implications

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1 Objectives and research questions

The objective of this paper is to broaden the knowledge base on the topic of innovation-based regional structural change and to discuss the possibilities of raising structurally weak regions to a dynamic growth path by means of innovation-promoting measures.

The background to this objective are political developments in Germany with regard to the development of a comprehensive German support system for structurally weak regions from 2020 onwards. While regional structural support (ERDF and German regional support) is so far essentially concentrated on regions in the eastern federal states, it should focus in future on structurally weak regions in all federal states and eliminate the differentiation between eastern and western Germany (Deutscher Bundestag 2016, 4). The experience gained in the eastern German states with the focus on innovation as a driver of structural change is intended to provide a starting point here, but taking into account the fact that some structural factors differ markedly between East German and West German regions.

Against this background, this paper focuses on the innovation policy component of a system for promoting structural change in structurally weak regions. It is planned to answer the following questions:

- How can innovation-based regional structural change be defined and measured?
- What are the causes of regional structural change and how can these causes be influenced?
- Which structures are affected and which are capable of change?
- What is the starting level, which basic conditions have to be considered?
- In which direction should change take place, who defines the goals and how are they defined?
- Which actors, organisations and institutions are affected, and which can be drivers of regional structural change?
- What are the starting points for innovation-based regional structural change, what instruments and measures are appropriate here?

In order to answer these questions, various forms of structural change are first defined (Chapter 2). This will be followed by a discussion of theoretical approaches dealing with different facets of regional structural change (Chapter 3). Subsequently, the innovation policy fundamentals of structural change are presented (Chapter 4). This is followed by exemplary results from empirical studies dealing with aspects of regional change processes (Chapter 5). Conclusions are derived by answering the research in Chapter 6.

2 Dimensions of structural change

Structural change is a widespread and therefore very comprehensive term, which is often not defined regarding its specific meaning. According to several definitions found in the literature, **structural change** can be understood as a change in the economic structure, i.e. the change in the relative weights of individual sectors during the development process. **Sectoral structural change**, on the other hand, refers to shifts in the sectoral economic structure as a result of different levels of strong growth in the individual sectors of the economy. Finally, from an economic-geographical point of view, **regional structural change** encompasses processes that change the components and elements, the competencies and skills as well as the interrelationships of the components and infrastructure of a specific region (cf., for instance, Imbs et al. 2011).

These definitions focus primarily on classical production factors and sectoral structures. Sectors, countries and regions affected by structural change are subject to changes in demand structures and factor supply structure. Modernization theories and also theories of stages of economic growth assume that change is an inherent feature of economic development and that economies move on a path from agricultural economies to industrial economies to service economies (Liefner and Schätzl 2012). This automatic process, which is derived from observing the development of many of today's successful economies and which has a positive connotation, has been criticized many times (e.g. formulated as early as the 1970s in the dependency theories; cf. Senghaas 1974). Examples given here are a number of less developed economies that do not follow this trend, or follow only very slowly, or old industrial regions that have failed to achieve a further development boost and are falling behind in their development.

In a newer understanding, **structural change and innovation are closely linked**. Both structural change processes and innovation processes are open regarding to possible results. In the understanding of innovation economics, innovation is a process characterized by search and uncertainty (Koschatzky 2001, 62). Innovations are alterations which do not yet exist and which, unlike an invention, must first prove themselves on the market. Whether a good idea will be accepted on the market is not yet known. Therefore, all investments in new solutions are initially uncertain and supported by the hope of success. Combined with external influences to which national economies and their regions are exposed, the existing uncertainty in the process of change will initially be intensified by focusing on innovation as a vehicle and goal of structural change. According to Schumpeter, daring is needed to deal with this uncertainty and to minimize the risk and to identify and tread successful paths through creative solutions and measures (Schumpeter [1911] 1993).

First of all, it has to be noted that diverse structures and processes are subsumed under the umbrella term "structural change" and that structural change is not an automatic process, but is dependent on many influencing factors. It should also be noted that structural change often involves a process in which 'bad' structures are replaced by 'better' structures (positive structural change). At the same time, however, it is possible that structures are not adapted (or do not adapt) to changed framework conditions and are thus transformed into 'bad' structures (negative structural change). Structural adjustments are also a continuous, sometimes disruptive process that affects structurally strong as well as structurally weak regions in equal way and can result in different growth rates and structural adjustment dimensions. Self-reinforcing processes can cause individual countries or regions to further develop and others to fall behind.

Structural change is thus defined by time, whereby the structures, the type of change, its intensity and the implications for those affected by the changed structures are to be defined on a case-by-case basis. If, as in Germany, comparable living conditions are a constitutional goal in all parts of the country, then the structures that have a decisive influence on living conditions (employment, income, access to knowledge and education, qualification and qualification, infrastructure equipment) are in the focus of structural change. In order to provide political support for regions and actors, it is necessary to provide quantitative support for the question of when it is socially necessary to promote structural change and the level of change to which this support must reach. In Germany, structurally weak regions (and thus structural change) are so far identified and measured by classical indicators, i.e. unemployment rate, gross annual wage per person employed, employment forecast, and an infrastructure indicator. With regard to an innovation-based regional structural change, these indicators are not sufficient, because they do not cover any aspect of innovation. Other aspects need to be considered here, which will be discussed in more detail in the following chapters.

3 Theoretical explanations

3.1 Regional location and growth theories

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. This econom-

ically oriented and often based on neoclassical equilibrium theories viewpoint has been a defining feature of German structural policy for many decades, for example implemented through the joint task of the federal government and the federal states "Improvement of the regional economic structure".

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). First of all, the classical location theories of Alfred Weber (minimum transport costs for a single firm), Johann Heinrich von Thünen (differentiation of land use depending on market price, production costs and transport costs), Walter Christaller and August Lösch (development of market areas and central supply locations of different hierarchies) can be mentioned (ibid, 37-48 and 63-91). 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.

Although transportation costs and dependencies on land as a production factor are no longer significant, in new economic geography, for example, agglomeration factors continue to be a central variable in explaining spatial structures and spatial differentiation (Marshall-Arrow-Romer externalities to explain the advantages of spatial and sectoral specialization versus Jacobs externalities to explain the advantages of sectoral and spatial differentiation; cf. Koschatzky 2001, 106-114).

Another theoretical field is **spatial mobility theories** dealing with aspects of factor and goods mobility (Schätzl 2001). In principle, a two-region model is used as a starting point by which the relationships and interactions between these two regions are analysed (Siebert 1970). Mobility theories provide information on how mobile production factors and interregional interactions influence the growth and development of the two regions. For example, sectoral differences may result in wage differentials between regions leading to migration to the region with higher wage levels. This increases the

accumulated level of knowledge, which in turn leads to efficiency advantages in production and spill-over effects between the sectors. This entails structural change processes which may have a positive impact on one region and a negative impact on the other. In the case of obstacles to mobility, other development paths would be conceivable, because then no workers could move from one region to the other.

Regional growth and development theories also deal with the economic development of regions and try to identify different spatially differentiating determinants as explanatory factors of regional development. With regard to the integration of regions into the national and international division of labour and in the trade of goods, the **export bases theory** shows the dependence of a region's economic growth on its export sector (Rittenbruch 1968). Exports generate income that is spent on local goods and services, which in turn strengthen the local sector. This increases production and income, resulting in an intraregional multiplier process that generates additional income. Regional structural change thus depends on regional export and trade activities, i.e. structural change can be supported by promoting regional export activities.

