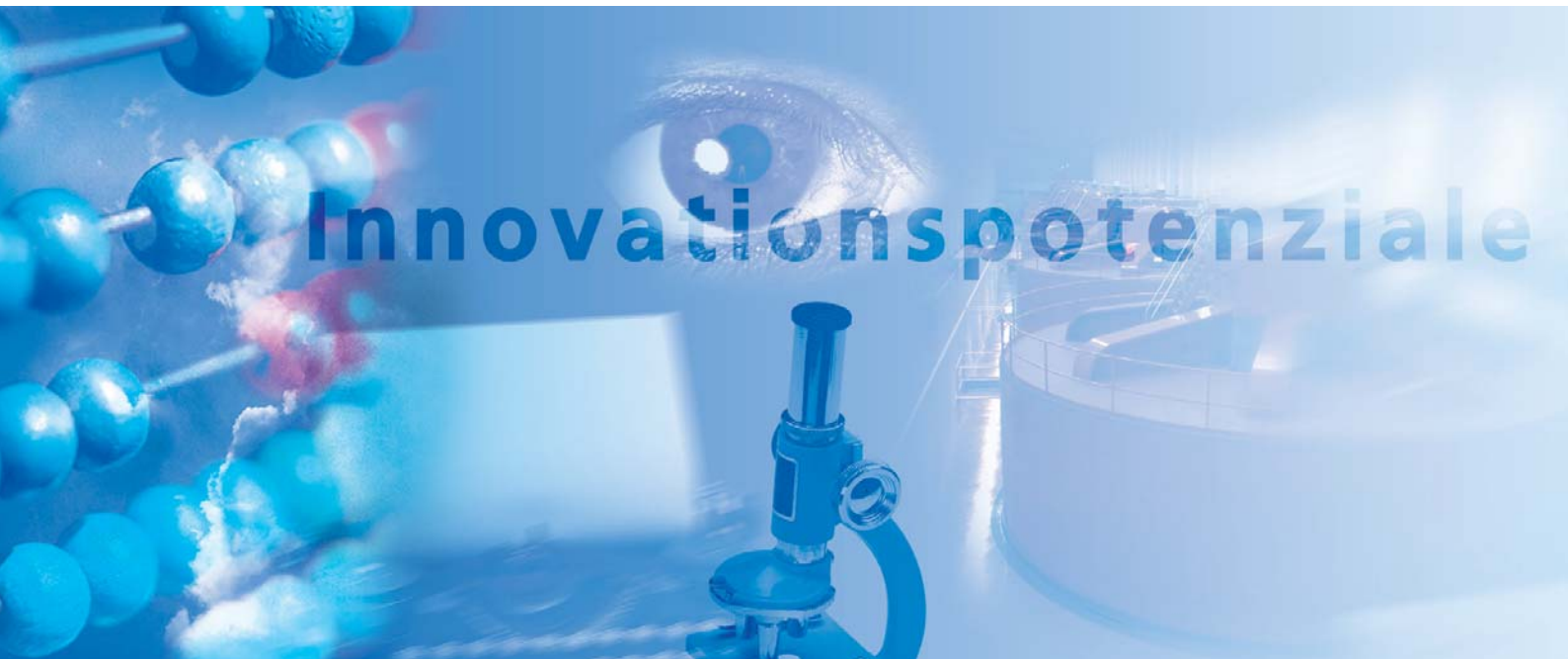
Innovation-based Regional Change in Europe: Chances, Risks and Policy Implications

Knut Koschatzky, Thomas Stahlecker (eds.)



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Innovation-based Regional Change in Europe: Chances, Risks and Policy Implications

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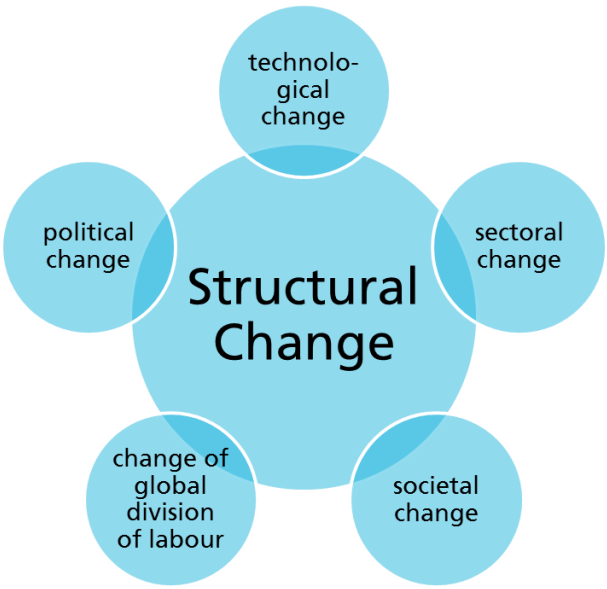
Knut Koschatzky, Thomas Stahlecker

Regional change and the reduction of regional disparities are major challenges at the supra-national, national and regional level. Structural change can be related to sectors, technologies, organisations, countries and regions. In the context of this edited volume, the focus will be on regional change, and especially change regarding innovation.

Innovation-based structural change describes the change in the innovation capacity and innovative competitiveness of regions over time. It is a central aspect of regional change processes with regard to the national and international division of labour as well as competition in the fields of technology and knowledge. It is caused by technological progress and political and social processes that trigger a shift in research and innovation activities and can thus indirectly lead to a shift in in the generation and economic valorisation of new knowledge (cf. Figure 1-1). These developments affect all regions, including those that are not structurally weak in terms of their capital, knowledge and qualifications, but are innovative and have been economically successful so far.

Figure 1-1: Dimensions of innovation-based structural change



Source: Koschatzky et al. (2018)

The concept of innovation includes a broad understanding of changes and new ideas as it encompasses technical and non-technical, organisational, social and other forms of innovation (Warnke et al. 2016). The focus here lies on the availability and adaptability of *actors* (organisations) from the fields of education and research (universities, non-

university research institutions), their *performance* (scientific output, third mission, training), the role of *mediators and enablers* (intermediary organisations), the *research, development* and, above all, the *innovation* activities of economic actors. The extent of *interregional networking and integration*, i.e. the exchange between different innovation systems, also plays a role in this context.

The European picture of income disparities between the richest and poorest regions reveal a range from 1:7 to 1:8 (European Union 2017). In high-income regions, structures change, in order to maintain or increase existing income levels. With a view to the goal of creating equal living conditions across Europe, low-income regions are particularly called upon to adapt and change structures, so that income disparities do not widen but instead narrow.

Studies show a positive correlation between income levels and innovation performance (Hollanders 2007, p. 12). However, innovation also plays an important role in low-income and structurally weak regions, at least as a factor for mobilising innovation potential. Just as the European Commission in its regional structural funding has relied on innovation-promoting measures, especially since the Seventh and increasingly the Eighth Framework Programme, the need to make the strengthening of the regional innovation base the starting point for political action is also increasingly seen at the level of regional policies in single nations.

The aim of promoting structural change with the focus on innovation should therefore be to prevent regions from failing in future when facing the challenges of structural change: as many regions as possible should remain in a position to compensate for their economic and innovative performance with new skills, and to enable regions with innovation potential that has so far been underdeveloped to increase their innovation output. However, since the transition that occurs within the framework of such a shift entails considerable adjustment costs, regions themselves often start to face structural change quite late and reactively.

Measures to promote structural change are country- and region-specific. According to the so-called "place-based approach" (Barca 2009), funding programmes and measures should not be implemented 'off the peg' and without being adapted to regional structures and needs, but instead should be formulated and implemented 'from below' in a dialogue between different organisations from the areas of business, science and politics and with the participation of civil society. In this respect, there are not only very different forms of structural weaknesses and structural changes, but there is also a wide variety of ideas and measures to reduce structural weaknesses and promote structural change at the regional level.

In general, measures to strengthen regional capacity to cope with structural changes are justified in three respects (Koschatzky et al. 2018):

- to maintain the necessary human capital and knowledge base,
- to dissolve and avoid sectoral or technological lock-in effects within the region,
- to strengthen the regional infrastructure, especially regarding specialised research and development organisations.

The target group for funding activities aimed at maintaining the ability to cope with structural change should above all be regions in which

- firstly, there is a high probability that they would fall back regarding technological structure or as far as the international division of labour is concerned due to (over)specialisation in certain economic sectors and,
- secondly, there are currently doubts as to their ability to independently establish new priorities in this situation.

This concerns many regions, not only those with an already developed innovative basis. Measures for innovation-based regional changes should primarily be oriented towards opportunities and potentials that need to be identified and exploited.

In Germany, according to the 2018 coalition agreement (Bundesregierung 2018) and the New Hightech Strategy 2025 (BMBF 2018), structural funding should be extended to all "structurally weak" regions from 2020 onwards. This includes both regions from the eastern and western part of Germany. Two approaches are pursued:

1. reorientation of the existing funding mechanism "Improvement of the regional economic structure" (*Gemeinschaftsaufgabe Verbesserung der regionalen Wirtschaftsstruktur)*,
2. implementation of a new framework concept "Innovation and structural change" within the new societal challenge "Town and Country" as formulated in the Hightech-Strategy 2025 (BMBF 2018, pp. 26ff.).

With regard to the question of how innovation-oriented regional change takes place and how innovation policy can contribute to regional change, the Federal Ministry of Education and Research (BMBF) is carrying out various funding activities. One measure is the support of 16 regional pilot projects addressing regional change in East and West Germany. Fraunhofer ISI was entrusted with the accompanying research for this funding measure between 2016 and 2018.

Common features of the pilot projects are the cooperation between scientific organisations and companies, in part between East and West German, partly only between East German or only between West German partners, and the explicit task of developing and

implementing measures for regional structural change in relation to the specific topic of the project (from steel applications to urban development to new recycling concepts).

The accompanying scientific research focusses on the following three aspects:

- Development of new scientific findings on innovation-oriented structural change,
- analysis of the developments and impacts of the pilot projects and analysis of regional structures and innovation potentials,
- initiate learning processes in the pilot projects and disseminate results from the accompanying research.

The fundamental aim of the accompanying research project is to develop basic findings on innovation-based structural change and to link developments and measures in the policy field to scientific discourse. In addition to specialist workshops for the project coordinators and other partners in the pilot projects, the tasks of accompanying research also include the scientific analysis and reflection of regional structural change and its various dimensions.

For this purpose, Fraunhofer ISI organised a publication workshop on "Innovation-based regional change in Europe: Chances, risks and policy implications" on March 28, 2018 and invited scientists and practitioners from the political administrations and regional economic development agencies from several European countries to attend. The aim of the workshop was to exchange views on the subject, but also to reach an agreement on the preparation of this edited volume.

The contributions submitted for this edited volume deal with regional change in different types of regions in Europe (Chapter 2), with innovation opportunities and innovation activities outside metropolitan centres (Chapter 3), with the role of universities in the development of structurally weak regions in England (Chapter 4), with the influence of foreign direct investment on the regional development in South Moravia (Chapter 5), with the development possibilities of a peripheral regional innovation system in Portugal (Chapter 6) and with the additionality effects of a regional promotion programme in Emilia-Romagna (Chapter 7).

The edited volume has been compiled by renowned experts from different disciplines and with different, but in each case long-standing, experience backgrounds. This volume therefore provides an overview of current European research on the topic of regional change.

We would like to thank all authors for their commitment and adherence to the tight schedule. We would like to thank the reviewers who reviewed all contributions in a short time. We would also like to thank the BMBF and the Project Management Organisation Jülich (PtJ) for their support of the research project that made the publication of this edited volume possible.

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

Thomas Stahlecker, Knut Koschatzky, Henning Kroll

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.

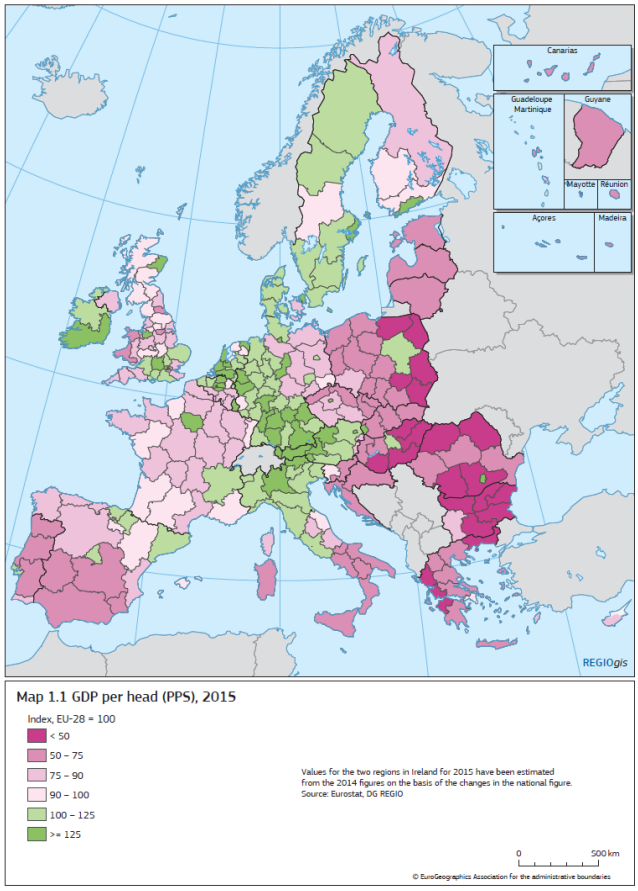
The **concept of innovation systems** (e.g. Cooke 1992 for the regional perspective; new elements in Warnke et al. 2016) offers a further opportunity to look at regions and to derive policy recommendations. The importance of systemic interaction within a country or region for economic development is 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.

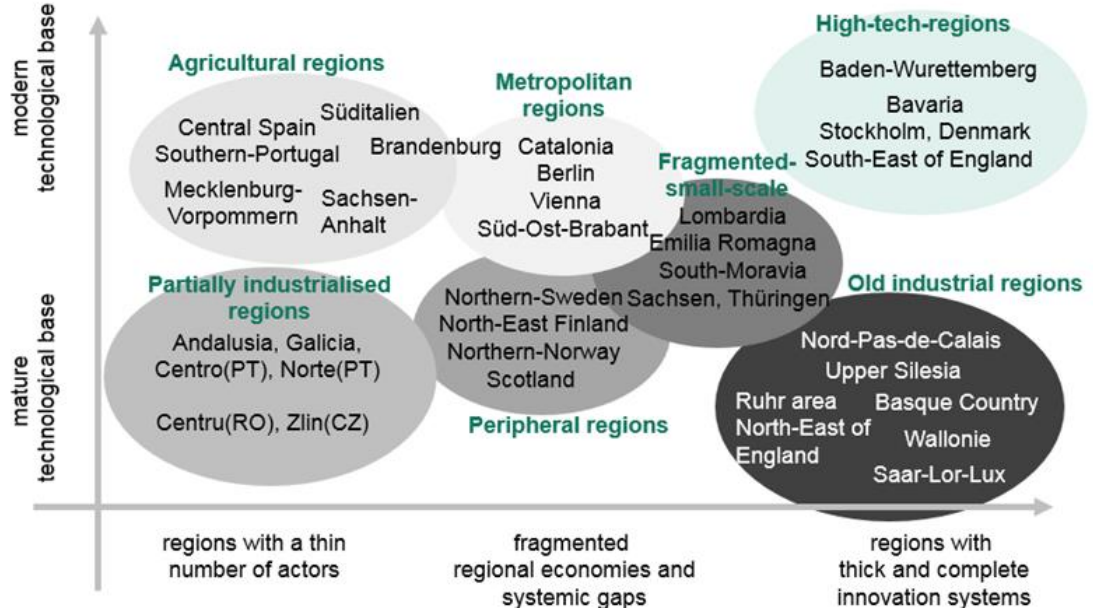
Overall, this results in the following seven types of regions, form which six form the basis for further structural and policy analyses:

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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3 Broadening perspectives: innovation outside of agglomerations

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3.1 Introduction

A central assumption in current debates on the geography of innovation is that a firm's location affects its ability to innovate (Isaksen and Karlsen 2016). Conceptualised as geographical proximity, it is argued that co-location of firms and actors such as universities and intermediaries effectively supports the emergence of innovation, especially in larger agglomerations. This assumption rests on two theoretical building blocks: localisation and urbanisation economies. The idea of localisation economies goes back to Marshall (1927) who suggested that a regional specialisation of economic activities provides pecuniary and non-pecuniary benefits to firms from related industries, for instance through eased exchange of knowledge and common use of regional resources such as a specialised labour market. Discussed in terms of urbanisation economies (Jacobs 1969), the diversity of economic activities and actors and the associated potential of cross-fertilisation provide further positive externalities. Diverse economic structures bring together heterogeneous actors and facilitate a fruitful exchange of resources.

These building blocks were integrated into contemporary conceptualisations of dynamic regional economies. Debates on territorial innovation models (TIMs), which started to emerge in the 1980s, essentially focussed on the notion of geographical proximity (Moulaert and Sekia 2003). In TIMs, innovation, competitiveness and growth are seen as endogenously induced and directly linked to the particular attributes of local and regional environments: e.g. the sectoral structure, density of actors and related network potentials and institutional arrangements (Lorentzen 2008). Following this logic, geographical proximity is not only considered a facilitating element, but often regarded as a mandatory precondition for innovation. Consequently, firms which cannot benefit from agglomeration advantages and localised knowledge exchange, i.e. firms located outside of agglomerations, are portrayed as less dynamic and innovative (Graffenberger and Vonnahme in press).