Regional polarization theories attempt to explain regional growth and shrinkage processes on the basis of cumulative socio-economic processes and the existence of spread and backwash effects. First of all, cumulative change processes are triggered by changes in demand, income, investment and production (example: a factory burns down, workers have to move away, income in the region decreases as well as demand, which in turn has a negative impact on other firms), which leads to an increase in regional imbalances and structural change processes (Myrdal 1974). There are dependency relationships in such a way that negative developments in one region trigger positive developments in another region. This construction makes it clear that change processes are influenced endogenously, but can also depend on external conditions. The polarization theories were applied in particular to the contrast between North and South, i.e. industrialized and developing countries, and provided explanations as to why developing countries could not develop in the same way as industrialized countries. Due to their cumulative nature, the regions have an advantage/disadvantage in which positive/negative cumulative processes are set in motion. Regarding the topic of "structural change", a political conclusion would be to initiate cumulative processes in regions that lead to self-reinforcing developments and changes.

Polarization theories do not follow the equilibrium thinking of neoclassical theory (Borts and Stein 1964), according to which interregional income differences are balanced by market forces in the long term, but reversal processes are certainly possible ("Polarization Reversal"), which so far may favour less developed regions (Richardson 1980). Triggered by agglomeration disadvantages in the growth regions or growth centres

(e.g. shortage of space for industrial settlements, rising transportation costs due to congestion of the transport infrastructure), firms relocate their location to the surrounding area or make new investments not in the growth regions but in the surrounding area (Koschatzky 1987). Spatial transformation processes will be initiated which are based on centrifugal spread effects and create advantages of agglomeration also in regions outside the previous growth centre. Geographically, the location and settlement structure changes with the emergence of new sub-centres (Friedmann 1966). Settlement patterns can emerge which correspond to the location structures as proposed by Christaller and Lösch.

3.2 New economic geography

From today's perspective, the polarization theories argue with economic effects whose relevance is limited or no longer existent. Advances in communications technology open up new location factors and evaluate infrastructure from other points of view (digital connection versus traffic connections). Since the beginning of the 1990s, the new growth and foreign trade theories, but also innovation economics and new economic geography have shown that classical production factors are increasingly less suitable for explaining growth differences at the national or regional level (Koschatzky 2001). With the endogenization of technical change in economic equilibrium models, it became clear that knowledge and appropriately trained human capital are key growth resources and innovations resulting from knowledge generation are drivers of competitiveness and prosperity. Regions with a higher level of human capital then grow faster than regions with a lower level of human capital. Since knowledge diffuses, for example through spillover effects (knowledge transfer via people, written documentation, technology, organisational processes, etc.), regional growth is based not only on the firms own human capital stock, but also on knowledge that diffuses from other regions. Proximity effects play a role here, since the intensity of spillover effects decreases with increasing distance (Anselin et al. 1997; Greunz 2005; Funke and Niebuhr 2000). Factor migrations can lead to convergence and divergence depending on the intensity of the knowledge spillovers. However, not every knowledge is mobile, but can be bound to persons in the form of implicit knowledge. According to Grossman and Helpman (1994), knowledge is never fully mobile due to mobility barriers for researchers, proximity effects and external returns in knowledge generation. Therefore, the region always has a temporary advantage in which knowledge is generated.

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.

In contrast to the qualitatively arguing polarization theory, in growth and foreign trade theories and in the New Economic Geography spatial processes can be formally modelled. This has led to a rapid dissemination of this theoretical framework. However, many models show a rather superficial understanding of technical progress (and thus also of innovation). Technical progress is explained endogenously, but mainly by the diffusion of technical knowledge in one sector and the use of this knowledge in other sectors (e. g. in the innovation model by Romer 1990). Blueprints and external effects (spillovers) of the existing knowledge base serve as transfer media. This means that the findings of innovation economics on the relevance of interactions in the innovation process (e. g. presented in the innovation model of Kline and Rosenberg 1986) are not taken up and are not integrated into the models. The development of technical progress is explained only very rudimentary and important factors influencing the genesis of technology (cf. Dosi 1988) are excluded.

3.3 Innovation economics

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.

Fundamental characteristics of innovation processes are

- uncertainty,
- dependence on scientific progress,

- the complexity of research and innovation,
- the importance of knowledge and learning processes through production and product use, and
- the cumulative nature of technological change.

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. For example, geographical and cultural proximity between innovation actors is particularly important when innovation projects involve a particularly high degree of uncertainty. This is especially the case in the development of new technological paradigms and systems as well as in the early phase, especially in innovation processes aiming at a radical change. On the other hand, spatial proximity plays only a minor role if it concerns incremental innovations with low uncertainty potential, and when innovation processes are standardized and hierarchically structured (e. g. in supply chains; cf. Heidenreich et al. 2012), or if the innovation project has reached the end of the innovation chain. 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.

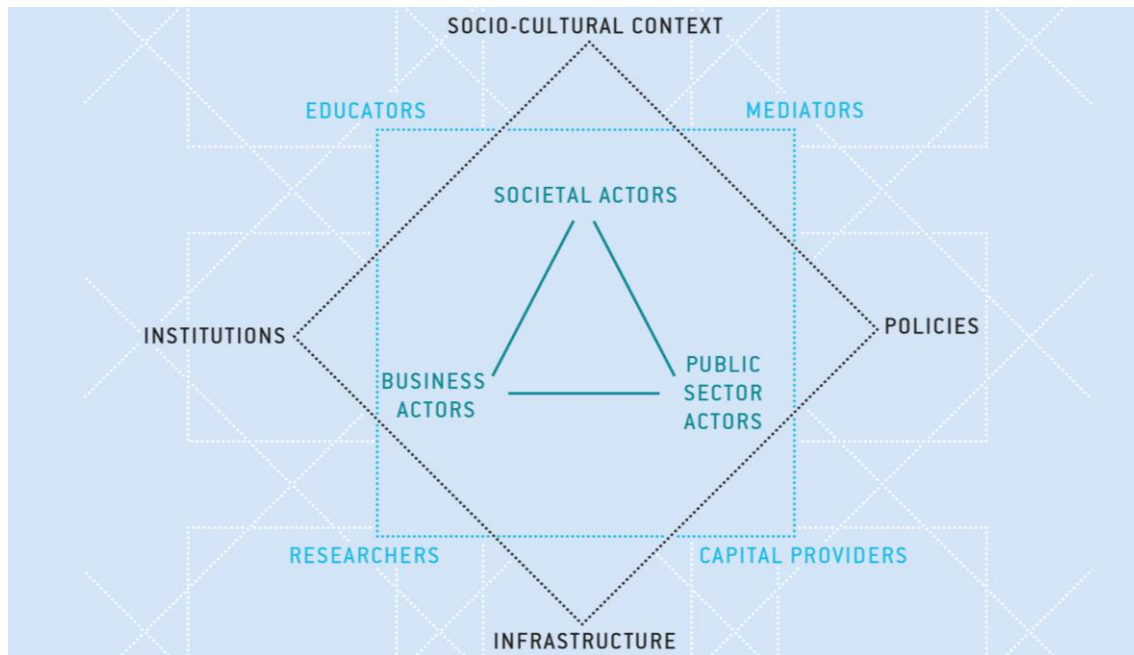
In recent years, **new forms of innovation** such as user innovation (von Hippel 2005), social innovation (Howaldt and Schwarz 2010) and collaborative innovation (Benkler 2013) have become popular, often based on IT-based platforms and exchange processes as well as on the increasing digitization of production and services. This is accompanied by a loss of spatial contexts, which represents a countertrend to the just described relevance of proximity effects. The differentiation of innovation processes is accompanied by 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). According to the literature on technological regimes and transitions, the niche represents the local framework for innovation processes: "Niches represent the local level of the innovation process and are commonly referred to as protected spaces or incubation rooms, in which new technologies or socio-technical practices emerge and develop isolated from the selection pressures of 'normal' markets or regimes" (Markard and Truffer 2008, 605). In the event of success in the niche, such new solutions can quickly develop into a broad supply (e.g. Uber, sharing services). This can be realized both via existing and newly founded firms.