In this chapter, we argue that this perspective is outdated. And indeed, more recently, this dichotomous interpretation on the interconnection between innovation and space has increasingly been challenged (Shearmur et al. 2016). In response to critiques on the rather absolute understanding of space in TIMs in which territories are framed as self-contained entities of economic and social coordination (Moulaert and Sekia 2003; Lorentzen 2008; Crevoisier and Jeannerat 2009), studies based on relational conceptions

of space and agency illustrate that firms' social relations and networks are typically not confined to a certain region. Rather, processes of knowledge creation and circulation traverse and (re-)combine various scales (Lorentzen 2008) and thereby become territorially dynamic (Crevoisier and Jeannerat 2009). This shift in perspective provides novel insights into the geography of innovation and helps us to re-conceptualise the role of peripheral regions in the geography of innovation discourse. So far, this type of regions has not been adequately represented in wider academic debates about innovation. In quantitative approaches, innovation is often measured through indicators such as expenditures on research and development or patents that are for various reasons biased towards core and high-tech regions (Shearmur 2017). If framed and empirically measured by these indicators, innovation appears to be spatially concentrated mainly in larger city regions (e.g. Rodríguez-Pose and Wilkie 2016). However, these indicators might systematically underestimate innovation activities in peripheral regions because these regions tend to be more oriented towards traditional economic activities (Petrov 2011). Hence, a substantial part of their innovation activities remains hidden precisely because formal R&D is less relevant and the number of patents granted is lower.

The contribution of this chapter is twofold. First, it contributes to ongoing debates on a more differentiated perspective concerning the geography of innovation. We illustrate for the German context that innovative firms can also be found outside of larger agglomerations and that these firms generate outcomes that range from incremental improvements to first on the market novelties. Thereby, we oppose commonly held associations concerning the state of regions and actors outside of agglomerations as being substantially less or even non-innovative. Second, the chapter makes a contribution to existing literature by highlighting alternative pathways to innovation. In particular, we illustrate that firms outside of agglomerations seem to have lower interaction requirements and exhibit different patterns regarding their innovation-oriented collaboration partners.

In the theoretical section, we present a broad range of approaches that allows the reader to understand how firms located outside of agglomerations can mobilise their innovation potential even if geographical proximity and localised interaction do not constitute viable options. To contest common spatial associations, in the empirical section we present analyses on the spatial distribution of Hidden Champions in Germany. Furthermore, we analyse the innovation and collaboration behaviour of firms located within and outside of agglomerations in Germany and, thereby, empirically illustrate some of the alternative innovation mechanisms discussed in the theoretical section.

3.2 Extending perspectives on innovation activities in economic geography

The following theoretical discussion establishes a link between the widely acknowledged understanding of innovation as knowledge-driven, interactive and multi-local processes and recent theoretical developments in the geography of innovation literature. The focus lies on theoretical arguments that help to explain the emergence of innovation outside of agglomerations – and thereby to challenge conventional perspectives which assume that innovation is less likely to occur in peripheral regions.

Contemporary conceptualisations of innovation can be associated with the 'open innovation' paradigm (Chesbrough 2003). The open innovation approach serves as an umbrella concept and integrates a number of determining features of innovation processes. Innovation typically evolves in an evolutionary and cumulative fashion (Dosi 1988; Koschatzky 2001), i.e. existing knowledge is newly combined and/or genuinely new knowledge is created as part of this process (Fagerberg 2006). Perceiving innovation openly suggests that innovating firms rely on both, their specific and specialised internal capacities (Cohen and Levinthal 1990), but also on knowledge and expertise obtained from external organisations. Purposefully and effectively linking internal resources and external expertise allows firms to expand knowledge bases and to generate innovative outcomes. Furthermore, this perspective emphasises that innovation is essentially an interactive and social process (Welz 2003; Bathelt and Glückler 2011). As a consequence, innovation activities typically rely on interactive and collaborative arrangements between actors. These collaborations are often not tied to single localities but organised in multi-scalar and territorially dynamic ways (Crevoisier and Jeannerat 2009), thereby engaging multiple localities (Schmidt et al. 2018).

However, the interactive nature of innovation has traditionally been framed as a spatially bounded phenomenon, vividly illustrated by the central position of territorial innovation models (TIMs) in economic geography. The different conceptual approaches within the TIM family such as industrial districts, innovative milieux, innovation systems and clusters, which mainly evolved throughout the 1980s and 1990s, commonly ascribe a beneficial role to geographical proximity. In fact, these concepts treat geographical proximity as a necessary condition for innovation (Moulaert and Sekia 2003) and inscribed a distinct 'core region thinking' into theoretical approaches (Isaksen and Sæther 2015). Undoubtedly, certain geographic contexts provide more conducive contexts for intense innovation activities than others. However, such prevalent theoretical positions assume a straightforward link between location and innovation, often implicitly and explicitly excluding locations and actors outside of agglomerations (Graffenberger and Vonnahme, in press). Recent theoretical developments and a growing number of empirical studies

(see Eder 2018 for a recent overview) suggest that the geography of innovation might be more diverse than conventionally assumed, resembling a complex set of multiple geographies of innovation (Gibson and Brennen-Horley 2016; Shearmur et al. 2016).

Given contemporary conceptualisations of innovation in which, apart from internal capacities, external knowledge acquisition through interaction also operates as a key mechanism, a number of conceptual approaches can be identified that qualify rather than preclude peripheral regions as contexts for innovation. We argue that these approaches can contribute to a better understanding on how firms outside of agglomerations organise innovation activities, for example regarding the way they source and implement knowledge and expertise relevant for innovation.

Given that an intense localised exchange is not a viable option due to the relative thinness of regional contexts (Tödtling and Trippl 2005), it appears that interactions and collaborations over distances might operate as valuable knowledge sourcing mechanisms. It has been emphasised that actor relations spanning beyond local settings "may lead to precisely the same benefits that arise from agglomeration" (Johansson and Quigley 2003, p. 166). Conceptually, this idea relates to the notion of global pipelines, seen as complementary to the local buzz overserved in agglomerations (Bathelt et al. 2004). In the context of firms located outside of agglomerations, purposefully and strategically established pipelines might even act as effective alternatives to local buzz. This substitution mechanism was empirically corroborated in recent studies on the innovation related interaction behaviour of firms from peripheral Sweden (Grillitsch and Nilsson 2015) and Norway (Jakobsen and Lorentzen 2015). The studies find that, within the national setting, firms from peripheral regions collaborate across larger distances and even exhibit higher collaboration frequencies than firms in agglomerations. In a similar vein, it has been shown that collaboration with international partners has the largest impact on the innovation activities of firms from peripheral regions (Fitjar and Rodríguez-Pose 2011). Firms from peripheral regions that seek access to knowledge relevant for innovation are urged to engage in collaborations that span across distances and to establish purposefully built pipelines to spatially dispersed and functionally diverse collaboration partners (Jakobsen and Lorentzen 2015; Fitjar and Rodríguez-Pose 2017; Gibson and Brennon-Horley 2016).

These findings can also be related to the multi-dimensional proximity approach (e.g. Gilly and Torre 2000; Boschma 2005; Torre and Rallet 2005). This approach emphasises that geographical proximity (and distance) constitutes only one particular dimension in collaborative arrangements. To pursue innovation activities, firms from peripheral regions can link up to geographically distant partners by building upon cognitive, social, institutional and organisational proximity. Within the debate on the geography of innovation,

this perspective highlights two relevant aspects. First, too much proximity in each dimension impedes, for various reasons, fruitful interaction (Boschma 2005), highlighting at the same time the potential productivity of relational distance (Ibert et al. 2014). Second, geographical proximity is not necessarily the most important dimension facilitating effective collaboration.

A related aspect that has so far only been insufficiently considered in innovation theory is actor mobility (Shearmur 2017). Given that mobility constitutes a central feature of contemporary globalised economies (Maskell et al. 2006) and everyday business practices (Amin and Cohendet 2004; Schmidt et al. 2018), this negligence is at odds with firms' actual behaviour – vividly summarised by Amin and Cohendet (2004, p. 108): "The everyday possibility of striking and maintaining distanciated links, the everyday possibility of action at a distance, the everyday possibility of relational ties over space, the everyday possibility of mobility and circulation, the everyday organization of distributed systems, make mockery of the idea that spatial proximity and 'being there' are one and the same". Diverse mobility opportunities and the possibility to participate in the full range of temporary events can be seen as particular mechanisms through which firms from peripheral regions balance the organisational thinness of their regional contexts. Mobility allows access to information and knowledge that circulate in temporary settings and, thereby, effectively supports innovation activities (Torre 2008; Maskell 2014; Henn and Bathelt 2015). Furthermore, the notion of mobility illustrates the multi-local nature of innovation, as these processes become situated in multiple locations, sites and regions – interwoven and linked by actors being mobile within and across space. Thus, mobility can be considered a central means to overcome geographical isolation when needed and deemed productive.

However, it has also been suggested that firms outside of agglomerations might adapt to their thin regional environments by reducing their interaction requirements, compensated for by comprehensive internal capacities (Shearmur 2015). If their innovation activities do not depend on rapid acquisition and processing of the latest knowledge, innovation activities might rather build on strategic expansion of internal capacities and experience-based expertise coupled with rather few, but strategically mobilised external collaborations (Isaksen and Sæther 2015; Graffenberger 2019).

Given the focus of this chapter on firms' innovation outside of agglomerations, the conceptual approaches discussed can be considered valuable starting points to better understand the emergence of innovation beyond urban core regions. Building on widely accepted conceptualisations of innovation as knowledge-driven and interactive processes, these approaches emphasise that it is not only large agglomerations and their actors that are able to bring forward innovation. Purposefully activated collaborations can

also be established and effectively maintained over great distances. Coupled with an expanded understanding of geographical proximity, devoting relevance to the diverse possibilities of mobility and considering the potentially important role of internal capacities, this allows us to outline a geography of innovation that exceeds designated innovation hotspots.

3.3 The spatial distribution and innovation patterns of innovative firms in Germany

With the empirical part, we aim at contributing to a more differentiated understanding on the link between innovation and space and challenge the dichotomous representation of innovative versus less innovative settings. Therefore, we compare firms from within and from outside larger agglomerations in Germany, paying attention to their ability to innovate and the particular strategies mobilised for innovation.

First, we present findings on the spatial distribution of so-called Hidden Champions in Germany (see 3.3.2). Hidden Champions are commonly described as extraordinarily innovative companies that successfully compete and hold a leading position in global markets. This analysis allows us to strengthen our argument that innovation is not primarily a phenomenon observed in bigger agglomerations and to take innovation activities of firms located outside of larger city regions more seriously. Second, we present results of quantitative analyses on the dispersion and use of research and development activities, the innovation endeavours and cooperation behaviour of firms in different regional settings (see 3.3.3). These analyses are based on the 2017 IAB Establishment Panel data. The analyses illustrate certain differences in the innovation behaviour of firms from within and outside of agglomerations but support our argument that innovation also frequently occurs outside of agglomerations.

3.3.1 Remarks on methodological proceedings

First, the focus of our analyses is on firm-level economic innovation with a particular consideration of innovation activities of manufacturing firms. While the service sector is usually concentrated in agglomerations (Deza and López 2014), the manufacturing sector is relevant for both regions within and outside of agglomerations.

Second, given the chapter's focus on innovation outside of agglomerations, the spatial conceptions that inform our empirical analysis need to be illustrated. It has been emphasised that spatial categorisations that build merely on geographical factors induce rather narrow spatial conceptions and essentially re-emphasise an absolute understanding of

space (Kühn and Lang 2017). Thus, we integrate both geographical and functional aspects for spatial differentiation (Kühn and Weck 2013). In the two empirical sub-sections we mobilise a functional differentiation regarding types of towns and municipalities: large cities, medium-sized towns and small towns/rural municipalities.[1] Given that the functional centrality of a city/town is linked to its size, this differentiation allows us to perceive small towns and rural municipalities as particular approximations of non-agglomerated locations. Furthermore, we mobilise geographical, i.e. distance-based factors to determine the spatial categorisation. This categorisation distinguishes between (very) central and (very) peripheral locations.[2] As centrality decreases from very central to very peripheral locations, we approximate peripheral and very peripheral locations as being outside of agglomerations.

As our empirical analyses build on different data sets, deviations regarding the spatial reference units occur. Specifically, analyses on the spatial distribution of Hidden Champions in Germany refer to both functional and geographical factors, and allow for a refined approximation of firms located outside of agglomerations. Conversely, and due to data limitations regarding the actual location of observations, analyses on the IAB Establishment Panel only refer to a functional differentiation and, accordingly, consider small towns and rural municipalities as an approximation of locations outside agglomerations.

3.3.2 The spatial distribution of Hidden Champions in Germany

The term Hidden Champion (HC) was first introduced into academic discussions by Hermann Simon, as part of his research on small and mostly medium-sized companies in Germany which were found to be exceptionally successful on the world market (Simon 1990). Simon (2012) defines three criteria to determine the notion of Hidden Champions. Firms must:

- be amongst the three leading players on the world market or be market leader on one continent,
- not exceed a turnover of 5 billion euros,
- exhibit only a low level of visibility and public awareness.

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1 Based on the classification of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR): large city: >=100,000 inhabitants; medium-sized town: 20,000 - <100,000 inhabitants; small town and rural municipality: <20,000 inhabitants (BBSR 2012).

2 Based on the classification of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR), each county/municipality in Germany can be assigned to one of these four spatial categories (BBSR 2012).

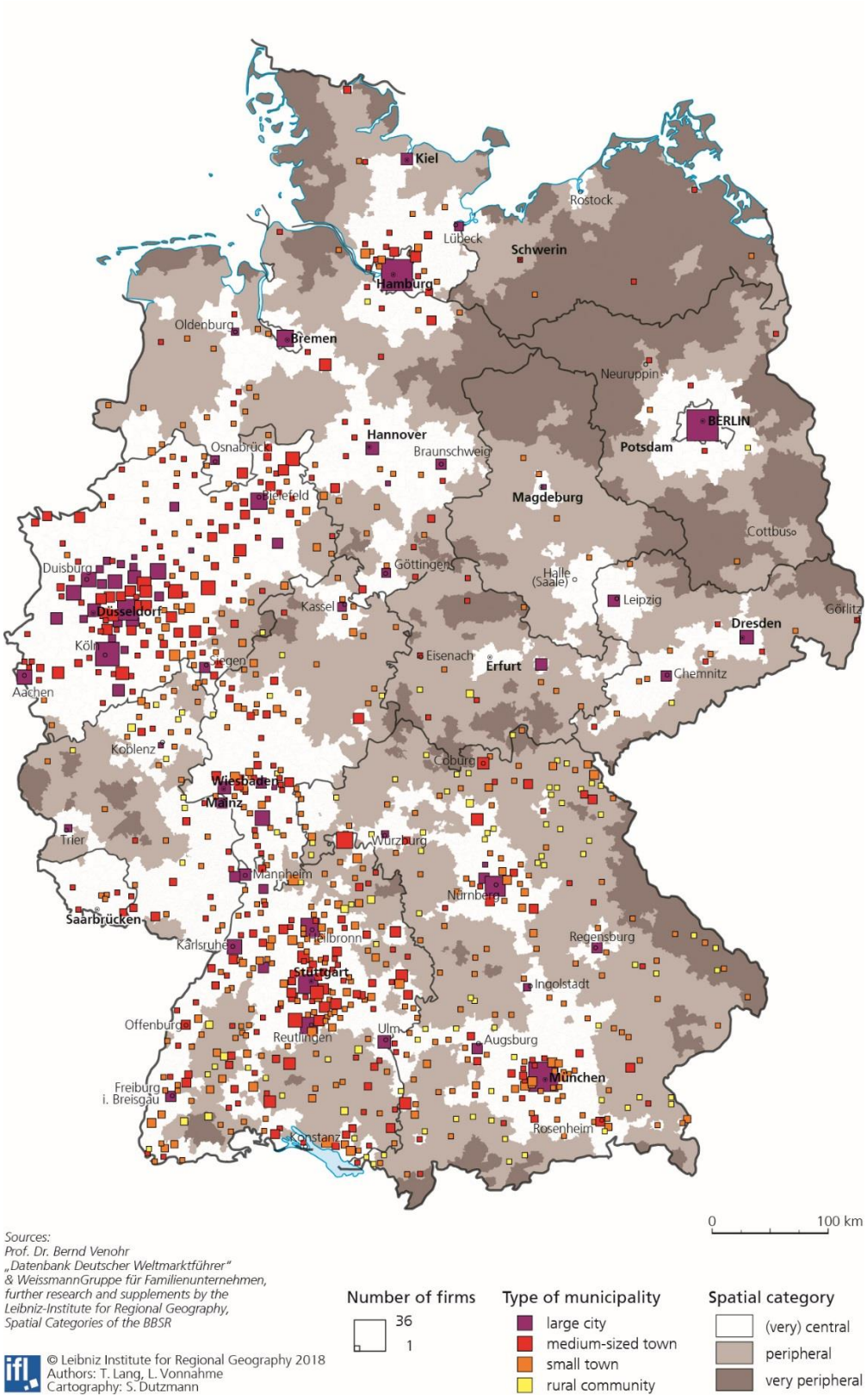
Other studies on HCs largely adopt these differentiation criteria (e.g. Rammer and Spielkamp 2015; Venohr et al. 2015; Schlepphorst et al. 2016). In his studies, Simon (2012) shows that Germany's export strength is not primarily attributable to large companies but mainly driven by these comparatively small firms. Furthermore, it has been highlighted that HCs account for increased R&D expenditures, create an above average number of jobs and exhibit, also due to their international orientation, an overall strong economic performance and are thus rather insensitive to crises. Several studies emphasise that HCs are frequent innovators (Simon 2012; Kaudela-Baum et al. 2014; Rammer and Spielkamp 2015; Venohr et al. 2015). For example, they invest twice as much as other firms in R&D activities and, on average, the number of patents granted is five times higher than for larger, well-known corporations in Germany (Simon 2012, p. 259). Due to their rather small size, HCs operate with a high degree of flexibility and are capable of swiftly adapting to technological changes and market requirements. One major feature to explain the firms' market success therefore is their excellence in innovation which often enables them to be not only the market, but also the technological leader in their respective field (e.g. Simon 2012, p. 259; Venohr et al. 2015, p. 17). Another – and in the context of this chapter central – feature is the spatial distribution of HCs headquarters in Germany as these innovative firms frequently prosper in rural areas.

In order to identify HCs, we have merged two lists of world market leaders in Germany.[1] The aggregated database has been established according to the definition of Simon (2012). It contains 1,691 firms and the locations of their headquarters in Germany, including the official municipal identification code and additional company data (e.g. turnover, numbers of employees and information on economic activities according to German classification (WZ-Codes)).

The analysis of the spatial distribution of HCs across Germany highlights a number of distinct patterns (see map). Apart from major concentrations in and around metropolises such as Munich, Hamburg, Cologne and Berlin, many HCs can be observed in the federal states of North-Rhine-Westphalia, Baden-Württemberg, and Bavaria. This distribution is not unexpected, since especially Baden-Württemberg and Bavaria are known for their strong manufacturing sector (Kollewe 2012). Further concentrations of HCs can be observed in more peripheral regions such as the Black Forest in the southwest, in Franconia, a region in Northern Bavaria and Hohenlohe, a region in the northeast of Baden-Württemberg.

1 We used and edited lists provided by Bernd Venohr (Venohr et al. 2015, http://www.berndvenohr.de/) and the Weissmann Gruppe für Familienunternehmen (https://www.weissman.de/). Additional information has been added from the MARKUS-database, a firm database by Bureau von Dijk https://www.bvdinfo.com/en-gb/our-products/data/national/markus.

Figure 3-1: Locations of headquarters of German World market leaders



Source: own elaboration

A comparison of the headquarters of HCs in Germany with types of towns and municipalities and their location demonstrates that this observation is not an exception (Table 3-1). Almost one third of the firms is located in small towns and about 20% are located in towns and municipalities outside of agglomerations (peripheral and very peripheral location). This distribution is roughly in line with the distribution of the population as well as that of the employees across the different types of towns and municipalities. Thus, a clear preference of these firms for agglomerations cannot be observed.

Table 3-1: Spatial distribution of Hidden Champions in relation to population and employee distribution in Germany

			Spatial location				
			very central	**central**	**peripheral**	**very peripheral**	**total**
Types of towns and municipalities	**Large city** (=> 100,000 inhabitants)	**HCs**	23.8%	2.7%	0.0%	0.0%	**26.5%**
		Population	28.0%	3.4%	0.0%	0.0%	**31.4%**
		Employees	35.1%	5.1%	0.0%	0.0%	**40.2%**
	Medium-sized town (20,000-<100,000 inhabitants)	**HCs**	16.6%	14.6%	4.7%	0.1%	**36.0%**
		Population	13.1%	10.1%	5.1%	0.3%	**28.6%**
		Employees	12.5%	11.5%	6.2%	0.3%	**30.5%**
	Small town and rural municipality (<20,000 inhabitants)	**HCs**	7.1%	15.2%	14.1%	1.0%	**37.5%**
		Population	6.0%	14.6%	15.5%	3.9%	**40.0%**
		Employees	4.6%	10.3%	11.8%	2.6%	**29.3%**
	total	**HCs**	**47.5%**	**32.5%**	**18.7%**	**1.2%**	**100%**
		Population	**47.1%**	**28.2%**	**20.7%**	**4.1%**	**100%**
		Employees	**52.2%**	**26.8%**	**1.0%**	**3.0%**	**100%**

Source: own calculations based on data provided by Federal Statistical Office and the Statistical Offices of the Länder (www.regionalstatistik.de) for the year 2015 and BBSR (2012).

This descriptive analysis serves as a first hint towards innovative firms located outside of agglomerations. Within the scope of our research, we understand the concept of Hidden Champions as a heuristic for successful and innovative firms. As discussed in other schools of literature on so-called 'Mittelstand' firms and family firms in more general terms (Block and Spiegel 2011; Venohr et al. 2015; De Massis et al. 2018), HCs only present a sub-group of mostly medium-sized manufacturing firms in Germany which operate in international markets and ensure their competitive advantage by technological enhancement and product development. Based on the spatial distribution of HCs, we

can thus expect that the phenomenon of innovative firms outside of agglomerations is rather the rule than the exception in Germany. For these firms, geographical proximity to agglomerations is apparently less important for securing their competitive advantage and their ability to innovate. It can be assumed that they follow alternative strategies to satisfy their need for interactive innovation activities, i.e. creating and maintaining knowledge creation processes over great distances.

3.3.3 An analysis of R&D intensity, innovation activities and co-operation behaviour of firms across Germany

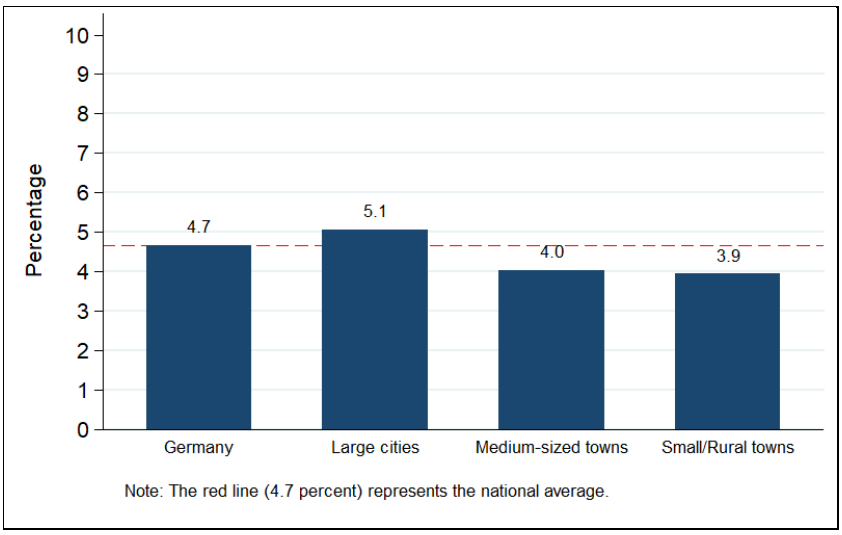
In this section we present findings that go beyond the particular, yet illustrative case of Hidden Champions. Based on analyses of the IAB Establishment Panel of the Institute for Employment Research (IAB) in Germany, we provide an overview of research and development (R&D) activities, innovation endeavours and the interaction behaviour of a representative sample of firms.[1] In these analyses we distinguish between panel firms located in larger agglomerations and firms located outside of agglomerations (according to types of towns and municipalities). This approach allows us to illustrate the extent to which firms, depending on their location, exhibit differences and similarities regarding their overall innovation activities and interaction behaviour.

3.3.3.1 R&D activities and human capital

The IAB Establishment Panel contains data on firms conducting and not conducting their own R&D activities. General analyses for Germany show that the proportion of firms conducting R&D activities was fairly constant in the 2007-2017 period (Müller et al. 2018). On average, 4.6 to 4.8 per cent of firms in Germany perform R&D activities. These figures are confirmed by the recent wave of the IAB Establishment Panel (see Figure 3-2). With regard to the differentiation between firms located in different types of towns and municipalities, the panel data display certain differences. The proportion of firms that perform R&D activities is the highest in large cities (5.1%) and gradually decreases with town size. 3.9 per cent of firms located in small towns and rural municipalities conduct R&D activities, which is below the German average of 4.7 per cent (see Figure 3-2).

1 The IAB Establishment Panel (Betriebspanel) is an annual survey of approx. 16,000 German firms active across economic activities and size categories. The survey is representative for Germany as a whole, the specified sub-regions as well as economic sectors. The survey encompasses a diverse set of questions on employment and innovation related issues. The present analysis builds on innovation relevant aspects of the survey and draws on the 2017 survey wave.

Figure 3-2: Firms with R&D activities by types of towns and municipalities

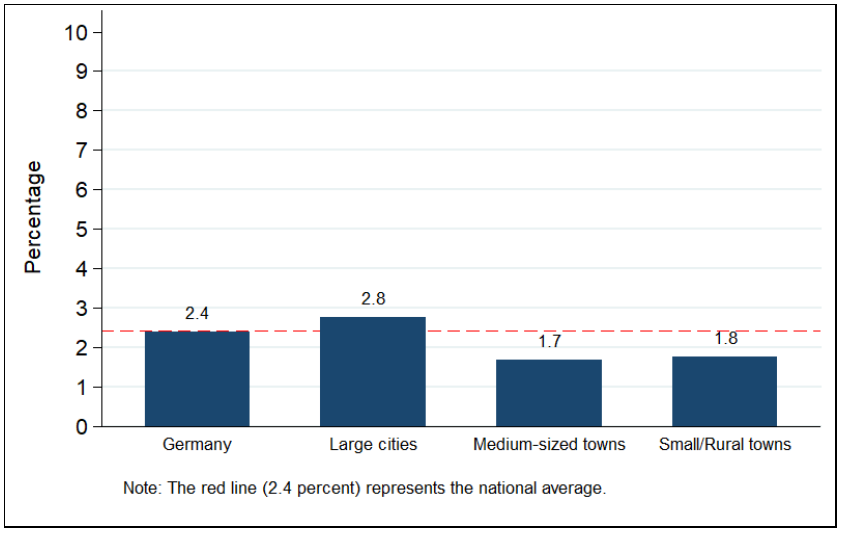


Source: own calculations based on IAB Establishment Panel, wave 2017

However, when differentiating between firm size, these results are not consistent across the board. Interestingly, the share of large firms (250 and more employees) which conduct R&D activities is larger for firms located in small towns and rural municipalities (30.2%) compared to firms in large cities (25.9%). While these indications require cautious interpretation due to the rather small number of observations in this firms/town size category, they are in line with the observation of Hidden Champions frequently being located outside of larger agglomerations (see section 3.3.2). Regarding the sectoral distribution of firms conducting R&D, the manufacturing sector is most important: 53.9 per cent of firms located in small towns and rural municipalities that conduct R&D activities are active within manufacturing. Conversely, most firms performing R&D in larger city regions provide business-related services (39.0%), while 34.0 per cent are active in manufacturing.

As stated previously, overall differences in the proportion of firms conducting R&D activities in different types of towns and municipalities are only moderate. However, these differences are more profound when taking into consideration the intensity with which R&D is performed. Using the share of employees with R&D related responsibilities as an approximation of overall R&D intensity at the firm level, shows that associated activities are less intensively pursued by firms in small and medium-sized towns (see Figure 3-3). Our data further reveal that this lower R&D intensity can be observed consistently across firm sizes.

Figure 3-3: Employees with R&D tasks by types of towns and municipalities



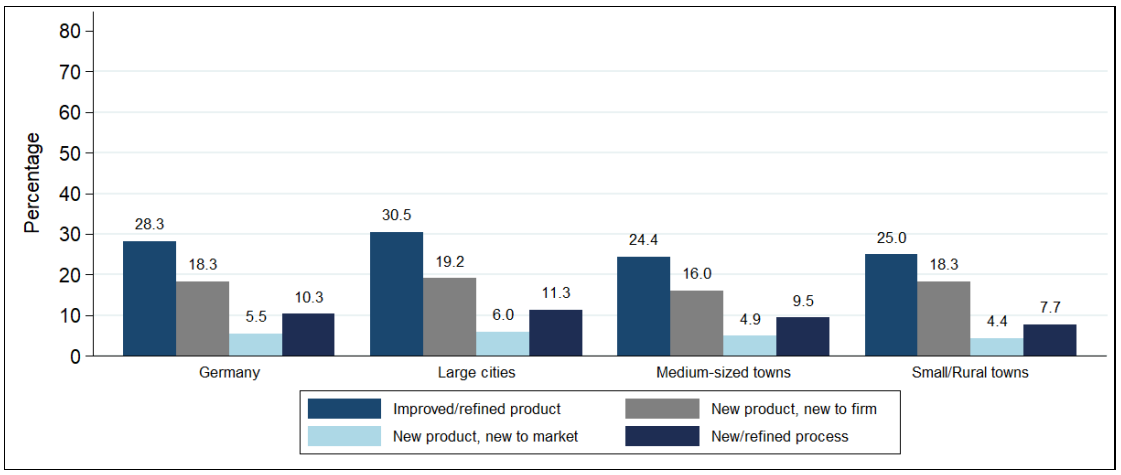
Source: own calculations based on IAB Establishment Panel, wave 2017

The workforce related qualification structure of firms can be used as a further approximation of R&D intensity. In this regard, the data indicate differences regarding the proportion of roles that require higher education degrees. Specifically, 15.7 per cent of jobs provided by firms in large cities require university graduates, while this requirement can be observed for only 7.6% per cent of jobs provided by firms located in small towns and rural municipalities. Conversely, these firms provide a higher proportion of jobs for which vocational training activities suffice: 61.9 per cent compared to 55.4 per cent for firms in large cities. Overall, these indications might point towards differences regarding underlying approaches to innovation and the types of knowledge these approaches require. Collectively, these R&D related data are supportive of the view that innovation of firms located in small towns and rural municipalities rely more on practical and experience-based expertise rather than on scientific knowledge and methods.

3.3.3.2 Frequency and types of innovation

In the theoretical discussion we have argued that innovation is a diverse notion and that there are multiple ways for firms to innovate. Additionally, the outcomes of firms' innovation activities differ regarding the degree of novelty involved and range from incremental improvement innovations to first to market novelties. The IAB Establishment Panel collects diverse data on the implementation of firms' innovations. It distinguishes between four different types of innovation: improvement innovation (improvement of existing product/service), adaptation (integrating existing product/service into firm portfolio), radical innovation (product/service new to market) and process innovation (development/introduction of new process/method).

Figure 3-4: Types of realized innovations by types of towns and municipalities



Source: own calculations based on IAB Establishment Panel, wave 2017

The data reveal that improvement innovation is the most commonly implemented type of innovation, realised by 28.3 per cent of all companies in Germany. 18.3 per cent of firms have actively pursued adaptations and 10.3 per cent have implemented new processes. Due to the high degree of novelty, as well as higher levels of costs, risks and uncertainties regarding market acceptance etc., it is not surprising that radical innovations are implemented rather infrequently (5.5%).

Introducing the differentiation regarding different types of towns and municipalities into the analyses illustrates that this general pattern on different innovation types remains constant (see Figure 3-4). However, the analysis shows notable differences in the frequency of implementing certain types of innovation between firms located in larger cities and small towns. Generally, it can be observed that all types of innovation are implemented most frequently by firms located in large cities. Interestingly, the data reveal that the differences regarding firm location are not too substantial. Data for large cities only moderately exceed indications for the German average. Likewise, it is important to note that firms located in small towns and rural municipalities frequently implement innovations that range from small scale improvements to first to market novelties – despite the relative lack of agglomeration advantages. Furthermore, it can be observed that the proportion of firms from small towns and rural municipalities that generate improvement and adaptation innovation is higher than in firms located in medium-sized towns.

3.3.3.3 Interaction and cooperation behaviour

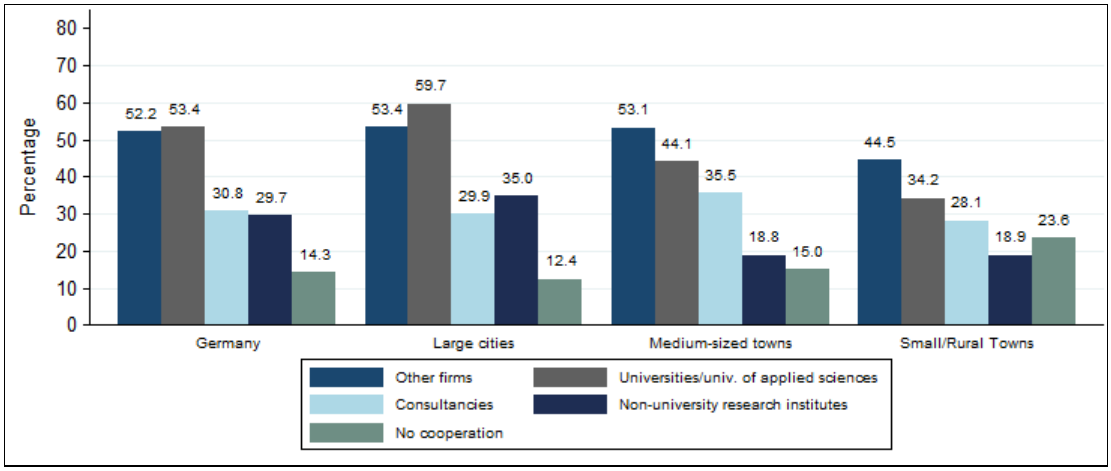
In the theoretical section we have outlined that innovation is broadly seen as an interactive process. Given the increasing (technological) complexity of innovation processes,

interaction and cooperation is ascribed an essential function in knowledge generating processes that induce successful innovation. Interaction with external actors functions as a central means to combine internal capacities with external expertise.

The IAB Establishment Panel differentiates a diverse range of potential partners firms might cooperate with in the context of R&D and innovation activities: other businesses, universities and universities of applied sciences, consultants (e.g. business consultants, engineering consultants), non-university research facilities and no cooperation (i.e. solely internal organisation of R&D and innovation).