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 basically 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.

The latter aspect, the cooperation between partners and regions, 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 a (regional) innovation system, organisations act and shape it through their mutual interactions and their interdependencies with other innovation systems (cf. Figure 1). 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, heterarchic, polycentric and dualistic (Cooke et al. 1997, 478).

In particular **enterprises** are the main (regional) innovation actors. Although there is no linear correlation between expenditures on research and development (R&D) and innovation output, the amount of business R&D expenditure in all national R&D expenditures indicates the importance of the business sector. In 2015, companies in Germany invested around 79.8 billion Euro in research and development, accounting for 68.9 % of all national R&D expenditures (Stifterverband 2017). Although this ratio cannot be broken down to the regional level and all regions, since firm sizes and sectoral structures influence the extent of R&D expenditure, it nevertheless highlights the importance of the business enterprise sector in the area of research and development and thus at least indirectly also in the area of innovation.

Figure 1: Elements of the innovation system



Source: stylized figure according to Warnke et al. (2016)

As the evaluation of various studies on **firms' innovation activities** shows, R&D-oriented and innovative firms are also located outside agglomerations. Although there are fewer innovative firms in rural areas than in other types of regions, the firms located there are comparatively innovative like those in agglomerations. The studies could also show that even in peripheral regions an environment conducive to innovation can develop if firms, research and transfer institutions and other organisations supporting innovation work together (Koschatzky 2001, 292; see also Section 5.2).

The innovation system concept can also be used as a starting point for the definition and **measurement of regional structural change**, for the identification of regions which should be politically supported in their structural change, for the assessment of the ability to change and for the monitoring of the change processes. One possibility in this context would be to use the elements that make up an innovation system as structure defining factors (see Figure 1). An innovation-based structural change is directed towards the availability and suitability of actors (organizations) from the education and research sector (universities, non-university research institutions), to promote and support structural change through their effectiveness (scientific output, training), mediators (intermediary organisations), research, development and especially innovation activities of economic actors as well as regional (political) activities. Interregional networking, i.e. the exchange between different innovation systems, also plays a role. The other

aspects mentioned above are also relevant, but often elude direct measurement or are not so important regionally (e. g. financing).

The concept of (regional) innovation systems also leads to **innovation policy conclusions** that are relevant for innovation-based regional structural change. The policy orientation is based on the central hypothesis of the concept, according to which the growth and competitiveness of a region is determined by the innovation and networking capacity of the firms and other organisations. This leads to the political conclusion that in the case of innovation and cooperation deficits, measures promoting cooperation should be implemented (Cooke et al. 1996, 6). With regard to the knowledge-economic interpretation of network relationships, it implies that innovation is a learning process that can be promoted through proximity to innovation support institutions. Regional policy has an important role to play in supporting this learning process by providing services and other instruments that reinforce links between actors and sectors (ibid, 6). According to the criteria for an ideal-typical regional innovation system, system fragmentation can thus be overcome by intensifying intraregional cooperation and new potentials for structural change can be mobilised. In order to derive suitable strategies, it is necessary to identify the firms' need for support offers as well as the type of regional innovation system and its political control mechanisms. Depending on the needs structures, the financial and budgetary options for action and the ability to influence regional processes, the use of different strategies and measures is necessary (Koschatzky 2002).

4 Innovation policy foundation

4.1 Regional structural and innovation policy

The topic of "innovation-based regional structural change" touches on a wide range of different policy measures which, with a view to promoting innovation, competitiveness and employment, address both the spatial construct 'region' as a target and also use the 'region' as a framework for the realisation of superior, i.e. per se non-regional objectives. In order to show the diversity of possible public governance options (Heidenreich and Koschatzky 2011), it is necessary to clarify basic concepts and policy approaches.

Regarding the **spatial framework** for policy activities, three spatial levels can be identified that are closely interacting: the European level in the sense of coordinated measures within the European Union (European Research Area, Horizon 2020, cohesion and regional policy), the national level (in Germany, for example, framed by the

New High-Tech Strategy of the Federal Government), and finally the sub-national level. The latter can have very different characteristics, which are often associated with the term "regional" but do not necessarily have to be identical. From a European and sometimes German perspective, "regional" is put on the level with the political unit 'Federal State'. For example, the operational programmes for the ERDF and ESF funding of the individual federal states represent the implementation of the national strategic framework planning of the European regional structural policy. In the context of the Smart Specialization Strategy, the federal states were also asked to prepare strategic plans (Kroll et al. 2016, Koschatzky et al. 2017). Within the operational programmes and the Smart Specialization Strategy, different regions and regional types are identified in the federal states, mostly on the basis of the NUTS-2 or NUTS-3 classification (NUTS: nomenclature of territorial units for statistics). While there are clear interfaces between the federal and state levels and thus national and regional levels can be clearly defined, the diffuseness of the concept of the region 'downwards' is increasing. "Regions" can be the mentioned NUTS region types, but they can also be labour market regions, city regions with their surroundings, metropolitan regions or clusters. At this point the transition from regional to local is fluent. When it comes to policy-making, an understanding of the region that corresponds to the field of action of the respective political responsibilities (administrative or political regions) is helpful. If, on the other hand, the effects of (innovative) political measures are concerned, then aspects such as spatial and socio-cultural proximity, exchange processes in networks etc. play a role that are not usually oriented towards given spatial boundaries, at least within a country.

In the scientific discussion, contributions deal with the issue of an open regional concept which fits better with regard to innovation processes and which could reflect the spatial diversity in innovation processes (Schmidt et al. 2017). Innovation processes and the underlying interactions do not stop at an imaginary border, but proceed spatially distributed and networked (spatial multi-dimensionality) (Koschatzky 2009). From a regional political perspective, such an open concept is not necessarily congruent with political responsibilities and policy measures. Especially policy makers who are responsible for a certain clearly defined region, have to implement instruments and measure for 'their' region. On the other hand, when it comes to innovation-oriented measures, impact analyses require a different, more open understanding of space (even if this is called "region") than the regions to be considered for the analysis of policy measures. Additionally, depending on the type, size and structure of a "region", different policy objectives, instruments and measures are relevant, since these "regions" (e. g. convergence regions, growth and employment regions) need to be addressed differently with support measures (Tödtling and Trippl 2005).

When applying the concept of innovation to the field of regional support measures, some specific aspects need to be considered. Innovations are basically 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 broadly at the regional level, and is a **relative construct** intended to promote regional or sometimes national objectives, but does not have to claim 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.

Among the **policies** that are closely related to regional innovation policy, spatial economic policy should be mentioned first of all. It refers to the deliberate design of economic spatial systems in the form of location and location structure policy, spatial mobility policy, regional and regional structural policy (Schätzl 1994). Spatial development policy is directed at individual locations (location policy), at individual regions (regional policy) or at several or all regional sub-areas of a superior territorial unit (regional structural policy). Technological projects are a starting point in the context of regional innovation policy or innovation-based political support approaches that are intended to promote regional structural change. Technology policy concentrates on scientific and technical areas in the sense of promoting application-oriented research and development (R&D) and the application of R&D results in the form of new technologies in industry. On the other hand, innovation policy, which has a broader focus than technology policy, focuses on supporting science and industry from the initial generation of ideas (invention) to market introduction (innovation) by promoting scientific, technological, economic, organizational and social change (Meyer-Krahmer 1997).