Figure 3-5 suggests that R&D activities, treated as an approximation of innovation activities, do indeed constitute interactive processes. Data for the German average indicate that only 14.3 per cent of innovating firms have not cooperated with external partners as part of their R&D activities. Most frequently, firms have collaborated with universities (of applied sciences) (53.4%) or other commercial partners (52.2%). Collaborations with external consultants (30.8%) and non-university research facilities (29.7%) are of secondary importance.

Figure 3-5: Types of cooperation partners in R&D activities by types of towns and municipalities



Source: own calculations based on IAB Establishment Panel, wave 2017

Introducing the differentiation regarding types of towns and municipalities highlights that these patterns not only differ from the aggregate average, but further illustrate substantial differences on the specific cooperation patterns of firms located in large cities and small towns. Generally, the data demonstrate that the proportion of firms conducting R&D in isolation, i.e. based solely on internal capacities, is almost two times higher for firms in small towns (23.6%) than for firms in large city environments (12.4%). Furthermore, the

data illustrate differences regarding the choice of collaboration partners. While firms located in large cities prefer to engage in collaborations with university partners (59.7%) and other commercial actors (53.4%), firms located in small towns and rural municipalities most frequently liaise with commercial (44.9%) and university partners (34.2%). Interestingly, the data illustrate that the role of scientific collaboration partners gradually decreases with declining town sizes. Thus, firms located in small towns and rural municipalities collaborate less frequently with university partners and also non-university research partners such as Fraunhofer, Leibniz or Helmholtz institutes.

These indications of different collaboration patterns can be interpreted along a number of tracks. The regional economic structures between large cities and regions outside of agglomerations often differ as we mentioned earlier (Tödtling and Trippl 2005). Small towns and regions outside of agglomerations tend to be more oriented towards traditional economic activities and manufacturing, while business services and high-tech activities tend to be less important. Given these differences in economic structures, it can be supposed that collaborations with scientific institutions are less important as the demand of firms from outside larger agglomerations for scientific knowledge is lower. Also, it might be the case that firms from outside agglomerations have difficulties in mediating access to scientific partners, have a reduced awareness of the potential use of scientific knowledge for the firm's operations or generally lack experiences and, consequently, have higher reservations towards collaborations with research organisations. The latter aspect would point towards certain hurdles in the overall knowledge transfer landscape and suggest an insufficient spatial diffusion of scientific knowledge and approaches.

Besides differences regarding the role of scientific partners, Figure 3-5 further illustrates that external consultants, such as engineering offices, constitute relatively important collaboration partners for firms from small (28.1%) and especially medium-sized towns (35.5%). Assuming that due to sectoral affiliation, the demand for scientific knowledge might be lower for firms that operate outside agglomerations, external consultants that provide practical knowledge and problem-oriented (engineering) solutions appear as appropriate collaboration partners.

3.4 Conclusions

The main contribution of this chapter is to challenge the general focus on core regions in the geography of innovation literature. Therein, agglomerations are usually seen as the main source of innovation and economic dynamics. Small cities and rural municipalities do typically not enter this discussion because actors are assumed to suffer from organisational thinness and a lack of public knowledge infrastructure (Shearmur 2017; Eder 2018).

We contest this confined perspective by drawing attention to firms and ways of successful innovation outside of agglomerations in Germany. First, we have shown that a good share of a particularly successful and innovative group of firms, the so-called Hidden Champions, can also be found in these types of regions. Hence, there are indeed firms able to overcome the assumed barriers to innovation in peripheral regions or which might even benefit from specific advantages these locations provide. For these firms, geographical proximity to agglomerations is apparently less important for securing their competitive advantages and their ability to innovate. Second, with the analyses of the IAB Establishment Panel we have affirmed these indications on a broader level and highlighted differences regarding the interaction requirements and interactions patterns between firms from within and outside agglomerations. The chapter shows that associating the peripheral nature of regions with less innovativeness is misleading and that innovation activities take place across different spatial categories. However, these activities seem to follow different modes of innovation, result in different outcomes and are characterised by a lower intensity of formal R&D efforts.

Our empirical analyses support some of the theoretical and empirical arguments made in previous sections of this chapter, especially given the fact that firms outside of agglomerations generate all kinds of novelties. We have shown that the level of innovative performance of firms located in small cities – across all different types of innovation – is considerable and in fact not too far from the German average. Still we see a dominance of innovation in agglomerations that might indeed provide beneficial local or regional conditions or conscious location choices of firms particularly active in the development of new products. This finding confirms spatial differentiations of innovation modes according to the types of information and knowledge needed (Shearmur 2015). However, this should not be interpreted to mean that the conditions of locations outside of these environments prohibit innovation. Firms in 'peripheral' environments find different ways and adopt different practices through which a lack of agglomeration advantages can be compensated. This especially holds true for the firms' interaction and cooperation behaviour.

One major insight of this study is that firms in small towns conduct R&D and innovation more frequently without external collaborators. This implies that these firms might, overall, have lower interaction needs and build on internal capacities to higher extents – which might act as a substitute to frequent collaborations (Shearmur 2015). A further difference regarding the choice of collaboration partners becomes obvious. The data highlight that interaction with partners that provide access to scientific knowledge (universities and non-university research facilities) plays a reduced role for firms in small towns and rural municipalities. Thus, it can be assumed that the German research sys-

tem does not reach firms equally in all parts of Germany. Conversely, external consultants seem to be relatively important external partners. Their knowledge and expertise, such as practical knowledge and engineering-based problem solving, might be more attuned to the needs of innovating firms operating outside of agglomerations. On a final note, it should be stressed that the findings of our analyses apply for manufacturing firms in the German context. More research on innovation outside of agglomerations in different geographical and institutional contexts is needed to contribute to more differentiated perspectives in the geography of innovation literature.

Acknowledgements

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4 Great expectations – inconsistent delivery: universities in the regional development of England's lagging regions

David Marlow

4.1 Introduction

The roles of universities in regional development are important and multi-faceted (Trippl et al. 2015), but they vary widely by character of university, type of region, and the national systems in which they are located. This chapter describes university positioning and performance in two 'lagging' regions in England – the 'metropolitan' North East and rural Lincolnshire – from the perspective of a policy and executive practitioner (as opposed to academic).

Differential productivity performance of regions in England are amongst the most extreme in the OECD. To counter this there are increasing 'great expectations' of university contributions to innovation-led growth in these types of regions from national and local governments, businesses and communities (HM Government 2017). This chapter questions how far these expectations can be met in a predominantly national system of higher education and knowledge-based growth; and given the core characteristics and business models of the universities themselves.

The case studies suggest that, as a consequence, both Newcastle and Lincoln Universities are 'necessary' and major players in the local and regional turnaround – but they are far from 'sufficient'. It then considers the advent of Local Industrial Strategies (LIS) as a key foundation of England's approach to place-based growth and development. The LIS may offer an opportunity to redress these shortcomings – but only if they are accompanied by radical changes of approach by national and sub-national governments, universities and other partners.

In making the case for radical changes of approach, the chapter considers:

a) How the university itself defines and regularly refreshes its vision, strategies and priority interventions so that these deliver purposeful 'civic-ness' – as opposed to local impact being an incidental outcome of the university's size and scale;

b) The case for local and regional leadership teams to welcome 'disruptive' institutional role players – sometimes smaller universities – into decision-making structures and processes, rather than these processes running the risk of cosy conversations between incumbent anchor institutions;

c) The requirements of and possible shape of reforms of national systems to drive and incentivise local and regional impact, including some aspects of university policy being within the scope of devolved structures.

4.2 Background

4.2.1 Differential place-based challenges of productivity and innovation-led growth

In the UK, as with most of the more advanced economies, perhaps the major paradox and problem post the global financial crisis of 2007 and 2008 (GFC) has been that, despite huge technological advances, productivity growth has been sluggish and falling (Majumdar 2017). World productivity growth more than halved from 2006 to 2016, with rates in all G7 countries averaging below 1% p.a.

The situation in the UK is particularly acute. Within G7, output per hour worked was over 15% lower than the G7 average in 2016; and the difference between post-GFC productivity performance and the pre-downturn trend – was 15.8%. This is the largest in the G7 and almost double the average of 8.8% across the rest of the G7 (ONS 2017).

Analyses of the UK "productivity puzzle" and how to solve it are numerous and voluminous – across both academic and policy literature. Cyclical and structural factors such as 'labour hoarding', underinvestment, overprotecting the 'long tail' of low productivity organisations and industries stress firm-level and national policy causes (Office for Budget Responsibility 2012). A slowing of the rate and take-up of innovation associated with total factor productivity improvements has been argued to account for a high proportion of the productivity growth slowdown, and to operate at both technological and institutional levels (Jones 2016).

However, alongside technological, firm and institutional-level analyses, there has been an increasing focus on the wide inter-regional disparities in the UK. Interregional differentials are amongst the largest in the EU and OECD. For instance, in 2016 GDP per capita the region Inner London West had the highest NUTS2 regional average in the EU at 711% of the EU average, with the whole London NUTS1 region at 219%. Concurrently, two NUTS1 regions (North East and Wales), and six NUTS2 regions have scores below 90% of average, comprising six of the eight poorest performing regions of Northern Europe by this measure (Eurostat 2017).

These gaps across many metrics between London and the South East on the one hand, and the rest of the UK has been enduring and increasing. This 'decoupling' of London and the Greater South East suggests that growth is unlikely to 'trickle down' or out from

the world city region (McCann 2016). Consequently, the importance of unlocking indigenous regional and local potential has increased.

This is recognised most recently and explicitly in the UK government's Industrial Strategy (HM Government 2017). Whilst still largely a list of national policies and programmes, the strategy explicitly suggests that centralisation has been part of the UK's economic growth and productivity problem. The analysis outlines five foundations for productivity improvement – ideas, people, infrastructure, business environment and places. It recognises that all areas need to participate in and benefit from the national Industrial Strategy. It expects local areas to develop Local Industrial Strategies (LIS), led by elected mayors and Local Enterprise Partnerships (LEPs) – focusing on that areas' distinctive assets, strengths and potential. And it suggests strongly that universities have key roles and functions in both the formulation and delivery of the LIS.

In summary, therefore, the UK has a productivity problem in general, that is exacerbated by chronic, enduring underperformance in many places outside 'hot-spots' in London and the Greater South East. The problem requires innovation-led growth as a key part of the solution, and universities are expected to be major contributors to this process.

4.2.2 Universities, innovation-led growth, and place-based development

The higher education (HE) sector in the UK is large and diverse. It comprises well over 300 institutions. These range from designated universities (of which 133 are members of Universities UK [UUK]), through colleges of higher education, further education colleges offering degree courses, to overseas universities with UK campuses, to private universities.

Universities range in size from two 'mega-institutions' – the Open University (around 170,000 students) and the University of London (around 130,000 students) – down to small specialist colleges, some with less than 1,000 students. The average university size is around 15,000 students with around thirty having 25,000 students or more.

Similarly, the character of higher education institutions (HEIs) are extremely varied. Most will combine teaching, research and 'third mission' (i.e. support for businesses, consultancy etc.) activities, but the balance between these types of activity is wide. There are a number of typologies of universities and 'mission groups' that typically represent cohorts of HEIs – from globally-significant research intensive (Russell Group), to economic and business facing (University Alliance), to groups representing distinctive cohorts across the sector (e.g. Cathedrals Group, GuildHE, Million+).

The UUK "Impact of Higher Education on the UK economy" study (UUK 2014) describes a sector with £73bn of economic output, generating over 750,000 jobs, 2.8% of GVA, and £10bn of export earnings. To put this in context, the university footprint as an economic sector is akin to that of chemicals, automotive, aerospace and pharmaceuticals combined.

Many major universities and university mission groups undertake impact analyses (e.g. London Economics 2017) These tend to confirm larger HEIs amongst the largest economic role players (top 10 or even top 5) in their cities and sub-regions. Impacts include direct employment; spending; attraction and retention of talent; provision of business support; cultural, sport, and transport provision; drivers and multipliers of economic activity – skills training, qualification of doctors, teachers etc., and positioning issues such as profile and reputation of places in both national and global markets.

More ambiguously, high university and student footprints are sometimes associated with housing pressures (especially for affordable housing), traffic and congestion, acquisitive real estate demands, anti-social behaviour, and examples of social cohesion pressures – both intra-(international) student and sometimes student-local (town-gown) tensions.

So, universities are crucially important to place-based development, and development options may be precluded in places without universities. Many impacts are positive, but there are externalities from large HEIs that need to be managed effectively (Marlow 2015).

Positive impacts have made universities archetypal 'anchor institutions' in UK policy debates about large, spatially immobile, strategically significant institutions with some social purposes in their mission. Policy development has sought to determine how to maximise benefits of, and increase collaboration between, anchor institutions in cities and regions.

In the UK, the Industrial Strategy and intentions for the LIS may be seen as the culmination of several major anchor institution investigations and policies. These include the Cities Growth Commission's UniverCities report (2014), the government's 'Witty report' (2013), their encouragement of university involvement in Local Enterprise Partnerships (LEPs) to promote local growth, to several major HEFCE programmes (the government university regulator until its closure in 2018) to incentivise university collaboration with local authorities and other anchors. This trend continues with, for instance, the inception of a well-regarded 'Civic Universities Commission' due to report in late 2018.

How universities deliver these innovation-led, place-based growth outcomes purposefully has been rooted academically in the 'civic university' work of John Goddard of Newcastle University, and related analyses. In 'Connecting Universities to Regional Growth' (Goddard and Kempton 2011), he describes four major contributions of the university anchor to local and regional growth. These are research and innovation (through science parks, research and innovation centres etc.); business growth (network and cluster support, international linkages, intellectual property generation etc.); skills and human capital (teaching, talent attraction and retention etc.); physical and cultural (placemaking, widening participation etc.).

His work on the civic university (Goddard and Vallance 2011) which universities such as his and Sheffield, for instance, have adopted in their core mission, outlines major challenges of universities as autonomous institutions, with often fragmented academic and administrative departments operating within national policy and global market systems. The 'civic university' seeks to deliver local impact purposefully – as opposed to it being an 'incidental' outcome of its activities. He defines the characteristics of the 'civic university' as **actively engaged** on a **holistic** (whole-institution) basis with a **sense of place**; local **sense of purpose**, willing to **invest**, transparent and **accountabl**e, and using **innovative** methodologies to progress that engagement (my emphases).

This orthodoxy – i.e. that civic universities can be broadly positive for the places where they are located, and that positive outcomes can be increased by better anchor institution collaboration – is now a relatively pervasive foundation of UK local growth policy prescription. These roles are considered particularly important in underperforming areas (Benneworth et al. 2017). Where business and capital are thinly spread or very narrow, the university may be the major, if not only, player able to operate consistently at scale in relatively weak innovation-poor eco-systems (Goddard 2013).

However, at the same time, the evidence that universities are discharging these roles purposefully and consistently is contested. Morgan (2007) characterises research intensive universities in low capacity, less-developed regions as 'cathedrals in the desert'. They are much more likely to operate nationally and globally than locally, and their links to their regional innovation system can be weak and limited in scope. More recent empirical analysis (Brown 2016) suggests that the pervasive civic university policy orthodoxy is not matched by local and regional impacts – especially in less developed areas, where the absorptive and translational capacity for university R&D may be low.

4.2.3 Barriers to the university roles

Whilst civic university models as a sub-set of anchor institution orthodoxies are, therefore, well-recognised in the policy context for innovation-led, place-based development, achieving positive outcomes in practice is much more problematic. This 'civic-ness' requires purposeful choices by university leadership and the broader 'academy' itself, a willingness of local and regional leadership teams to welcome and embrace these university roles, and, most importantly, needs to be enabled by national and EU HEI and innovation policies and systems.

The internal tensions facing a mission-led civic-ness are deep and broad (Kempton 2016). Both institutional and individual incentives and drivers for global research excellence, and latterly student satisfaction, exist detached from local and regional innovation systems – particularly where these are narrow, lacking multiple hooks for absorbing or shaping university activity.

Exacerbating the internal logic of the institution, local and regional systems (in England at least) are multi-layered, complex, and sometimes incoherent administrative geographies – making the 'places' where universities operate arbitrary, contested and shifting. Efforts to build synergies between particular characters of universities and different, highly nuanced capabilities and potential of place(s) is challenging and time consuming. It stretches the capacity and commitment of both the university and local leadership teams. This is especially the case in England, where university responsibilities and accountability for their externalities are modest and voluntary. Moreover, as they are normally 'charitable institutions' in legal terms, HEIs receive a favourable local taxation treatment that significantly reduces the financial contributions they make to their cities and regions.

Finally, UK innovation policies have tended to be place blind. The largest proportions of both public and private investment in research, development and innovation (RD&I) occur in London, the South East and the East of England – 62% of the 2016 R&D total (ONS 2018), with four institutions in London, Oxford and Cambridge – 'hot spots' typically accounting for over 30% of government funding.

Augmenting these structural institutional and policy barriers, in Britain after the EU referendum a narrative has evolved, particularly in 'left-behind' places that voted for 'Brexit' in the 2016 referendum. Universities as unaccountable 'remainer' institutions, led by 'fat cat' vice chancellors, full of privileged 'experts' disdainful of their civic neighbours and communities (Marlow 2017) is now the norm rather than exception in the national and local media.

With both the case study regions exhibiting many of these 'left behind' characteristics, they present useful urban and more rural landscapes on which to test and apply the context as outlined – albeit both cases in this chapter are necessarily high-level overviews.