When the regional level is introduced into innovation policy as framework and target group, two approaches are to be distinguished with regard to political hierarchy levels. **Regional innovation policy** covers all public policies formulated and implemented by regional organisations for the region in the context of innovation promotion. These measures can be self-financed or co-financed with other political hierarchies. This contrasts with **regionalised innovation policy**. It comprises all public measures of innovation promotion that are formulated and implemented by higher political hierarchical levels (EU, nation-state) in relation to individual regions. They can, but do not have to, be coordinated with the regional political level. Since the beginning of the 2000s, the top-

down approach of regionalised innovation policy has become increasingly important in many countries, including Germany (cf. Koschatzky 2005). Particularly with regard to the innovation orientation in European structural funding since the 7th Framework Programme, a complex coexistence of regional and regionalised innovation policy has emerged, in which top-down implemented measures are usually linked to larger programme volumes and bottom-up strategies with usually less funding are based on the respective regional strengths and weaknesses (usually within the individual federal states).

Regional innovation policy is not in itself a new topic, but was already discussed in the late 1970s/early 1980s (Ewers and Wettmann 1980). However, not only the environmental conditions for innovation issues have changed since then (e.g. regarding knowledge society or creative economy), but also science has gained new insights into the causes and mechanisms of spatial development in innovation economics (new growth theory, new foreign trade theory and new economic geography), which have a strong influence on the relevance and content of (regional) innovation policy (Pflüger and Südekum 2005).

As already described in section 3.2, **new arguments for spatial development and differentiation** have emerged as a result of findings from the new foreign trade theory, the new growth theory, innovation economics and the New Economic Geography (Lambooy and Boschma 2001):

- the characteristics of innovation processes such as the cumulative character of technological change, uncertainty, complexity and dependence from scientific progress,
- the existence of localised, non-standardised knowledge (e. g. in clusters or metropolitan innovation systems),
- the existence and quality of human and social capital,
- learning and learning processes,
- positive external effects, which are no longer interpreted only as localisation and urbanisation advantages, but in the sense of spillover effects and knowledge externalities,
- the existence of innovation support networks,
- interregional and inter-institutional openness, and
- production regimes without dependence on transport costs (with corresponding implications for the settlement structures and the environment).

From this approach and the theoretical conclusions of the New Economic Geography, the following **implications for political intervention** arise (c.f., among others, Heidenreich and Koschatzky 2011):

- Market and system failures justify political intervention in the economic and spatial process. This involves different policy approaches.
- Balance between regions (e.g. reduction of income disparities) is considered possible. However, this disparity reduction only takes place in the long run and does not affect all regions (e. g. of one country). A regional equilibrium in the sense of stable relations between regions can, but does not have to, develop.
- There is a need for regional policy if spatial integration does not lead to a decrease in disparities, but to an increase in the effects of agglomeration and to an increase in interregional income divergence. However, there is no indication of when this is the case and when political influence is justified.
- Regional policy is an appropriate instrument for the management of spatial processes, but it should be borne in mind that non-spatial policies also have regional effects.

4.2 Innovation policy implications

In the context of regional innovation policy, four important policy approaches can be identified that are not free of overlap:

- Regional growth and development policy aimed at promoting the socio-economic development of individual regions or regional structures.
- Mobility policy aimed at reducing barriers to trade and promoting territorial integration by reducing transport costs.
- Research and technology policy to build up knowledge potential and create structures for knowledge accumulation.
- Economic policy to improve production conditions, generate economies of scale and realize external effects and spillovers.

In principle, it should be borne in mind that different policies can pursue different and sometimes competing objectives. The most important conflicting goals at the regional policy level are those between the balance and growth targets (Lammers 2007). While regional structural policy is in itself oriented towards a regional balance, regional or regionalised technology policy in particular pursues growth policy objectives ("strengthening strengths" or "strengthening the strong") (Kulicke 2003). Innovation policy, at least if it follows a broad understanding of innovation, is located between these two objectives. Particularly in regions, a policy aimed at promoting creative potential and integrating previously inactive actors into the generation of new knowledge and new

ideas can also contribute to the development of new strengths, to reducing regional income disparities and thus to structural change. However, innovation policy is often filled with similar content and objectives to technology and research policy, in line with a narrower understanding of innovation. Both of these are aimed at those areas where potentials (research firms, research institutes) have already established and are thus far more in line with the growth target than the balancing objective. In accordance with the new paradigm of the New Economic Geography, regional development is carried out indirectly in the sense of expectations, in which external effects are hoped for spread effects, which should also benefit less developed regions. Support measures for regional structural change can therefore be implemented in the regions concerned, but also in regions with higher growth rates, if they aim to have spillover effects.

A problem with regional innovation policy is that identifying problems, identifying appropriate measures and implementing funding programmes does not only require financial resources, but also the knowledge and experience that are actually created over many years of policy-making ("strategic intelligence"; cf. Kuhlmann 2001). For example, the EU Commission's Smart Specialization Strategy relies on so-called entrepreneurial processes within the framework of the 8th Framework Programme, through which regional organisations and actors contribute their interests and develop a common strategy for the region (Foray 2015). However, the regions (actors and politicians) that belong to the group of regions with strong innovation are often particularly active. Regions that need to promote innovation and take structural change measures often have fewer competences and financial resources for innovation policy measures. This phenomenon is described as a paradox of regional innovation policy (Landabaso et al. 2001).

A look at the concept of the regional innovation system can help to determine which **starting points for policy measures** can be promising (see Section 3.3). This heuristic model shows which areas (subsystems) in regions are economically and politically relevant for innovation policy and thus act as possible levers to improve the framework conditions for innovation activities. It does not matter whether a region already has the characteristics of an innovation system. The concept itself formulates only a hypothesis with regard to the characteristics that distinguish an innovation system. It is based on the assumption that the political and economic system is capable of influencing and controlling individual factors or framework conditions in such a way that ideally a functioning innovation system develops. Policy measures at the regional and supra-regional level can be based on education and research, the business sector, the intermediaries, the regional knowledge base, the demand conditions and user-based innovation as well as on the general infrastructure (cf. Warnke et al. 2016). With regard to the economic structure, these measures require a corresponding absorptive capacity (cf. Co-

hen and Levinthal 1990) of the regional firms, both as driving forces for a transformation process and as users of support measures. Measures implemented at regional level require a well-functioning regional system of public governance, in which policy measures with the necessary strategic intelligence are developed and implemented. One approach in this context is the combination of reflection and policy experiments, since the complexity arising from social interactions in the region, the uncertainty of future developments and the need for a coherent approach can only be reduced through experimental political approaches (Lindner et al. 2016).