4.3 Cases

The cases below are based on the author's involvement as a practitioner in both regions, together with relevant secondary research of published material. In the North East the author has been a consultant and a visiting professor at Newcastle University over the 2013-2018 period, dealing, inter alia, with the North East's Smart Specialisation strategy. At a Lincolnshire business, he has operated in the Lincolnshire knowledge economy since 2009 and is a member of the Greater Lincolnshire Innovation Council.

4.3.1 Newcastle and the North East

The North East is one of nine English (NUTS1) regions, and on most standard economic metrics performs the poorest of the nine. It has a population of 2.6m, £51bn GVA, with per capita income 20%, and productivity 10%, below UK averages. There has been no major convergence with more successful regions (in the UK and Europe) in the last decade. The region is anchored by Newcastle, which is a core city with a city region population of around 600,000.

The North East can be characterised as a generally low wage, low skill economy. But it does possess significant national clusters in automotive (NISSAN), chemical, offshore, professional business and financial services, and healthcare industries. It has five large HEIs – two research-intensive ones in Newcastle and Durham Universities. The two HEIs in Newcastle city itself – Newcastle University and Northumbria – teach over 50k students (almost 10% of the core city population), and they are major players in most aspects of city development.

This case focuses on Newcastle University (NU) as a large, research-intensive, Russell Group university in the centre of the region's core city. NU has positioned itself explicitly as 'a world class civic university: excellence with a purpose' (Newcastle University 2012) so is well-placed to test the hypotheses stated above. In many senses NU does appear to play the archetypal positive roles one would expect from universities committed to innovation-led, place-based growth.

With over 26,000 full-time enrolled students and 6,000 staff (the fourth largest employer in the North East and 6% of all jobs in the city), NU demonstrates strong talent attraction and retention roles for the regional and city economy (Newcastle University 2017). Of

NU's £1.1bn GVA impact nationally, over £750m accrues to the North East, representing over 2% of regional and 3% of city region GVA. It is represented at all partnership-based leadership 'top tables' - firmly established as part of the incumbent local elite. It has an extensive major campus and student housing in the city centre, and innovation assets throughout North of Tyne – anchoring enterprise and development zones. Its global capabilities in societal challenges of sustainability, aging, and social renewal are recognised as national innovation centres, nurturing strong links with global and local businesses.

The university engages in some delivery of public services and public research agendas – including big data and sensor coverage in some city neighbourhoods. NU has convened and hosted 'Newcastle City Futures' (NCF) as a partnership vehicle for mediating and enabling a long- term vision for the city/city region (Tendwr-Jones et al. 2015), and for developing intervention strategies for transformational change to Newcastle as a 'smart future city'.

However, alongside the positive metrics, the ambiguities of the civic models are also present. 'Civic-ness' in the visioning and strategic planning documents is almost always defined in terms of responding to **global** societal challenges – rather than offering specificity on roles and responsibilities the university is prepared to discharge for the city and the region. Excellence is measured largely in national REF (Research Excellence Framework) and TEF (Teaching Excellence Framework) terms.

As predicted in the context above, it is very difficult for local and regional leadership to articulate consistent 'offers' and 'asks' of the university. The North East leadership and governance is highly fragmented and incoherent – and often conflictual. For instance, the impending advent of an elected executive mayor for North of Tyne actually separates the city council geography from Gateshead – its most relevant neighbour in city region terms. As a result, it is genuinely difficult for NU to position itself regionally, and, in response, the internal dynamics of the university may define local relevance as almost always having to be on the university's own terms – i.e. because it is in NU's best interest.

The processes for resolving significant tensions between NU and city populations on some issues – e.g. housing, employment, land development etc. – is therefore fairly piecemeal and tactical. Indeed, NCF – a vehicle that might have evolved institutionally to put these relationships on a deeper and more strategic deliberative footing – is struggling to attract both university and city support in the aftermath of the ending of government funding for the project as part of the national Urban Living Partnership pilot programme.

NU is only one of five universities in the North East together with one smaller specialist College of Art & Design which operates in both further and higher education sectors. Most of the academic and policy work tends towards singular university relations to place. Perspectives on the more normal pattern of multi-university configurations in specific cities and regions are described and prescribed much more superficially.

Each of the other five-six HEIs deliver significant innovation and economic impacts, much of it positive, often outlined in the fairly standard impact reports which are part of the PR armoury of the sector. However, there has been little consideration of whether the collective impacts add up to part of a coherent regional change strategy in any, let alone optimal ways.

'N8' – a collaboration of Newcastle and Durham, with six other research-based northern universities – follows a more mission group pattern. They cover the whole of the North of England – three regions with a collective population of over 15 million so this hardly amounts to a nuanced place-based collaboration.

For the North East five (or six), each university relates to different leadership, governance and civic structures locally and regionally – and they are as likely to be competing as collaborating over city and regional priorities, programmes and student numbers. Certainly, all universities are more concerned with managing Brexit and national reforms as institutions – before focusing on managing these issues holistically with partners on a city or regional basis. In summary, even the most self-avowed of civic universities in a major urban area appears to exhibit both the positive points and shortcomings that contextual analysis predicted in terms of contributions to place-based innovation-led growth – necessary, a high profile and generating 'great expectations', but these being very far from being sufficient and optimal.

4.3.2 The case of Lincoln and Lincolnshire

Greater Lincolnshire is a geographically large, 1.1m population, £22bn GVA sub-region in the East Midlands, stretching from the outer limits of the London mega-city region/Greater South East in the south, to the South Bank of the Humber and Yorkshire in the north. Its per capita GVA and productivity are up to 30% and 15% below UK averages respectively (so even worse performing than much of the North East); and there has been no major convergence with national averages in the last decade.

The area is largely rural and sparsely populated, with a long coastline on the East Coast. There are no major agglomerations. Lincoln – the biggest city – has a population of around 120,000 and is just outside most typologies of the major UK cities (e.g. the 'top 65'). Greater Lincolnshire may be characterised as a low wage, low skill, (and much more

starkly than the North East) low innovation economy. However, there are small but significant clusters in engineering (SIEMENS) and food and drink (production and processing).

The region is traditionally a university 'cold spot'. If it had average UK HE densities one might expect +/-40,000 students across the region. In recent decades two new universities have been designated. The University of Lincoln (UoL), established in 1992, has grown rapidly to 15,000 students; and Bishop Grosseteste (2012) is a small specialist HEI with only 2,500 students. Overall, however, the region has a large outwards migration of talent and young people.

This case will deal mainly with UoL. UoL was established on a prime city centre site in 1992, very much an initiative of the city and county councils of the area – so with a strong civic pedigree. Although initially a satellite of Humberside University, it quickly overtook its parent and adopted its current identity and HQ in the city in 2001/02.

UoL has seen impressive rapid growth and progress in both student numbers, profile and reputation, and offer to the local and regional economy. It was awarded TEF gold excellence for teaching and was designated a top 50 HEI in 2016 rankings. It opened the first new engineering school in the UK in 20 years with Siemens in 2011; established the National Centre for Food Manufacturing in rural South East Lincolnshire; and has a new medical school approved for 2019. It has developed the city's first large science and innovation park adjacent to the main city campus.

A recent impact study (Regeneris 2017) estimates GVA impact at over £100 million p.a. for the city with over 1,500 jobs; and about double this impact for the UK as a whole. This amounts to about 5% of city GVA. More strikingly, Regeneris estimate that more than one in every 6 persons of working age in the city are either a student, an employee or their job is indirectly linked to the university.

The Vice Chancellor is a major player in local leadership teams – often in an 'honest broker' role; and has an increasing regional and national profile. The university's improving national and international profile and reputation is a major factor in countering Lincolnshire's image as rural backwater. The university is often presented colloquially as "the best thing to happen to the city since the Romans" (when Lincoln was second city of England after London).

UoL's recent history has some similarities but significant differences to NU. The university is certainly civic in its genesis (initially local authority-led); and UoL embraces major responsibilities for Lincoln's future success (and for the wider area to some extent) in its priorities like the engineering school, science park, medical school, and in its focus on agriculture, food and drink relevant to the rural areas. UoL has definitely been a radical

disrupter and transformational change agent of the city – arguably in advance of both Lincoln's and Lincolnshire's political leadership (which whether Conservative or Labour has been relatively traditional in character).

UoLs very rapid growth does put pressures on city land, housing, and infrastructure, which in a much smaller city than Newcastle is arguably more difficult to accommodate without town-gown tensions. Moreover, much of UoLs growth has been funded by debt. Dependence on the long run growth of student fees (to repay loans) means this pace of expansion must continue. There are high risks that the national system and Brexit will not be able to enable this.

The current strategic plan (University of Lincoln 2016) positions the university much more in terms of global rather than local challenges (although obviously the two are related). It describes an institution that has learnt from its Lincoln and Lincolnshire genesis, so it is now able to be a "thought leader for HE able to adapt to the changing needs in our world".

The UoL case is interesting. In its infancy, it certainly presented new dynamism and radical changes into a peripheral rural region and its main city. However, is in its adolescence and maturity, UoL's development trajectory to become more like NU – part of local elites responding to the national system, rather than continuing to be a disruptive transformer?

Moreover, Lincoln and Lincolnshire's sub-regional political leadership has always been weak and divided. A small city – often led by the Labour Party – is surrounded by a large, normally conservative rural county in a two-tier area for English local government. Building cohesive political leadership is further inhibited by the large extended geography and its divergent interests – from South Lincolnshire looking to London and East Anglia, to the South Humber looking North, to the small Lincoln city region part of the East Midlands, and the highly peripheral (and aging) coastal communities. A recent devolution agreement with the government (HM Government 2016), which might have put the sub-region at the forefront of England's intermediate structures for growth and development, collapsed shortly before inception in 2017 when two of the nine local authorities rejected the elected mayor model.

In these local and sub-regional tensions, UoL can often be one of the clearest and most influential voices articulating and mediating strategic priorities. But it almost inevitably, given the national pressures on the institution described above, will need to do this in a way that meets its own institutional needs first (e.g. for city centre real estate or public investment funds) even where this might be sub-optimal for either the city or the sub-region.

4.3.3 Tentative case study lessons

NU and UoL appear to confirm the propositions outlined in the academic and policy overviews above. For the proponents of the civic university as necessary for innovation-led growth in lagging places, NU and UoL play major, often dominant, roles in the innovation ecosystems and economic development landscapes of their respective cities and regions. They host game-changing assets and many of the capabilities of that landscape.

Beyond their direct impacts, they are also key institutional role players in moving cities and regions from 'disconnected' to 'connected' in terms of mediating and building cohesive relationships between government, business and academia (Goddard and Kempton 2011 ibid). This was the explicit role of Newcastle City Futures, and the implicit impact of UoL as a new and rapidly growing insertion in a previously very innovation-poor landscape.

However, the two cases also demonstrate the civic university contra-indicators – the tensions within the HEI itself, the underdeveloped leadership and absorptive capacity issues locally, and the predominance of national and global drivers over the local and regional – the 'necessary but far from sufficient' propositions.

Arguably in lagging regions, particularly given the prevailing post-GFC strategies of public austerity, this university is 'too powerful' – almost a monopolistic player in its innovation activities. This has the additional impact of exacerbating tensions with the local government and communities in university demands for real estate, student housing, other enabling infrastructure which contributes to the negative university 'remainer (anti-Brexit), out-of-touch' narrative.

It has also stimulated considerable national concerns of how the system will manage university institutional failure in 'left behind', vulnerable places which are already going to be under intense pressure as the UK proceeds with Brexit (Goddard et al. 2014).

The trauma of failure of a large university anchor, even for a metropolitan area like Newcastle (and other core cities) let alone a lagging rural region like Lincolnshire, is very different from the likely impact in London. In London, even the global university giants (like UCL and Imperial) are only one of over thirty HEIs and a huge number of other global innovation players. In Newcastle, NU is one of a very small number of major players. In Lincolnshire, UoL is almost the only player in some areas of economic activity.

4.4 Mitigating the tensions of inconsistent delivery

If the HEI is necessary but far from sufficient, this raises the questions of how to address the tensions and limitations identified – and how in particular to do this in the impending context of the UK's direction of travel post the Brexit referendum.

4.4.1 The university in its context

A first step concerns the university itself internally, and how it interfaces with its local and regional landscape. Universities need to refresh their civic and social purposes regularly. These "refreshes" should make the local and regional dimensions of their purposes much more explicit, and the process of determining them should be conducted in partnership with local and regional stakeholders – government, business and community.

One example of such a process that could provide this type of opportunity for NU and UoL is the University of Warwick's Chancellor's Commission of 2015-2016. On the 50th anniversary of its establishment (in 1965), the University of Warwick (UoW) established an independent commission chaired by its chancellor to consider the university's future roles and functions in Coventry, Warwickshire and the Midlands. This was at least partially in recognition of the university's extraordinary success in its first fifty years (from a 200-hectare greenfield site in 1965 to a 24,000 student, UK top 10 and global top100 Russell Group university) that had been partly achieved by disconnecting from and transcending its local and regional context. This resonates with some of the pressures observed in the UoL case after 20 years.

The Chancellor's Commission final report (University of Warwick 2016) sets out a framework and process for defining university relationships to place, and then applies this for UoW. However, the general applicability of the framework is powerful. The framework suggests university local engagement around three modes of intervention – leadership, partnership and citizenship. Strategic questions universities may wish to deliberate with other partners – say, in a quadruple helix formulation – might include:

- Leadership
  - What is/are the university's local and regional vision/mission(s)?
  - How does it participate in local leadership teams?
  - Is there an agreed agenda of priority areas where the university may play direct leadership roles?
  - How is the university contributing to thought leadership, research and development in meeting societal challenges, stimulating local growth, and supporting public services reform?

- Partnership
  - Are local and regional partners aware of existing university programmes and projects, their local and regional impacts, and how effective these are?
  - Are local authorities, other local partners and stakeholders involved in the selection, design and delivery of priority university interventions locally?
  - Does the university work with local partners on the promotion, profile and reputation of the place they are located nationally and globally?
- Citizenship
  - Do local communities have access to the campus, facilities and services of the local university, and how else does the university seek to improve the wellbeing of neighbouring communities?
  - How does the university's widening participating programmes play into local learning, education and skills priorities?
  - How does the university recognise and proactively manage the externalities it creates (e.g. on local housing market, transport etc.)?

Rather than the steady stream of impact studies universities seem compelled to produce to demonstrate their local and regional contributions, this type of exercise (adapting the questions to local and regional context) would surely be extremely helpful for NU and the North East, UoL and Lincolnshire as they navigate through impending changes in the UK.

4.4.2 Universities in leadership and governance of place

The second prerequisite for a more optimal university impact in lagging regions concerns the configurations and processes of local and regional leadership itself. Even if the large university anchor has embraced its 'civic-ness', a modus operandi where city and regional leaders of large anchor institutions meet to 'do deals' might be diagnosed as one of the contributors to the breakdown of trust and confidence in the motives and methods of anchor institutions in contemporary Britain (Brewerton and Marlow 2018).

The interests of the anchors around the 'top table', including the university, will always form the major focus of deliberative exchange, mediating respective priorities, and determining strategic direction – rather than starting with the interests of the place. The institutional self-interest of large anchors suggests the need for new approaches to city leadership to mitigate 'group think' and cosy backroom 'deals'.

Figure 4-1: Towards new forms of city leadership

Source: Brewerton and Marlow (2018, ibid)

Cities and sub-regions, especially in lagging places, need to make the most of their large anchor institutions for the reasons outlined. But they should also understand, welcome and involve 'loosener' institutions – smaller, sometimes disruptive, challengers. These can be equally passionate about and committed to place – but more agile and flexible in experimenting and demonstrating new approaches.

The Brewerton and Marlow provocation includes the hypothesis that too often models of collaboration assume a single dominant anchor HEI on whom collaborative activity is focused in the bottom left hand quadrant of Figure 4-1. Certainly, if one re-reads the UoW chancellor's commission report, all the 'easier' suggestions are in that quadrant.

However, as illustrated in the cases, different configurations of HEIs in local places need to develop synergies in their respective contributions.

The actual situation in the North East and Lincolnshire in terms of university anchors is quite complex, albeit relatively typical. It includes: the single dominant HEI and much smaller, perhaps specialist institution as with UoL and Bishop Grosseteste University; the two-university city as in Newcastle – with NU more research-intensive, and Northumbria more teaching-oriented; and the multi-university city or region, as with the North East as a whole.

Universities need to consider how regional associations develop beyond tactical alliances of convenience to meet local and regional challenges of the 2020s, and how they will add value to new and emerging forms of city and regional leadership and governance in all four quadrants of the Brewerton-Marlow matrix.

Smaller, specialist HEIs might well have a role to play as 'looseners' in this more inclusive approach. For instance, in the North East, Cleveland College of Art & Design is a very small HEI, but it has specific pedagogic and participatory approaches that are very different to large anchor university orthodoxies. Even in Lincolnshire, arguably, the distinctive role that the smaller new HEI – Bishop Grosseteste University – might play has not yet been discussed and developed, let alone agreed upon by the two universities and local leadership teams.

4.4.3 City and regional leadership and governance development

A more activist and tailored approach by universities, though, will achieve progress only if local and regional leadership teams are welcoming and engaging with it. Too often, local authorities are territorial and defensive with regards to their administrative geographies, and they have a longstanding distrust and scepticism of intermediate tier institutional arrangements and partnerships working at that tier (Marlow 2014).

The emergence of metro-mayors might offer an opportunity for new forms of engagement. They have the sub-regional democratic legitimacy and some powers devolved from the central government to experiment with them. This is an important area of policy and practice worthy of further work, but it is 'early days' and very much a work-in-progress. Moreover, although a mayoral combined authority is imminent in Newcastle (April 2019), it only partially covers the city region. And no such entity is likely in Greater Lincolnshire in the short term.

Strategically, there are also important issues of how to enable holistic, integrated, mutually-reinforcing approaches. Even if the quadruple helix processes in innovation are purposeful, a whole-system approach is required. 'Fishing in one particular theoretical pond…' (Rodriguez-Pose and Wilkie 2018) is a 'strategy of waste' if it cannot draw on and influence skills and education, physical planning and infrastructure investment, capacity-building for institutional effectiveness in delivering interventions in these and complementary 'development axes' of activity relevant to redress lagging regional performances.

One of the key potential roles of the university can be to bring the rigour of robust academic analyses to these issues, and to facilitate the 'difficult conversations' those analyses suggest. This was part of the landscape that Newcastle City Futures tried to explore. However, it takes very bold university leaders, trusted and valued deeply by partners, to enable and animate this type of reflective process successfully, as NCF has found. The risks to the university institutionally of failing in this endeavour (e.g. when they next apply for planning permission or financial assistance) are often too high for them to even attempt it.

4.4.4 Reforms of national systems and enhanced devolution

Despite the civic genesis of many of the UKs greatest and newer universities – including NU and UoL – the HE system is overwhelmingly determined nationally. It also tends towards being strictly bounded. National separation is the norm when it comes to linkages between HE policy and wider education and skills reforms, or between skills and national innovation systems. Moreover, even where the government has encouraged universities to engage locally (e.g. at the top tables of Local Enterprise Partnerships, or through place-based programmes like the Local Growth Fund and University Enterprise Zones), these policies remain fundamentally about local leadership teams bidding for resources from government policies and funding, assured and determined by national departments and agencies.

The types of radical local reforms therefore need to be accompanied and incentivised by a recalibration of national and local policies towards higher education.

In terms of regulatory policies, there are no a priori reasons, for instance, why Teaching Excellence Framework (TEF), Research Excellence Framework (REF), and the proposed Knowledge Exchange Framework (KEF) cannot provide incentives for local relevance alongside global excellence.

However, if a government is inclined to enable local and regional relevance more powerfully, they could incorporate HE policy and practice into devolution 'deals' and agreements. For instance, the RSAs 'Univercities' report (RSA 2014 ibid) made proposals concerning topics like curriculum, student fees, and international student visas in this regard – in addition to a greater regionalisation of innovation programmes and funding.

National policy should also break down policy silos between HE and the rest of the education and skills system to encourage ease of ladders of progression, and business involvement in linking technical, managerial and employability skills and aptitudes.

Arguably in these respects, the government's Industrial Strategy is a missed opportunity. Expectations of universities are high – but predominantly within existing business models and trends. Fundamental reforms of HEIs as institutions and of place-leadership are not proposed, although the newly-elected 'metro-mayors' might have the legitimacy to experiment with them. It will be interesting to see if any of the elected mayors or other local leadership teams seek to progress these agendas in their Local Industrial Strategies, the first of which are due in 2019. If they wish to seriously address the productivity and innovation challenges, especially in lagging regions, the case for them doing so is strong.

4.5 Conclusions

4.5.1 Issues of UK policy and practice

This is explicitly a policy paper. Its main conclusions are policy-oriented suggestions.

First, the argument over the importance of universities to placemaking in general and to innovation-led growth in particular, and the amplified importance of this in lagging regions, is largely won. It is prominent in government thinking and practice, and in the way that universities are increasingly engaged in local and regional policy-making and programme delivery. The, admittedly high-level, NU and UoL cases are useful illustrations of impact and influence in both metropolitan and rural lagging regions. However, all university impact studies confirm high HEI local significance.

Second, however, the institutional logic of the universities themselves, combined with the predominantly national drivers of the HE system, mean that large impact is NOT evidence of 'civic-ness'. Indeed, in many cases the impact is more likely to be incidental than integral to the vision and mission of the institution. The future civic university needs to be defined by how its purposes and interventions contribute to and are shaped by the places where they are located, and the communities on whom they have most impact – NOT solely by the needs of the universities themselves as institutions. In this respect, the current strategic and business plans of NU and UoL would be enhanced by a much clearer, explicit statement of local and regional purposes agreed with a quadruple helix of major local and regional role players (i.e. government, business, community, and other local HEIs).

Third, even where universities have large, purposeful local and regional impacts, there is some merit in considering whether the character of these interventions reinforce or disrupt the status quo. This is particularly important for lagging regions. For instance, a science park or innovation centre might significantly improve economic metrics of a region in GVA terms, but if it exacerbates inequality and delivers exclusive rather than inclusive growth it will have negative regional development impacts that need to be managed and mitigated.

The major interventions of both NU and UoL have certainly enhanced the indigenous assets and capabilities of their regions. But, without integrated, multi-faceted, complementary strategies, they will not transform the prospects of disadvantaged and excluded communities, or the long tail of lower productivity businesses in their regions. To illustrate this narrowness of intense impact, the UoL economic impact report (Regeneris 2017 ibid) calculates a £100m GVA impact of the university on the city of Lincoln (around 5% of

GVA), but only an additional £10m for the Greater Lincolnshire sub-region with a GVA of over £20bn – so miniscule.

The amplification of university benefits in lagging regions will need to be, at times, disruptive to the status quo (effectively of existing 'failed development trajectories), at scale, and part of a whole system approach to local and regional development. The disruptive component may require welcoming 'loosener' institutions and 'challenger' HEIs into the city and regional leadership and governance. The NCF project represents an attempt by NU to provide this loosener/challenger for the city region, but it has struggled to gain continuing strategic support from one of the most long-standing 'civic' universities in the UK. Whether large, research-intensive HEI anchors can play this role is questionable.

Smaller, specialist HEIs might sometimes be better-placed to play these types of important, positive, transformational change roles in place-based industrial and inclusive growth strategy, social mobility, education and skills reforms. However, this needs further and more robust investigation; and will require changes in approach from local leadership teams dominated by large anchors (including the dominant university).

However, most important of all is the requirement for changes in the national policy context if universities in lagging regions are to meet the 'great expectations' placed upon them. The chapter makes a series of suggestions to this end. However, by far the most important both conceptually and practically must be to identify some areas of HE policy that are 'in scope' for new devolution arrangements. Conceptually, HEIs can only meet the great expectations of their cities and regions if they are, in some senses, accountable to them. This requires those places to have some autonomy of powers and resources with respect to HE. Practically, these powers and resources must be of sufficient scale to enable cities and regions to intervene effectively to shape and steer those aspects of HE policy impact.

It is relevant that England's current devolution agreements and deals have eschewed any such terms. Nor has there been any serious advocacy for them from the HE sector, which may be deeply suspicious and sceptical of mediating sub-national strategic priorities within their challenging national and global HE market-places.

The Industrial Strategy's approach to 'place' also gives little confidence that HE will be in scope, or that concerns about place will trump national ambitions for the other four foundations of the strategy – ideas, people, infrastructure and business environment. Nevertheless, the process of formulating Local Industrial Strategies could address these issues. Where they are a priority for the incoming metro-mayors they may get some traction with the government, and most of the metro-mayors are in regions that would tend to be classified as lagging on national and global metrics.

4.5.2 Recommendations for further academic work

Despite the policy character of this paper, it is appropriate to finish with some suggestions for further academic research and development, and a comment on read-across to European and EU policy issues.

Too much policy and practice for university roles in innovation-led place-based development is founded on standard models of a single, dominant, probably research-intensive anchor that can be incentivised to contribute positively either because of its internal values or for external instrumental reasons (e.g. planning permission, grants etc.).

Much further academic work is required to unpack this. Robust research which explores 'what types and configurations of universities work better in what types of places with what package of policies?' will be particularly valuable for England going forward.

This research will be strengthened if it develops the concept of 'loosener' and 'challenger' institutions, the circumstances in which disruptive interventions are required, and how city and regional leadership can support radical change that challenges their own institutions.

This sits alongside a more critical assessment of anchor institution collaboration – especially where this is the transactional doing-business of cosy local elites. Given their significance, under what circumstances can large, traditional, research-intensive global HEIs become disruptive challengers? And where they can't, can smaller specialist HEIs be encouraged and supported to play these roles?

This work needs to recognise the complexity of multi-level sub-national geographies, and their relationships to national (and in some cases EU) policies.

4.5.3 Tentative insights for EU policy and practice

This chapter has neglected the EU dimensions of the 'great expectations' debate – but they are hugely significant. The role of EU structural funds in Newcastle and Lincolnshire has been critical in delivering the infrastructure assets on which the university-led innovation eco-systems are founded. How this will be replaced in the 2020s – by a Shared Prosperity Fund (amongst others) – will be a major determinant of the future prospects of the North East, Lincolnshire and other lagging regions in England.

However, the England case studies also raise read-across for EU post-2020 programmes and priorities. Increasing levels of alignment and synergies between EU structural funding and R&D programmes was a strong ambition of the 2014-2020 programmes

(European Commission 2014). Yet the English experience suggests the collision of research excellence with structural fund underperformance has tended to benefit better-off regions and has not been of significant scale or character to reverse divergence.

As the EU designs its future intervention strategies, and as approaches like smart specialisation (S3) evolve, the English experience will be relevant – even if the UK is no longer shaping the EU's strategic approach.

The need for EU instruments to embrace holistic place-based mutually-reinforcing approaches across the development axis, supporting national governments in doing the same, can be an important contributor to redressing the types of national drivers that have thwarted and distorted university contributions in England. Recognition of the importance of challenger, 'looseners' as well as traditional research-intensive anchors, and encouraging traditional anchors to behave in more disruptive ways, may be helpful. And building the capacity and commitment to address and resolve town-gown divides is crucial to turning around the emerging negative university-elitism narratives.

That narrative has gained traction at least partly because, especially in lagging regions, great expectations have been accompanied by inconsistent delivery. What this chapter seeks to illustrate is the converse. In lagging regions, probably more than anywhere else, more modest expectations of universities, in new mutually-reinforcing, joined-up development strategies including some disruptive radical elements and role players, are the foundations on which great delivery of the future will be built.

4.6 References

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5 South Moravia: from a quick fix by foreign investments towards a bottom-up policy learning?

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5.1 Introduction: specific challenges of a recent economic and institutional evolution in Czechia

Czechia, like other Central East European countries, has undergone a fundamental transformation since the reintroduction of a market-economy in the early 1990s (e.g. Pavlínek 1992; 1995; Hampl 1999). The former command economy was based upon state-owned companies, which often enjoyed the position of a monopoly. In contrast, private entrepreneurial initiative (except for cooperatives) was not only discouraged, but even considered a criminal activity. Consequently, for about two generations, entrepreneurial spirit and culture was lost. Yet more importantly, after the collapse of the state-socialism, when the former state-owned monopolies were suddenly exposed to international competition, they had to swiftly find a new position on the market to survive. A common strategy has been an "adaptive" type of functional downgrading (Blažek 2016), where the then current management of those companies decided – in the face of sudden intensive international competition – to retreat from the final market and to focus upon production of some components, where the company had a comparative (often cost-based) advantage.

Consequently, many of the former state-own companies became lower-tier suppliers of well-established European and/or global companies. Other companies were privatised going to the hands of foreign companies, and new owners often downsized the company to increase its efficiency and narrowed its production portfolio to fit into the overall business group. In both these cases, higher-level functions such as R&D were restricted or even eliminated completely. Likewise, in case of new greenfield investments, foreign investors typically localised low value-added production in Czechia again mostly without R&D functions (Pavlínek 2012). Despite the fact that these investments helped in capital accumulation, stimulated exports and subsequent expansion of employment, this specific developmental trajectory incurred considerable long-term structural costs due to external ownership and dependence upon foreign capital, technology and business models. Namely, this evolutionary trajectory led to a "truncated development" (Pavínek 2017; Hayter 1982) or to what has been aptly called "dependent market economies" (e.g. Smith and Swain 2010).

As a result, the structure of these truncated economies exhibits three distinctive features: (i) a weak endogenous SME sector formed either by a new companies often established

without any tradition and experience or by "spin-offs" from the former state owned companies, (ii) lock-in of many local companies as lower-tier suppliers of global production networks (GPNs), and (iii) widespread "branch plant syndrome", when higher value-added functions are performed abroad (Pavlínek 2012; Novotný et al. 2016). The general weakness of SMEs resulted not only in lock-in in the least advantageous position within GPNs and into branch plant syndrome, but in many cases, even the newly established firms have been attracted by a strong demand for relatively simple components by foreign firms either located abroad or in Czechia. This represented a relatively easy business model based on those days' low-cost advantage (Blažek and Csank 2016).

These specifics of economic structure have several important consequences. First, lower-tier suppliers are exposed to severe cost pressure and are permanently threatened by replacement by yet cheaper suppliers esp. from the Balkan countries or even from Asia. As a result, bargaining power and, consequently, the profitability of these lower-tier suppliers is really limited. As a result, such firms struggle even to safeguard sources for a mere capital replacement and thus refrain from any ventures into the sphere of innovations. Even more important is the fact that these lower-tier suppliers are required to produce large volumes of standardised goods using a well-established technology. Therefore, these firms are not supposed to innovate with the exception of various cost-saving measures. Thus, the space for collaboration with a research organisation or a university even if it is conducting research regarding the potentially relevant topic and is located nearby is limited. Moreover, it needs to be emphasised that the institutes of the Czech Academy of Sciences as well as universities were traditionally preoccupied with basic research. Applied research was performed within institutes of applied research, which were swiftly privatised after the collapse of the command economy and subsequently went into bankruptcy due to the drop in demand for applied research as a result of changes in the production portfolios of companies under the new market conditions.

Consequently, the distance between the needs of companies and research focus of academic organisations (financed predominately according to scientometric parameters) is truly vast. Thus, the intensity of academia-business linkages, which are generally considered as drivers of competitiveness and constitutive feature of regional innovation system, are limited (Blažek et al. 2013; Marek and Blažek 2016; Kadlec and Blažek 2015). Moreover, the nature of inter-firm linkages has also been severely affected by a culture of discredited "collectivism" enforced under the state-socialism. Consequently, as a sort of pendulum reaction, many entrepreneurs leaned towards unrestrained individualism, which represents another severe hindrance for the functioning of national and regional innovation ecosystem.

Moreover, in Czechia, despite its strong industrial tradition, one can identify a systemic mismatch between the needs of the economy and pockets of its excellent research. In Czechia (and in the South Moravian Region as well) there are quality scientific teams in disciplines that rarely have industrial counterparts in the region or in the country. At the same time, there is only a limited number of successful scientific research teams at universities (esp. in mechanical engineering, electrical engineering), i.e. in industrial disciplines in which Czechia enjoys an international reputation.

As a result of all these factors, the Czech economy has been integrated into the European and global economy in a mode that differs fundamentally from advanced market economies (Novotný et al. 2016). Namely, the economic structure of Czechia as well as of other countries with similar evolutionary trajectory is severely skewed towards the low value-added production and towards supply of relatively simple components. This specific situation not only severely limits the possibility of an effective transfer of foreign experience and tools aimed at enhancement of the innovation ecosystem, but also has important implications in terms of available evolutionary trajectories (Isaksen and Trippl 2017). In particular, this model is clearly unsustainable due to rising input costs as well as due to the enhancement of production capabilities in newly industrialised countries. All of this makes the design of innovation policy a challenging venture inevitably entailing numerous obstacles and conflicts (Karlsen and Larrea 2017). This is even more true in the case of the level of self-governing regions with only limited fiscal powers, completely missing competence in the sphere of research, development and innovations, and generally lacking know-how in the sphere of policy design. Nevertheless, despite this generally unfavourable framework, there is a large variation in the way the Czech self-governing regions embark upon pro-innovation policy, where the South Moravian Region is generally considered as forerunner, even at the European level (Morgan 2017a).

Therefore, the aim of this chapter is to investigate how key stakeholders in one of the Czech regions (South Moravia) struggled to overcome numerous severe hindrances elaborated upon above. It has to be stressed that some of the key stakeholders took in their effort inspiration not only from several highly developed regions in Western Europe, but tried hard to also follow the conceptual advances in the sphere of regional development and innovation support (esp. the results of a senior expert panel of DG RESEARCH "Constructing Regional Advantage" chaired by the key proponents of the regional innovation system theory (P. Cooke and B. Asheim). Thus, more broadly, the main inspiration came from regional innovation system theory and from its main protagonists, and as a consequence, the main ambition from the onset of a bottom-up effort was to build a modern regional innovation system in the South Moravia Region.

As a result, from a conceptual point of view, this chapter seeks to elaborate how regional stakeholders tried to approach the construction of key elements of a sound regional innovation system, which can be summarised in the following key dimensions: i) intensive localised learning, ii) strong geographic concentration of actors, iii) vigorous networking at both intra- and inter-regional scale, iv) identification and engagement of key regional stakeholders and leaders and finally, v) the existence of a favourable institutional framework for innovation – trust, policy support as well as overall "atmosphere" in the region (Asheim et al. 2011; Cooke 2002; 2004; Isaksen and Karlsen 2011; Morgan 1997; Rodríguez-Pose 2001; Tödtling and Trippl 2005; Uyarra and Flanagan 2010). Consequently, in the following text we will scrutinise how regional stakeholders struggled in their efforts to strengthen these key dimensions of an innovation system in their region.

Methodologically, this chapter represents a sort of meta-study based on several research projects and related publications of authors of this study dealing with specific aspects of an emerging regional innovation system in South Moravia (esp. the European Framework Programme project "Constructing regional advantage: towards state-of-the-art regional innovation system policies in Europe?" led by B. Asheim, CRP project "Cluster life cycles – the role of actors, networks and institutions in emerging, growing, declining and renewing clusters" lead by R. Hassink and the Framework Programme "Smart Specialisation and Regional Innovation" led by K. Morgan). Within the framework of these research projects, the authors of this chapter engaged deeply with various regional stakeholders, performed several dozens of interviews with a broad spectrum of stakeholders and participated in various regional networking and training events. Despite such a close relationship and even direct involvement in shaping a regional innovation system in South Moravia by the two co-authors, every effort has been made to ensure that the arguments provided in the text have not been compromised.