While the innovation system concept, in spite of its generality, can give indications for starting points of innovation policy measures, additional indications can be derived from further economic geographic theory concepts. These include network economics, the cluster concept, but also approaches such as learning regions, creative or innovative milieus and industrial districts (cf. Schätzl 2001; Liefner and Schätzl 2012). They look at individual aspects in a spectrum of possible fields of action. Put into an order of developmental steps, the promotion of knowledge development, research and the awakening of creative potentials offers a basis for the establishment of networks between the economic and innovation actors and the intensification of different, purposeful cooperation relations. Cooperation projects are not an end in themselves, but rather their results (e. g. inventions) are to be introduced to the market (innovation) and should generate income and employment. This requires investments, the provision of appropriate capital and accompanying subsidies. As a result, further inventions can be brought to market either from existing firms or, in the sense of innovation competition, from newly founded firms, which in turn contribute to market expansion or the creation of new markets. Appropriate **concepts and instruments** can be:

- innovation enabling of firms, e. g. through intermediaries,
- establishment and support of regional network structures, in particular between firms and between firms and research organisations,
- offers for financing R&D and innovation projects,
- establishment of interregional cooperation with more innovative regions to initiate dissemination effects,
- design of creative open spaces, e. g. for firm founders,
- multi-actor multi-initiative support (e. g. in clusters),
- making research infrastructures more flexible and hybrid (e. g. by creating joint research facilities between firms and universities or non-university research institutes),
- Interactive measures (e. g. discursive and reflective processes, scenario development).

The central aim of all these measures is to improve the regional conditions for knowledge and technology transfer, qualification in innovation management and the mobilisation of new or additional innovation actors.

Overall, it can be seen that a distinction is made between "top-down" (regionalised innovation policy) and "bottom-up" (regional innovation policy). Region-specific approaches 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 another 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.

5 Starting points from empirical studies

In addition to the theoretical and innovation policy analyses and considerations carried out so far, current studies are used in this chapter to highlight certain aspects and characteristics of an innovation-based regional structural change. This overview does not claim to be exhaustive, but rather aims to examine important elements of the innovation system concept in relation to the subject areas of "institutional framework conditions", "firms, actors and organisations", "path dependency and resilience" and "policy".

5.1 Institutional framework conditions

The importance of non-regional factors for regional development is highlighted in an analysis by Coenen et al. (2015). Often, it is not so much regional factors that play a role, but rather the **institutional framework conditions of the most important regional sectors and industries outside the region**: "Our study shows that important bottlenecks to unlock an old industrial region prevailed beyond the local level and outside the direct sphere of innovation policy. Some of the greatest obstacles for renewal are not specific to the region but specific to the industry, which makes them largely out of reach for regional policy measures alone. The region, and its industries, is nested in an against process of industrial transformation and institutional adaptation" (ibid., 862).

This means that approaches to structural change cannot be decoupled from the institutional influences of the dominant regional economic sectors or must take them into account in order to set successful development impulses. However, this raises the question of where regionally governable starting points for subsidy measures lie and whether regional development, here in the case of old industrial regions, can even be governed regionally under these conditions.

Ooms et al. (2015) have found out that the success of regional innovation systems depends on their **research orientation**, **agglomeration pattern** and **economic profile**, based on an analysis of 36 differently structured European regions whose profiles are documented in the Regional Innovation Monitor Plus. For example, regions with a specialized economic structure tend to benefit from a market-oriented orientation of research organisations, whereas regions with a diversified economic structure primarily benefit from basic research: "Our findings illustrate how the research orientation and agglomeration patterns of regional innovation systems interact ... Regional innovation systems with local specialization patterns benefit from market-oriented research orientations. Similarly, regional innovation systems with an industrially varied and urban setting profit from a focus on fundamental understanding" (ibid, 89).

5.2 Firms, actors and organisations

As has already been pointed out on several occasions, firms are important innovation actors and in particular small and medium-sized enterprises (SMEs) are important target groups for policy support measures for regional structural change. Kumi-Ampofo and Brooks (2009) use the Yorkshire and Humber region to show that while SMEs active in innovation are present in structurally weak regions, they lack internal opportunities to manage and control innovation activities. External collaborations focus primarily on core activities in the value chain and rarely on exchanges with universities. The authors conclude that support measures aimed at supporting R&D activities are not an appropriate approach for these firms.

Harris et al. (2013, 102f.) conclude from an empirical analysis of the innovation behaviour of 606 SMEs from Ireland, Northern Ireland and Southwest Scotland that SMEs in these regions are less competitive and innovative than in agglomerations, their locations are less accessible and their costs in terms of market distance and raw material procurement are higher. Other disadvantages are infrastructure deficits, less large firms that can be traded with and higher service costs. Support measures must therefore focus on training and development as well as on increasing competitiveness through business improvement methods.

According to Mitze et al. (2015), who analyse the relationship between collaborative R&D strategies and the research and innovation performance of German SMEs in peripheral regions in the period 2001-2007, cooperating SMEs are characterised by increased research and innovation activities. The simultaneous cooperation with other companies and research institutions also contributes to an above-average innovation performance. The geographical proximity to the research partners is of minor importance.

Although the assessments of the importance of R&D for SMEs in structurally weak regions differ, the studies show that there are innovative and R&D-driven enterprises in these regions. However, these are subject to particular challenges due to their location. A mixture of different support measures is mentioned (e. g. cooperation support, qualification, innovation management), which seems to contribute to a reduction of the disadvantage situation.

A study of three Czech regions (Capital Region Prague, South Moravia and Moravia-Silesia) has shown for the old industrial region Moravia-Silesia that central **regional actors or promoters** with a high level of commitment, which are not influenced by institutional or structural problems in their commitment, constitute an important success factor for regional development: "... in each of the three case-study regions, a different type of actor provided the primary impetus for embarking on a more proactive development trajectory "(Blazek et al. 2013, 290).

Universities are a major stakeholder group and are regarded as important knowledge-generating and mediating organisations in regional innovation networks. In an analysis of 18 East German networks funded by the funding programme "InnoRegio", Kauffeld-Monz and Fritsch (2013) conclude that "the analysis of the different types of organizations in regional innovation systems clearly shows that public research organizations (PROs) can be regarded as central actors in regional innovation networks" (ibid, 679). They have also found that "... universities outperform non-university research organizations, which tend to engage poorly in the knowledge exchange processes of their regional innovation networks" (ibid, 679). However, they point out that most of the universities considered are located in cities, while some of the non-university research institutions "... have locations in more remote places that are characterized by a small stock of innovative firms" (ibid., 679-680). These results can be linked to those of Ooms et al. (2015). According to this study, basic research organisations (universities) play a greater role in regions with a diversified economic structure (cities), while application-oriented research organisations (non-university institutes) in regions with a specialised economic structure (often regions with weaker economies) are more important for regional development.

Goddard et al. (2012) and Pugh (2016) also highlight the role of universities in regional development. Goddard et al. come to the conclusion "... that in practice regions are not, nor should they be, a primary focus for universities. While universities can be incorporated into an RIS [regional innovation system] this needs to be carefully planned" (Goddard et al. 2012, 624). From this point of view, orientation to one's own region is not a primary task of universities. If such orientation takes place, the university strategy should be appropriate to the regional environment. In his analysis of the higher education situation in Wales, Pugh notes that universities also appear to be suitable for regional development in ordinary regions: "... there is certainly support for taking a university-based approach to economic development in both exceptional and 'ordinary' regions" (Pugh 2016, 9). However, the interactions with the regional environment must be taken into account in such a way that an 'innovation push' strategy of the university does not make sense if the environment, e.g. defined by the regional firms, does not have the necessary absorption capacities. It is therefore necessary to increase the capacity of firms to cooperate with the university before the university actively involves the regional economy in its strategy (ibid.).

Bonaccorsi (2016) points out that the type of knowledge that universities use and exploit is crucial to their impact on regional growth. While excellence with few regional impacts refers to the use of new knowledge, regional interdependence in the use of existing knowledge "... for the benefit of the regional economy, through consulting, technology transfer and practical training, particularly with respect to small firms" (ibid, 10) is much higher. According to Bonaccorsi, it is necessary to take a differentiated view of the role and function of higher education institutions in the context of regional development, and not to expect all universities to set regional development impulses in equal measure. Research universities ("generalist Humboldtian universities"; ibid, 12) perform other functions than regional universities and non-university research organisations which appear "... more motivated to engage into training and applied research needs of their respective region" (ibid, 12). Professional intermediaries" are important here.

This interface function between research institutions and firms through **intermediary organisations** is also highlighted in other analyses. Goddard et al. (2012, 624) argue that the regional integration of the university should "... be part of a long-term strategy that may in certain instances need public support for the establishment of a professionally staffed intermediate organisation or organization with specialist facilities like the TICs [Technology and Innovation Centres]". These can be organisations in the university with corresponding tasks, but also external organisations. Using the three north-west German regions Oldenburg, Oldenburger Münsterland and Elbe-Weser as examples Klein et al. (2016) show the importance of innovation promoters in regional innova-

tion processes. In these cases, business promoters and innovation consultants act as an interface between firms, research organisations and other actors and perform tasks as promoters, intermediaries, door openers or pilots (ibid, 418). Parjanen et al. (2011) deal with the role of 'Knowledge Brokers' to increase absorptive capacity in the Finnish region of Lahti. However, these authors also point out that the entire innovation process and the environmental conditions must also be taken into account: "Successful knowledge brokerage and improvement of absorptive capacity may well be of great assistance, but they require a holistic approach to entire innovation processes and their wider environment" (ibid, 945-946).

5.3 Path dependency and resilience

The concept of path dependency is used in both innovation economics and economic geography models. Cumulative processes and routines, as well as a lack of knowledge and willingness to initiate changes, lead to a (often stagnating) development that moves along a path resulting from the previous structures. Path dependency means, for example, that structural change does not take place in continuous radical upheavals, but takes place continuously through incremental developments: "... once a path has been selected and established, it shows a momentum of its own, which contributes to defining the directions in which the problem-solving activity moves ..." (Dosi 1984, 85). However, Martin and Sunley (2006) warn to use the term too uncritically and in any case to assume path dependency: "... our conclusion is that a path dependence perspective has much to offer economic geographers but that it needs closer interrogative explication to reveal its geographical foundations and implications. We need to know much more about how local economic paths emerge, develop, become rigidified and are eventually destroyed. If path dependence is a contingent and place-specific outcome and event sequence then further research needs to clarify how and why the mechanisms that produce path dependence operate to different degrees in different places" (ibid, 429). Path-dependent developments that have, for example, led to structural and innovation weaknesses in regions are conceivable, but should not be regarded as automatism. If a path dependency could not be broken, then private and public measures to define new paths would also be ineffective because they would have no effect.

However, there are regional examples that demonstrate **long-term path dependency**. The term 'lock-in' is also used for this. Grabher (1993) sets rigid specialisation and the development of strong, stable regional network relations ("strong ties") in connection with the decline of the Ruhr Area as a formerly dynamic industrial district: "The initial strengths of the industrial districts of the past – their industrial atmosphere, highly de-

veloped and specialized infrastructure, the close interfirm linkages, and strong political support by regional institutions – turned into stubborn obstacles to innovation. Regional development became 'locked in' by the very socioeconomic conditions that once made these regions 'stand out against the rest'. In other words, they fell into the trap of 'rigid specialization'" (Grabher 1993, 256). The development of the Ruhr Area has made it clear that with the increasing importance of regional network relationships, the flexibility and dynamics of local systems are diminishing and room is being created for solid, non-innovative structures. Lock-ins have different dimensions: functional lock-in, cognitive lock-in and political lock-in. These lock-ins can also develop persistent forces within a region independently of each other. For example, Funder (1996, 57) points out for structural change in the Ruhr area: "Strategies for coping with structural change... must once again interlock the separate political and economic arenas more closely with each other" [citation translated into English].

If too much **specialisation** under the framework conditions described above can develop structures that hinder long-term development, then strategies that promote regional specialisation should be viewed critically. At the same time, the interregional openness of cooperation and network relations should also be at the focus.

The concept of **regional resilience** does not necessarily stand as a counterposition, but as an approach to overcoming path dependency (Hassink 2010). It refers to the "economic adaptability and responsiveness to crises and structural disruptions" (Fromhold-Eisebith 2012, 36) [citation translated into English]. Regions can free themselves from path dependencies or overcome structural crises if they have sufficient capacity and ability to adapt. Pike et al. (2010,67) differentiate between adaptation and adaptability: "... we distinguished adaptation as the geographically uneven ways in which strong and tightly connected social agents in places respond, cope with and shape movements towards pre-conceived paths in the short run. Interrelated and in tension or complementary with adaptation, we interpreted adaptability as the geographically differentiated capacity of loosely and weakly connected social agents in places to interpret, frame and effect multiple evolutionary trajectories over time". While "adaptation" entails coping with short-term crises or challenges, "adaptability" entails a comprehensive and long-term ability to cope with structural crises and breaks (Fromhold-Eisebith 2012, 38). In the context of innovation-based structural change, the latter term describes the ability to successfully cope the structural change.

From a political sciences point of view, this requires sufficient "strategic intelligence" (Kuhlmann 2001, 971). Strategic intelligence includes "... foresight, technology assessment, evaluation studies and benchmarking. ... Recent research, however, shows that the quality of this information could be considerably increased, for instance by link-

ing the various sources of strategic intelligence and by this exploit potential synergy, building up an architecture of distributed intelligence for innovation policy making" (Smits and Kuhlmann 2004, 9). From an innovation economics point of view, the concept of absorptive capacity (Cohen and Levinthal 1990) describes the ability to deal with problems and crises and to transform them into a positive development (Koschitzky 2001, 54).

From the point of view of the concept of resilience, there are starting points for political action through the promotion of regional adaptability. To this end, Pike et al. (2010, 64-66) define three central aspects: Agents, mechanisms and sites:

- Agents comprise the key actors in the region (cf. Section 5.2), who have the skills to deal constructively with structural adjustments and to formulate and implement regional development strategies. Networking with actors and organisations in other regions or at national and international level is also important.
- Mechanisms include the interdependencies at the sectoral and technological level. The connection with the concept of "related variety" is established (Frenken et al. 2007). This describes the growth advantages resulting from the presence of technologically and product-related industries (specialisation) and the growth paths resulting from this connection, as well as the opportunities to provide growth paths with a new dynamic or to generate new growth paths. Pike et al. (2010, 64) cite the western Münsterland as a positive example of structural change: "In West Münsterland, for example, a degree of adaptability explained the re-direction of its development paths by successfully connecting textile producers to new markets for industrial and medical applications". A negative example is Mecklenburg-Western Pomerania: "In contrast, Mecklenburg-Western Pomerania experienced less success in the adaptation of its shipbuilding and engineering specializations in the context of fierce international competition and the lock-ins of entrenched vested interests in the local, regional and federal state, capital and labour" (ibid.).
- Sites refer to the regional structures and contextual conditions that define the framework conditions for adaptation and adaptability and influence them via links to other regions and spatial levels. In this context, Pike et al. (2010) point to the globalised economy as a challenge for regions: "... increased global economic integration is promoting spaces of flows and more expansive relational networks that transcend and challenge territories (for example transnational corporations; transnational governance institutions). For old industrial regions carving out new roles in spatial divisions of labour, for example, the recent and rapid decimation of the UK's semiconductor fabrication industry in Scotland and North East England demonstrated that the attraction and embedding of high-technology and highskilled foreign direct investment remained vulnerable vulnerable to the vagaries of extra-local corporate sociospatial power relations and industry dynamics" (ibid, 65).