The chapter is structured in the following way: In the next section, the socioeconomic evolution of the South Moravia region is sketched. Then follows an outline of the role of key organisations in shaping an emerging regional innovation system in the region. Section 5.4 is devoted to the explanation of the rationale for the shifting design of particular generations of regional innovation strategies. The next section elaborates the approaches employed to build a collaborative model of partnership with special attention given to a critical examination of hindrances to academia-business collaboration. Finally, conclusions summarise the main findings with a special focus on experience with bottom-up policy learning mechanisms.

5.2 Socio-economic profile of South Moravia

Established in 2000, the South Moravian Region currently belongs to the group of Czech regions which are relatively developed, with a considerable concentration of activities with a high value-added. This is primarily attributable to a strong position of the regional capital city, Brno, which is the second-most important economic centre of Czechia, with key specialisations in IT, precision instruments, advanced manufacturing and business services (JIC 2014). Consequently, nowadays, in terms of GDP per capita, the region is second only to Prague. Brno (380,000 inhabitants) boasts 70 thousand university students at 6 public and 6 private universities (altogether encompassing 29 faculties).

The strong role of Brno contrasts with the less developed rural and peripheral nature of a sizeable part of this region, esp. alongside the border with Austria, but also in the northern part of the region. Therefore, intra-regional disparities are profound. In particular, the unemployment rate varies considerably within the region. Nevertheless, despite the relatively strong economic performance of the region, the regional unemployment rate even nowadays exceeds significantly the Czech average (see Table 5-1 and Table 5-2).

Table 5-1: Basic socio-economic indicators of South Moravia

Basic socio-economic indicators	**South Moravia**
Population (3/2018)	1,183,550 (11.15% of Czechia)
Unemployment rate in % (2017)	3.1 (national rate: 2.9; EU-28 average*: 7.6*)
GDP per capita; purchasing power parity (2017) *EU-28 average 100% (29,900 EUR)*	25,700 EUR - 86% of EU28 average; 89% of national average

Source: Czech Statistical Office, available at https://www.czso.cz/csu/xb/1-xb and http://ec.europa.eu/eurostat/web/products-press-releases/-/1-26042018-AP

Thanks to numerous factors, including a proactive approach over the last 25 years towards designing modern innovation policy inspired by advances in regional innovation theory, a profound transformation of the regional economic structure can be observed in the South Moravian Region even though substantial challenges are still ahead. Due to a targeted effort to improve the conditions for a knowledge-intensive economy, there has not only been rapid growth of new endogenous companies, but also an influx of foreign manufacturing as well as service firms with a higher value added. The most profound transformation of the economic structure has been recorded in the city of Brno, but also in its hinterland. Brno hosts a range of administrative functions of national relevance (such as the Constitutional Court, National Competition Authority etc.), which helps to diversify employment structure and creates a number of multiplier effects in the regional

economy. In contrast, the economic profile of the peripheral areas of the South Moravian Region remains relatively traditional.

Table 5-2: Basic R&D indicators of South Moravia compared to the Czech and EU averages

Values in S. Moravia compared to CZ and EU averages	CZ=100	EU=100
Tertiary education	132	97
Lifelong learning	117	100
International scientific co-publications	108	94
Most-cited scientific publications	99	89
R&D expenditures public sector	119	129
R&D expenditures business sector	126	115
Public-private co-publications	101	68
EPO patent applications	111	51
Trademark applications	93	73
Design applications	107	104
Employment medium high-tech manuf./knowledge intensive services	103	133
Exports of medium high-tech manufacturing	99	118

Source: Regional Innovation Scoreboard 2017 (data for: NUTS2 Jihovýchod)
Note: South Moravia represents a dominant part of NUTS 2 region Jihovýchod

The share of expenditures upon R&D represents 2.8% (2016; EU28=2.0%), of which 1.7% represents business expenditures on R&D (BERD) compared to the EU28 average of 1.3%). Importantly, the overall trend over the last decade is a notable increase of expenditures on research and development. In 2001, it stood at mere 1.23% of regional GDP (0.48% BERD), and in 2009 R&D expenditures for the first time exceeded 2%, while in 2011, BERD for the first time exceeded 1.0%. Traditionally, Brno is the second-most important research centre in the Czech Republic. The domain of public research institutes is represented by six universities offering a broad spectrum of study programmes and by eight institutes of the Academy of Sciences. The relatively well-developed research base of the region translates into a strong position among the Czech regions in terms of research outputs (publications, patents).

In addition to a strong role of public research organisations in the region, nowadays, there is also a large number of companies with their own R&D capacities. According to this parameter, the South Moravian Region is the most successful in Czechia. The number of companies with in-house R&D is currently about 400 and the volume of private expenditures committed to R&D is steadily growing. The firms invest in R&D especially

in the sector of engineering, electrical equipment, ICT and life-sciences (JIC 2014). One of the key companies, which became a driver of regional economy is Honeywell. This global company set-up its global development centre in Brno in 2003 (the centre currently employs over 1,800 people). The key activity of the centre is research and development in the area of aircraft and aviation technologies (such as navigation, air traffic safety), electrical engineering (control and safety systems, sensor systems) and precision engineering. Honeywell's multidisciplinary focus (linkages with instrumentation, IT, etc.) supports the development of businesses across the whole region. More importantly, Honeywell's recent efforts to open up and integrate some of its activities with the wider innovation ecosystem promise to magnify the already strong spill-over effects through collaborations with local universities and technology start-ups. Besides, Honeywell's position as a technological leader contributes to the region's growing connectedness with global technological centres and brings with it the knowledge of global market needs. These links are beneficial well beyond the company itself. For the corporate partners from the region, it opens a possibility to cooperate within these intensive knowledge networks. Moreover, many Czech technology companies have joined Honeywell's value chain as suppliers and technology partners. One of the main factors driving the transformation of the regional economic structure are the EU structural funds, which contributed substantially to the transformation of the region. Over the last years, about 700 million EUR were invested in the construction of research centres and related infrastructure alone. Thanks to this, four centres of European excellence and 11 regional research centres of applied research were built. These centres currently employ over 1,500 researchers. According to the latest Regional Innovation Scoreboard 2017, the South Moravia region belongs into the "moderate+" category according to its innovation performance.

5.3 Key organisations of regional innovation system in South Moravia

In the South Moravian Region, the key role in enhancement of regional innovation system rests with the public organisations that in various ways contribute to research and innovation policy. Key public sector stakeholders are the Regional Office of the South Moravian Region, the Brno City Municipality, Masaryk University, University of Technology in Brno, Mendel University in Brno and University of Veterinary and Pharmaceutical Sciences in Brno. In addition, in 2003, these stakeholders jointly established The South Moravian Innovation Centre – JIC (its legal form is the "association of legal entities"), which became a pivotal organisation in enhancing regional innovation ecosystem. JIC's task from the outset was twofold: (i) to provide a set of support services targeting firms, especially start-ups from local academic organisations, and (ii) managing the Regional Innovation Strategy on behalf of its public founders.

Over time the portfolio of activities of JIC developed and broadened. Nowadays, JIC promotes entrepreneurship, especially towards young people, it supports establishment of knowledge-intensive start-ups, supports the development and innovation in mature SMEs with a large growth potential. The spectrum of the products on offer is regularly reconsidered via a policy learning cycle and overall the number of instruments gradually increases while some have also been phased out. Some of the firms that were accepted into the incubation programme in the South Moravian Innovation Centre some ten years ago and which have successfully expanded, are now in close liaison with the South Moravian Innovation Centre, even investing in start-up projects themselves. The whole spectrum of instruments offered by JIC is available at www.jic.cz. Most importantly, JIC bears responsibility for the design and implementation of the Regional Innovation Strategy. The backing of JIC by the key stakeholders, esp. by the Regional Office of South Moravia is fundamental.

The Regional Office annually provides direct support to JIC (about 1.1 million EUR/year), but also to the South Moravian Centre for International Mobility (0.4 million EUR/year), the Regional Development Agency South Moravia (0.45 million EUR/year) and the Moravian Science Centre Brno (0.5 million EUR/year). Moreover, in addition to this annual support, the Regional Office has provided financial support to various types of innovation infrastructure such as the construction of the Technological Incubator II (4.3 million EUR), the construction of the biotechnological incubator INBIT and the acquisition of research equipment (5.8 million EUR), the construction of the scientific and technological park INMEC (14.3 million EUR), the construction of the Competence Centre INTEMAC in Kuřim dedicated to mechatronics, machinery and the implementation of digital technologies in manufacturing SMEs (2.6 million EUR) and the construction of the Moravian Science Centre Brno (25 million EUR).

The organisations constituting the backbone of the regional innovation system in the South Moravian Region are presented in the following Table 5-3.

Table 5-3: Key organisations in the South Moravia innovation system

Name	Main activities/contribution	Year of establishment
Regional Office	This is the main organisation of regional self-government that is ultimately responsible for innovation policy in South Moravia. Given its financial strength and its administrative powers, the Regional Office represents the crucial organisation. The Regional Office invests heavily in support for research, development and innovations and became an informal leader among Czech regions and beyond. The deputy governor of South Moravia chairs the Steering Committee of RIS/S3 of South Moravia.	2000
Brno City Office	The City Office comes second according to both volume of financial resources and administrative powers. The Brno authorities fund a number of projects and initiatives of the Regional Innovation Strategy. The deputy mayor is a member of the Steering Committee of RIS/S3 of South Moravia.	Municipal self-government was re-established in 1990s
South Moravian Innovation Centre (JIC)	One of the key drivers enhancing the overall innovation system of the region as well as developing projects supporting innovation business. JIC, charged with the design and implementation of the Regional Innovation Strategy, inspires other Czech regions and beyond. JIC provides targeted support to companies in various phases of their life-cycle from incubation programmes to mentoring for well-established companies, it also facilitates collaboration and coordinates the needs of diverse actors (start-ups, SMEs, large corporations, academics). The director of JIC is a member of the Steering Committee of RIS/S3 in South Moravia.	2003
South Moravian Centre for International Mobility	Provides support for talented students and researchers. Its objective is to identify young talents and attract them to science and technology careers as well as to attract international scientists. Its director is a member of the Steering Committee of RIS/S3.	2005
The Regional Development Agency South Moravia	The agency helps municipalities with the preparation of the project applications for the EU structural funds. It also deals with the revitalisation of brownfields. Its director is a member of the Steering Committee of RIS/S3.	1998
Technology transfer offices (TTOs)	Provide support for the commercialisation of academic research at four major public universities. However, the quality of provided services differ among the TTOs due to numerous factors such as experience and know-how of their staff, general atmosphere at the given university towards commercialisation, and, obviously, the volume of their financial support.	1998-2011

Name	Main activities/contribution	Year of establishment
The Regional Chamber of Commerce	Represents the main association of the business community. Provides a range of services in the area of consultancy (customs, exports, law, subsidies, etc.), training and development of human resources. Moreover, it enhances internationalisation of companies and various forms of networking. It is also responsible for the implementation of selected activities within the RIS and its director is a member of the Steering Committee of RIS/S3.	

Source: own compilation

The activities of all these organisations fit well together and there are no major overlaps in their activities. Thus, each of these organisations aims to fulfil its specific role within a broader institutional framework.

5.4 The evolution of regional innovation strategies in South Moravia

In the case of the South Moravian Region, one can see a consistent effort at drafting a long-standing concept for the development of a research and innovation base for the region in line with the recent advances of regional innovation system theory (Cooke 2002; Tödtling and Trippl 2005; Uyarra and Flanagan 2010). The delocalisation of a major foreign investor (Flextronics) and closure of its Brno operations in 2002 was the key trigger for the activation of key stakeholders and for the design and coordination of innovation policy at the regional level. The main idea was to transform Brno and the South Moravian Region into a centre of innovations that constitutes a major competitive advantage in the present-day globalised economy. Since then, the Regional Innovation Strategy has already lived through four generations of planning and implementation periods (see Table 5-4).

The first generation of the Regional Innovation Strategy was formulated by the Regional Development Agency of the South Moravian Region in 2002. The establishment of the South Moravian Innovation Centre (JIC) in 2003 and the effort to start formulating and implementing innovation policy have been the main results of this first generation of innovation policy. In general, there was an increase in awareness and political will to support innovations via a dedicated regional approach. In 2005, the second generation of the Regional Innovation Strategy was approved by the regional assembly. JIC formally became its main implementing organisation. Among the main priorities of the second generation of the Regional Innovation Strategy were support of start-ups and SMEs via the provision of infrastructure, enabling access to external financial resources and high-

quality advisory services for businesses. In addition, vigorous effort was exerted for the enhancement of mutual linkages and collaboration among various actors, esp. companies and towards technology transfer from universities to companies. The key supported sectors were biotechnology, IT and engineering (RIS SMR 2005).

The third generation of the Regional Innovation Strategy was prepared for another five-year period (2009-2013). From a conceptual and methodological point of view, the main change consisted in an effort to utilise the key findings and recommendations of the senior expert panel on Constructing Regional Advantage (see Asheim et al. 2011) and of a follow-up research project ("Constructing Regional Advantage" – see e.g. Blažek et al. 2013). Namely, an effort has been exerted to systematically analyse the innovation demand according to the key knowledge bases in the region (i.e. synthetic and partly also analytical knowledge base, see Blažek and Csank 2016; Asheim and Gertler 2005) as well as the connectivity of firms and research teams located within the region through regular surveys. This helped substantially in extending and broadening the regional partnerships and in creating a sense of common purpose among different players. Also, the companies for the first time were actively involved in the design of policy instruments through working groups. Based on various analytical inputs, including the results of this survey, the following horizontal priorities were selected for the Regional Innovation Strategy in the 2009-2013 period: transfer of technologies, services for firms, support for human resources, and internationalisation. The analyses performed also identified the following set of key industries: engineering, electrical engineering, information technology, and life-science.

Finally, the current – fourth – generation of the Regional Innovation Strategy developed under the paradigm of "smart specialisation" – was adopted in 2014. The strategy was formulated on the basis of a broad and on-going participation of the relevant partners from the educational, research and innovation system of South Moravia. The crucial problems, proposals of their solutions, the formulation of objectives, measures and projects are outputs of a vigorous bottom-up participatory process consisting predominately of on-going efforts of several working groups targeting key areas of change. Over the whole course of the strategy formulation effort, the stakeholders adapted the EC RIS 3 Guide (Foray et al. 2012) as well as the methodological approach proposed by the Czech Ministry of Education and Sport to meet this ex-ante conditionality. The starting point was a meeting of about 30 key actors at the end of 2012 followed up by a discussion structured into four working groups. Based on the discussions in working groups, stakeholders started the process of strategy formulation, including elaboration of SWOT analysis (main strengths and weaknesses are captured in Table 5-5), selection of monitoring indicators, etc. A special effort has been expended on the preparation of strategic projects deemed to deliver expected results (JIC 2014). Unlike in the past, the work of the working

groups has gradually turned into a permanent process whereby the stakeholders meet on a regular basis to oversee the implementation of projects approved by the RIS Steering Committee and propose new projects and initiatives. Importantly, the Steering Committee, which previously consisted of public body representatives (the region, the city, universities) was also extended to include owners and top managers of the leading technology companies in the region.

Based on analyses of the business and research sector in the South Moravian Region, the main sectors with a proven international competitiveness were identified: advanced manufacturing and engineering technologies, precision instruments, the development of software and hardware, drugs, medical care and diagnostics and technologies for the aircraft industry. These sectors are believed to posses a strong potential for further growth of firms, public research, as well as for employment in the region. The firms from the above listed specialisations are the primary (but not the sole) target upon which the instruments of smart specialisation strategy are currently focused in the region. The main priorities in the regional smart specialisation strategy 2014-2020 include: A) pro-innovation administration and management, B) excellence in research, C) competitive innovative firms, D) top education of the European level, E) attractive region (communication and marketing). These priorities were discussed by all the relevant stakeholders and a consensus upon them was reached. As the number of the priorities is still relatively moderate, the individual instruments can be targeted quite precisely. Therefore, the stakeholders expect that substantial progress in the areas identified above will be accomplished by the end of the programme period.

Table 5-4: Evolution of the regional innovation policy in South Moravia

Generation of regional innovation strategy (RIS)	**RIS 1 2001-2004**	**RIS 2 2005-2008**	**RIS 3 2009-2013**	**RIS 4 2014-2020**
Underlying rationale	Shift from exogenous strategy relying on FDIs to endogenous strategy.	Addressing key bottlenecks of regional economy and preparation for efficient use of SFs for major public R&D infrastructure.	To embed R&D infrastructure within the regional economy by supporting various modes of networking and commercialising R&D results.	Gradual shift from generic support schemes to support for activities in five priority domains selected in line with the smart specialisation methodology and support for innovation in SMEs. Mainstreaming of support for mature SMEs (Platinn).