5.4 Policy

Political implications from the results of empirical analyses and case studies have already been pointed out in the previous sections. At this point, a few general aspects with relevance for political support approaches are mentioned. Capello and Lenzi (2015) show that regions with a limited scientific knowledge base, i.e. structurally weaker and peripheral regions, are characterised by knowledge expressed in skills or **human capital**, whereas in other regions scientific knowledge dominates. For this reason, economic development in the structurally weaker regions is more closely linked to human capital: "... inventive, and, indirectly, economic performance in less R&D-intensive regions is more closely linked to knowledge embodied in human capital (i.e., capabilities in the present case) than to additional investments in research and inventive activities" (ibid., 1801). They draw the conclusion that R&D funding is not a suitable instrument for regions with weak R&D performance: "... a policy supporting R&D can prove to be extremely valuable, while it may produce virtually little, if not nil, effect in regions where the path to innovation is not based on the development of an internal scientific knowledge base" (ibid.).

With regard to the structural characteristics of innovation systems and the type of knowledge generated and used mainly in the economy and region, Martin and Trippel (2014) derive an integrated policy framework for peripheral regions. These regions are often specialised in traditional economic activities and firms often use synthetic knowledge, i.e. knowledge based on the use and recombination of an existing knowledge base with the aim of solving practical problems (ibid., 28). Such "synthetic industries" are present in organisationally thin innovation systems and can benefit from a wider range of regional innovation actors, e.g. application-oriented research centres and corresponding training and qualification opportunities. The promotion of supra-regional knowledge networks is also a political approach to promote development in peripheral regions (ibid., 30).

Performing a quantitative analysis of publicly funded R&D projects in Germany based on 270 labour market regions, Broekel (2013) concludes that **publicly funded R&D projects** can increase regional innovation efficiency. If a distinction is made between cooperative and non-cooperative projects, non-cooperative projects have a negative impact on innovation efficiency in regions with low innovation capacities. This means that such regions are primarily dependent on projects in cooperation alliances. In these projects, regional firms should cooperate with non-regional public research organisations in order to use their knowledge for their own innovation activities: "For regions with small innovation capacities, joint projects should focus on including regional firms and non-regional public research institutes" (Brökel 2013, 1103).

Almeida et al. (2011) use four case studies (Norte and Centro in Portugal as well as Galicia and Cantabria in Spain), which they call 'Follower Regions', to identify four structural and growth-enhancing factors:

- the leverage created by general purpose technologies,
- the need for effective promotion of technology-oriented entrepreneurship,
- the accelerating and supporting effect of regional competitiveness in terms of attracting clusters and other external initiatives, and
- the need to establish new intermediary organisations to promote networking and interaction (Almeida et al. 2011,1354-1355).

Here, too, the importance of intermediaries is pointed out, which should contribute to "innovation enabling" and improve the effectiveness of the regional innovation system.

6 Conclusions

In the previous chapters, different determinants and elements were identified on the basis of a theoretical discussion and the analysis of exemplary results of empirical studies, which initiate and influence structural change processes in regions. With a view to the questions raised in Chapter 1, an attempt is being made here to summarise the characteristics and to find answers to the questions.

• **How can innovation-based structural change be defined and measured?**

Innovation-based structural change has many facets and characteristics. A definition and measurement approach can be derived from the concept of regional innovation systems and the elements listed there. The explanations in this paper have shown that a distinction should be made between structural change and the ability to change structures (potential factors). Innovation-based regional structural change describes the transformation of regions' ability to innovate and their innovative competitiveness over time. It is a central aspect of regional change processes in national and international technology and knowledge competition and results from technological change, the associated national and above all global transfer processes of research and innovation activities as well as the corresponding spatial focal points of the generation of new knowledge. Structural change is affecting all regions.

The capacity for structural change depends on the availability and adaptability of actors (organisations) in the field of education and research (universities, non-university research institutions), their performance (scientific output, training, qualifications), the role of mediators and enablers (intermediary organisations) as well as of groups of civil society actors, the research, development and, above all, innovation activities of econom-

ic actors. The extent of interregional networking and integration, i.e. the exchange between different innovation systems, also plays a role in this context.

In addition, the studies analysed provide further information on the foundations of a regional identification and measurement system: Existence and profile (research orientation) of organisations supporting innovation infrastructure (universities, universities of applied sciences, non-university research institutions, intermediaries such as transfer points, incubators, innovation laboratories, clusters), supply of skilled workers and regional employment structure, regional degree of agglomeration, regional economic profile (specialised, diversified), level of regional expenditure on research and development, innovation activities of enterprises (by size structure), regional start-up activities, scope and profile of scientific output (literature) and patents, existence of innovation promoters, existence of regional policy documents and funding programmes, degree of interregional networking (knowledge networks, goods and commuter networks). This compilation can be supplemented by other existing indicator systems. This means that not all facets of an innovation-based structural change can be grasped, but important elements of it can be analysed in relation to the initial level and the progress of development.

With regard to the spatial analysis level, it must be checked which data is available for which regional aggregates. Even if, as already mentioned, political-administrative spatial units may not always appear suitable for innovation-driven activities, an approach will usually be chosen for reasons of data availability and practicability that enables analyses at the district, labour market or regional planning level.

- **What are the causes of regional structural change and how can these causes be influenced?**

In the theoretical and empirical literature, there are a number of possible causes that have an impact on regional development processes and the change of economic and regional structures.

In location and regional growth theory, agglomeration factors, i.e. locational advantages from specialisation or diversification, are cited as the cause for the emergence of cumulative processes. These processes can generate growth impulses, lead to productivity gains through internal returns and thus contribute to a change in the weighting of sectors. If regions are not self-sufficient, but linked to other regions via interregional interaction relationships, positive/negative structural changes in one region can lead to negative/positive structural changes in another region. Interaction and mobility can thus have both growth-promoting and growth-inhibiting effects. New Economic Geography and innovation economics both regard the provision of knowledge

and human capital as important causes of spatial differentiation. Knowledge, which is fed by research, imitation, adaptation and practical experience, creates external effects which, if it is specific and not easily imitated knowledge, can have advantages in the regional growth process. However, spillover effects ensure that knowledge diffuses and can also be used to promote growth in other regions.

- **Which structures are affected and which are capable of change?**

In principle, all structures relevant to the economy and society are affected by regional structural change. In the context of regional development and change processes, it is primarily concerned with different growth in individual sectors of the economy and thus with shifts in the sectoral economic structure, but also with structures of the knowledge infrastructure (research organisations, intermediary organisations) and possibilities for the use of knowledge (elements/organisations of an innovation system). Additionally, infrastructures, in today's time especially communication infrastructures with regard to availability and quality (e.g. access to fast data networks), are related to structural change. Basically, all structures appear capable of change, but routines and path dependencies as well as concentration tendencies in the allocation of public and private funds lead to structural consolidation and limited possibilities for change.

- **What is the starting level, which basic conditions have to be considered?**

Structural change is taking place at all levels, i.e. in sectors, technologies and regions with different levels of development. For regions that differ negatively from a desirable average in terms of economic or social indicators it will be necessary that these differences will not become too great and that they initiate developments which will initially bring them towards the average. Development impulses can be exploited through links with economically stronger regions. Regional openness is therefore an important framework condition. However, regional openness can also lead to the migration of resources from economically weak to economically strong regions, so that in individual cases it is important to set external growth impulses without losing internal growth determinants.

- **In which direction should change take place, who defines the goals and how are they defined?**

As the development history of many regions, which are nowadays designated as old-industrial regions, shows, change can take place both in a negative direction and, as shown for example by developments in some regions, for example in eastern Germany, in a positive direction. From a political point of view, structural change is associated with the positive idea of taking appropriate measures to reduce structural deficits at the regional level and to initiate corresponding processes of change. Measures that are

formulated 'bottom-up', i.e. by regional actors and organisations themselves, often focus on sectoral, technological or substantive objectives derived from the interests of the participating groups. From the 'top-down' perspective of a regional structural policy, goals are derived from the overarching regulatory framework, e.g. defined by the creation of comparable living conditions. For identifying structurally weak regions with regard to innovation activities, an indicator and measurement system has to be developed for a regional classification system and a monitoring of innovation-based regional structural change.

- **Which actors, organisations and institutions are affected, which can be drivers of regional structural change?**

Basically, everyone in a region is affected by structural weaknesses and structural change. The analysis of empirical studies has shown that actors, stakeholder groups, civil society initiatives and promoters with a high level of personal commitment can play an essential role in the transformation process. In addition to firms (SMEs), universities and intermediary organisations, but also other civil society organisations that are involved in regional development projects, as well as policymakers are important drivers of (innovation-based) structural change. Universities must have knowledge and competence interfaces with the regional economy in order to become effective on a regional level.

- **What are the starting points for innovation-based regional structural change, what instruments and measures are appropriate here?**

From theories as well as empirical studies it becomes clear that structural change and innovation belong closely together, because knowledge is the central resource and structures are changing these days through newly generated knowledge, through new technical, organizational and social solutions, and thus innovations. Both structural change and innovation are open-ended processes that can be influenced and are not fully controllable. Both processes are dependent on external factors (developments in other regions, market developments) so that the specific environment should always be taken into account. New forms of innovation (collaborative, social or user-driven innovation) offer structurally weak regions opportunities to develop and test new solutions in the "niche" and, if successful, to open up new users and applications.

Important starting points are the strengthening of external effects, e.g. from the generation of new knowledge, the promotion of cooperations and spillover effects as well as the increase of the absorptive capacities oriented towards innovation of existing and new firms (innovation enabling). Various studies have shown that it is not enough to support public research organisations such as universities in strategic education pro-

cesses to cooperate with the regional economy, when the regional economy is unable to take advantage of the benefits of this cooperation (particularly small firms). This does not apply to all firms, but this aspect must be taken into account if broad regional effects are intended.

With a view to regional openness, it should be noted that innovation networks and co-operations do not stop at regional borders, but rather orient themselves on criteria of content. Therefore, a regional understanding is necessary for funding measures, which takes up this openness and implements it thematically flexible (project funding versus regional funding).

Various studies (e.g. Tödting and Trippel 2005) have shown that specific regional problem situations should be addressed with a specific mix of regional measures. Terms such as "place-based policy" describe that regional structures, problem situations and circumstances should be reflected in the development and implementation processes of measures involving regional actor constellations. According to Barca (2009, 5), a "place-based" policy can be defined "... through the production of bundles of integrated, place-tailored public goods and services, designed and implemented by eliciting and aggregating local preferences and knowledge through participatory political institutions, and by establishing linkages with other places". Promoters (individuals, groups) are important in this context, who drive projects and measures forward with great commitment.

Other policy-relevant aspects are:

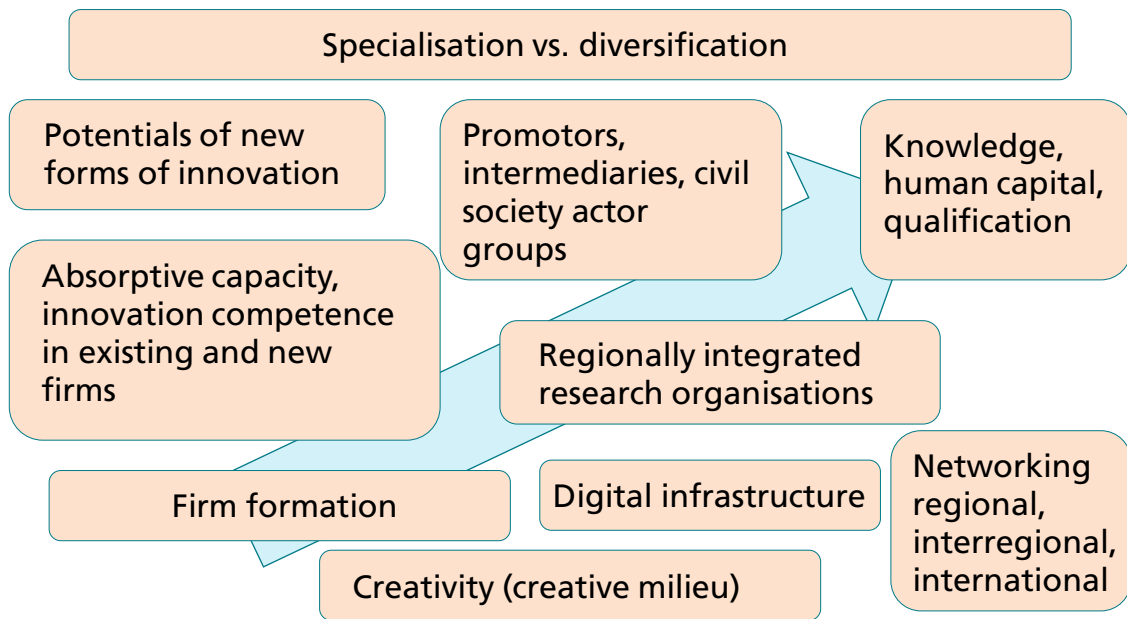
- Specialization as well as 'related variety' as an approach to structural change can strengthen the advantages of localization, but they can also lead to path dependencies and 'lock-ins', unless regional openness is used to reduce the danger of dependency on the path through influences outside the region (competition, new challenges).
- External influences from outside the region must be kept in mind, especially when it comes to measures aimed at the economic fabric. Cross-regional institutional structures of the dominant regional economic sectors must be taken into account here because they can have a significant influence on the success of regional support measures.
- In structurally weak regions, research projects should only be funded as funding of cooperation. Partners outside the region should be actively involved in such projects. Pure R&D funding is not suitable for such regions because there is often a lack of the necessary scientific knowledge base, but knowledge is primarily tied up in human capital (knowledge of experience). Due to this form of knowledge, applica-

tion-oriented (non-university) research organisations are better suited than universities with still strong basic research.

- According to the empirical studies, universities can be effectively linked to regional firms through intermediary organisations within or outside the university. Innovation consultants and economic promoters also play an important role here.
- Innovation promotion should not focus exclusively on the promotion of technology, but should reflect a broad understanding of innovation, according to which innovative solutions are developed that advance the region, but do not have to be oriented towards national or international scientific and technological excellence.

Overall, the aspects and funding options discussed for an innovation-based regional structural change can be summarised as follows with a view to the central starting points for innovation policy support measures (see Figure 2).

Figure 2: Innovation policy approaches for regional structural change



Source: own draft

Fundamentally, it is important for a regional structural change to promote regional adaptability (resilience) by building-up strategic intelligence in politics or absorptive capacities in the economy and society, so that the ability to actively shape innovation-based structural change (structural change ability) is strengthened. This requires a systemic perspective that takes into account regional interrelationships, actors' structures and contextual conditions and puts structural change, even in individual regions, in an overarching context. This is particularly relevant in the case of innovation-based structural change and its promotion, because knowledge generation and innovation processes are cross-regional and require cooperation across regional borders.

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