Generation of regional innovation strategy (RIS)	RIS 1 2001-2004	RIS 2 2005-2008	RIS 3 2009-2013	RIS 4 2014-2020
			First attempts to support mature SMEs through coaching scheme and a first competence centre (mechatronics and machining).	Effort to tackle financing of early stage start-ups.
Institutional evolution	1. Partnership of representatives of the Region, City of Brno and the two largest universities formed. 2. In 2003, the South Moravian Innovation Centre (JIC) was established.	In 2005, the South Moravian Centre for International Mobility was established to attract talented students and later also leading foreign scientists and technicians.	Formalisation of governance structure established: Steering Committee, Coordination Committee; RIS Manager, ad hoc working groups (internalisation, human resources, business support).	1. Involvement of key industrialist in the Steering Committee. 2. Permanent working groups reorganised into the following: Innovative Governance, Excellence in Science, Innovative Companies, Education, Image.
Key instruments	Support of start-ups via technology incubator.	1. Second incubator for start-ups established. 2. Support for HR (mobility schemes, grants to scientists). 3. New campus of Masaryk University (2005). 4. First attempts to financially support start-ups and to commercialise R&D results via spin-offs (with mixed results)	1. Support for start-ups 2. Support for human resources 3. Upgrading of public R&D infrastructure 4. Internationalisation of public research 5. Networking: provision of innovation vouchers and speed-dating of innovation actors orchestrated by JIC 6. Competence centre on mechatronics and machining (first sectorial instrument)	As in previous period, plus: 1. Czech-Swiss mentoring programme Platinn for identification of innovation opportunities and implementation of innovations in SMEs. 2. Support concentrated upon 5 domains of specialisation as envisaged by the smart specialisation strategy

Generation of regional innovation strategy (RIS)	**RIS 1 2001-2004**	**RIS 2 2005-2008**	**RIS 3 2009-2013**	**RIS 4 2014-2020**
Key achievemets	1. Ten start-ups established, a team formed to support technology start-ups. 2. Establishment of production and R&D centres of global companies such as Honeywell, offering hundreds of hi-tech jobs.	1. Five start-ups/year. 2. One million EUR/year of venture capital invested in regional companies. 3. Expansion of R&D centres of private companies. 4. Preparation of flagship R&D projects to be financed from SFs. 5. Setting up support for talents for research and innovation	1. Ten start-ups/year. 2. 2 million EUR/year of venture capital. 3. 700 million EUR public (SFs) investment in R&D. 4. 39 leading foreign researchers attracted. 5. 250 innovation vouchers issued. 6. 400 hi-tech jobs/year created by either local or foreign companies.	1. Opening of several centres of European excellence such as CEITEC (life sciences, nano-materials) or ICRC (medicine CARDIO and NEURO programme). 2. Growth of corporate R&D capacities (FEI opens the company's largest business hub, with 600 employees; Honeywell's R&D centre expanded in 2015; Konica established its European BIC in Brno. 3. The first 2 alumni of start-up incubator reach 1 billion CZK turnover, one approaching 1 billion USD.

Source: Successive generations of Regional Innovation Strategies for the South Moravia Region

Table 5-5: The main strengths and weaknesses of the regional innovation system in South Moravia

The main strengths	The main weaknesses
Long-standing financial support from the regional authority and associated strong leadership supporting the regional innovation policy.	Large intra-regional differences within the region (i.e. Brno and in its closest hinterland versus peripheries).
A positive cumulative mechanism (thanks to the achieved results, the region has a favourable image for its innovative ecosystem).	Low ambitions of owners of small and medium-sized companies in terms of innovation and scaling-up.
Broad consensus among key stakeholders on the vision of the region.	Underdeveloped entrepreneurial capabilities among the economically active population.
Attractiveness of the region for foreign direct investments focused on activities with a higher value-added.	Growing red-tape and insufficiently developed support services for researchers.
The presence of several ambitious firms aiming to achieve a technological edge in the long run.	Insufficient readiness of academia for cooperation with the business sector. Still persisting mutual distrust between academia and businesses.
Within the country, the region excels in its intensity of birth of new knowledge-intensive firms.	Relatively limited managerial and strategic capabilities at universities.
The existence of a critical number of highly skilled, technically-educated people (good opportunity to choose when filling key positions in the sphere of R&D, design, etc.).	The research teams often have insufficiently ambitious objectives and their research topics only have a limited relevance (i.e. the lack of ambitious research strategy).
The existence of "labour market pooling": the diffusion and development of knowledge through the mobility of experts among firms, industries and sectors.	University graduates' expert knowledge and soft skills do not meet employers' demands.
The build-up of a top research infrastructure over the last decade.	Limited soft infrastructure for the staff of multinational corporations, foreign researchers and their families.
The existence of several research teams able to generate globally unique results (such as speech processing, cryptography, stem cells research, etc.).	
The university character of Brno and a broad offer of areas of study with a potential for interdisciplinary development.	

Source: own, based on interviews with key regional stakeholders and upon key policy documents

5.5 Building a collaborative model of partnership

Nowadays, there is an extensive literature on the role of intra- and inter-regional networking and partnerships for competitiveness and innovation performance (see e.g. Bathelt et al. 2004; Herstad et al. 2014). Thus, the process of establishing an innovation partnership, which was sparked in 2002/2003 by a delocalisation of an important foreign investor (Flextronics) is now one of key pillars of the Regional Innovation Strategy. This delocalisation happened in the context of a wider economic downturn at the turn of the century where the arrival of Flextronics to Brno in 1999, a first major greenfield foreign investor in Brno, was regarded as an adequate policy response to increasing unemployment and the ailing regional economy. The departure of Flextronics thus came as a shock and generated a debate among local stakeholders – the city and regional governments and two leading universities – about the need for a new approach to regional development. These circumstances coincided in time with the preparation of the first generation of the Regional Innovation Strategy which was elaborated within an EU-funded project and was building on the experience of more advanced regions in Germany and the Netherlands. The main idea was to exploit the local assets, especially the large numbers of university students and existing research capacities and turn them into sources for a lasting competitive advantage for Brno and the South Moravian Region. The regional government authority (Regional Office) supported by the Regional Development Agency played the role of the main initiator of the establishment of an innovation platform which from the outset was built on a partnership between the public sector and local universities.

The talks resulted in the formation of a joint Steering Committee which approved a common strategic framework for the Regional Innovation Strategy (i.e. the mission, vision, key areas of change and the guiding principles), as well as an agreement to create a new entity dedicated specifically to dealing with innovation policy and support for business innovation and start-ups.

JIC started off as a start-up incubation centre in early 2003 and gradually developed its capacity not only in business incubation services but also in innovation policy. From the second generation of RIS on it took over the responsibility for the design and management of the innovation policy from the Regional Office which recognised the need for a close alignment between the strategy and its practical implementation. This step proved to be critical for the future development of RIS. First, it ensured that the innovation policy was delegated to a professional agency and was shielded from short-term political turbulence which inevitably affect the public administration with every swing of the electoral cycle. Second, it allowed JIC to develop an internal capacity for long-term planning combined with a direct, hands-on feedback loop linked to its direct engagement with client

businesses. Moreover, the visionary regional politicians insisted from the outset that innovation policy must be a matter of a collective consensus between the key stakeholders (at this stage the region, the city and the universities). This approach provided for greater stability of the governance of RIS than would otherwise be the case if JIC was, for example, an agency subordinated solely to the regional government.

With this stable institutional set up it was possible to gradually achieve first tangible results in the form of successful start-ups where some of the first *alumni* of JIC programmes started to achieve remarkable successes after the first five years of operation of JIC (first client to hit the 100 million CZK turnover, or 4 million EUR).

By the time of the third generation of RIS, the results were clearly demonstrable. This, in turn, made it easier to achieve further consensus on the importance of RIS and its future funding. Furthermore, the tangible results achieved in terms of a growing group of successful start-ups raised interest and confidence in public sector-led innovation among local businesses who were traditionally rather sceptical of any public intervention in business support. Such a situation gave greater confidence to the people responsible for RIS at JIC and the regional government so that by 2008 the third generation of RIS explicitly invited business representatives to the debate on the future development of innovation policy. This move was greeted with a positive response from local businessmen. In retrospect, it needs to be said that such a move would not have been possible from the outset (i.e. from the first generation of RIS) where the level of confidence that the private and public sectors had in each other was low and the public sector was not yet able to present any tangible results of its efforts.

Eventually, with the fourth generation of RIS from 2013 onwards the trust of both private and public partners (including the universities) in the region became such that it was possible to involve representatives of the leading technology companies directly in the Steering Committee of RIS. In this way the entrepreneurs and/or top managers of these companies were basically given a voice equal to the public partners in matters of public policy, its priorities, its design, as well as in monitoring and the evaluation of its results. It needs to be emphasised that the business representatives of the RIS Steering Committee are the true leaders of the local innovation ecosystems – managers of companies with the highest R&D expenditures and strongest innovation performance, not any proxies of representatives of collective associations.

Moreover, another important change in the design of regional partnership was achieved in the design of the RIS Working Groups. Namely, these were turned into permanent platforms where representatives of innovative companies – both small and large, locally-owned and multinationals – also meet on a regular basis to discuss the shortcomings of

the local innovation system. Thus, members of these Working Groups have a direct say in the process of formulating a policy response (e.g. design of new programmes or policy instrument addressing specific issues, such as a lack of entrepreneurship among youth, a new programme aimed at providing access to the latest digital technologies for manufacturing SMEs, or new measures to stimulate interaction between academia and industry, etc.). The experience clearly demonstrates that as long as the intellectual input provided by these companies is quickly turned into a policy action, the commitment of the WG members is high. Based on this experience, their loyalty to the RIS and their readiness to identify with a common vision for the region is not difficult to achieve.

Over time the RIS helped to develop a genuine sense of community where the core group of partners by far exceeds 100 people who represent businesses, academia and the public sector. Given the size of the region, with some 1.2 million inhabitants, the group represents a strong network with an ability to mobilise substantial resources, both locally and internationally.

5.6 The university – business nexus and key instruments enhancing connectedness

One specific aspect of any regional innovation system is the intensity of the cooperation of universities with private companies. However, in S. Moravia the situation varies substantially in individual industries as well as among and even within particular universities and research organisations. Some research teams at universities are already achieving results of global relevance and cooperate closely with important firms in the field. On the other hand, many researchers are one-sidedly focused on basic research without any ambition to collaborate with the application sphere while many research teams suffer from a lack of an ambitious research strategy overall. The main barriers for mutual cooperation as perceived by leading academics and businesses are elaborated on in detail in Blažek and Csank (2016). Nevertheless, despite efforts including the organisation of various networking and speed-dating activities prepared by regional intermediaries, a certain level of mistrust between firms and academic research teams still persists. In cases where this mistrust has been overcome, it was often due to personal affinity (acquaintance) between the key researcher and the entrepreneur. However, a gradual tendency towards higher openness of academic organisations to businesses can be observed in the region. Yet, under the present policy framework, under which universities are remunerated primarily according to the results of basic research (i.e. number of publications in prestigious journals with high impact factor), a more intensive collaboration between academia and companies is not widespread.

Nevertheless, perhaps the most important mode of cooperation between universities and private companies, which is nearly of a flagship nature, are represented by competence centres (supported by the Technology Agency of the Czech Republic). These centres signal well-functioning cooperations between university teams and companies. Within the competence centres, organisations are required to cover at least 30% of the costs from their own resources. Such a financial involvement therefore indicates that the partners involved show a significant commitment to the competence centre and bear a part of the risks as well.

From the business side, research and development is not a key priority for many small and medium-sized firms as they deal with other more "down-to-earth" issues such as recruitment and retention of staff, securing cash flow, etc. These firms also do not perceive a need for cooperation with the academic sphere and the contacts with universities tend to be irregular at best and focused on relatively simple activities like various sorts of measurement.

"Innovation vouchers", which were provided by the South Moravia Innovation Centre for a period of 7 years represent the main instrument employed to enhance the mutual collaboration between academia and businesses. This specific tool aims at overcoming the mistrust between firms and the scientific and research teams at universities. A firm is entitled to a subsidy of up to 3,600 EUR for covering the cost of contractual research, co-financed by the company. Therefore, the company can test the capabilities and added value of cooperating with a selected research team. In the ideal case, the business people acquire new know-how and research partners, while the scientists discover potential industrial applications for the results of their research. Overall, several hundreds of innovation vouchers were provided. Twelve research institutes have joined the project and the spectrum of participating firms significantly exceeded the borders of the region and even of the country. As a result, the biggest contribution of the innovation vouchers is a moderation of mutual mistrust between the corporate and academic worlds (JIC 2014). An evaluation of this tool showed that due to innovation vouchers at least 60 firms from the South Moravian Region found a new partner with whom they developed a subsequent collaboration.

Another networking tool is the speed-dating programme "120 seconds for innovations". This tool is designed to deepen the interdisciplinary cooperation among firms. The South Moravian Innovation Centre usually stages a specific speed-dating event four times a year. At these events the representative of a firm or a researcher has the opportunity to unveil the focus and capabilities of his/her company or research team within two minutes and to specify what type of partners for cooperation they are looking for. This results in a targeted networking and deepening of interdisciplinary cooperation. There are also

other instruments with a broadly similar purpose, such as various events organised within the incubation programme, seminars and workshops aiming primarily at training provisions, but, which as a side effect, also create a fabric of local networks that represent the backbone of the regional innovation ecosystem. The changing role of universities under the paradigm of smart specialisation, which places entrepreneurs into the "driving seat" has been recently elaborated on by Vallance et al. (2018) based partly upon the S. Moravian experience.

5.7 Conclusions

The aim of this case study was to show that the targeted effort of key stakeholders knowledgeable in the state-of-the-art conceptual developments in the area of regional development and innovation support can bear substantial fruits if the trust of key regional public authorities as well as of major private companies is gradually built.

Nowadays, the South Moravian Region ranks among the relatively developed Czech regions. The importance of the South Moravian Region is primarily based on the strong position of Brno, which is the second-most important Czech administrative, economic and cultural centre with a high concentration of advanced activities (ICT, specialised services, research, etc.).

Moreover, the region has become attractive for the localisation of direct foreign investments with a focus on the activities with a higher value-added (precision instruments, power engineering, and industrial engineering producing technology for complete plants). These achievements are at least to a certain extent attributable to the long-standing support from the regional authorities (esp. the Regional Office), where one can see a distinctive effort towards further development of the regional innovation policy. Currently, the fourth generation of the Regional Innovation Strategy designed under the "smart specialisation" flag is being implemented. However, to succeed, it is vital to achieve a real understanding and consensus on the mission and vision of the region in the years to come among key stakeholders. Recently (May 2018), a new, quite ambitious vision of JIC was presented at a gathering celebrating the 15th anniversary of JIC where more than 300 regional stakeholders came together. In particular, the following new vision has been accepted: "to build an open innovation ecosystem that will become a home to global entrepreneurs, and which will inspire the world".

Thanks to the efforts of numerous stakeholders, one could observe a substantial transformation of the regional economic fabric of the South Moravian Region over the last approximately 15 years. Due to a relatively sophisticated and truly bottom-up effort aimed at improving the conditions for the endogenous knowledge-intensive economy, there has

also been also considerable inflow of investments in the area of advanced business services offering a range of high value-added services. The transformation of the economic structure is profound especially in the city of Brno, but also in its hinterland, while the peripheral parts of the region are still based on traditional industries and agriculture. Among the important factors reshaping the socio-economic base of the region are interventions vigorously supported from the EU structural funds. Over the last few years, more than 600 million EUR has been invested in the construction of research centres and related infrastructure.

Due to the already quite favourable image of the South Moravian Region as an innovation hub for firms and services with higher valued-added, the region (and its smart specialisation strategy) inspires not only several other Czech regions in their pro-innovation effort, but in some cases even the national authorities. The South Moravian Innovation Centre (JIC) has been able to accumulate and effectively use state-of-the-art knowledge about the operation of research and innovation systems as well as concerning the mechanisms by which these systems can be enhanced (Cooke 2002; Asheim et al. 2011; Morgan 2017b). A vital precondition for the success achieved so far has been the leadership provided by the succession of regional vice-governors (Sotarauta and Mustikkamäki 2015 on the role of leadership), as well as a gradually built partnership and trust among key stakeholders.

The process of policy learning in South Moravia has been a gradual one. Over time, as the first tangible results of the Regional Innovation Strategy have become apparent, both the regional and local authorities gradually granted larger autonomy in policy design and implementation to the intermediary bodies and especially to JIC. This effectively created a situation in which JIC was both responsible for the design and implementation of much of the innovation policy (while its key stakeholders kept a supervisory role). This arrangement, where the feedback loops were very quick and it was possible to test and pilot new actions quickly before mainstreaming them thus are fully in line with the key arguments of Morgan (2017b). More importantly, it also gave JIC and to similar degree also to the South Moravian Centre for International Mobility (JCMM) enough freedom to adapt ongoing policy interventions to the changing needs of the final beneficiaries of the policy interventions. And in some cases also to drop existing initiatives which lost their importance over time.

One such an example may be the programme of innovation vouchers which was implemented between the years 2008 and 2014. The programme and its rules were amended several times based on the feedback collected from users. It was finally discontinued from one year to another when the national government decided to adopt a similar national scheme, in order to avoid duplicity of interventions. This illustrates that in South

Moravia the innovation policy and its instruments are largely designed to address a concrete policy issue while measures are taken to monitor how well this is being achieved. The policy thus can be labelled as needs-driven in contrast to frequently "subsidy-driven" policies. A similar learning process can also be documented for other policy interventions in RIS in South Moravia, such as the programme SoMoPro run by JCMM, which went through three generations that were gradually improved based on the user feedback.

One important conclusion that may be drawn from the experience of innovation policy in South Moravia is that trust among the key stakeholders is critical for any learning effect to occur over time. This concerns especially trust among those formally responsible for innovation policy (typically public administration which funds various policy initiatives) and the bodies implementing them who are in a daily contact with the end users (businesses, scientists, etc.). Innovation policy is not a straightforward process and cannot be easily planned in detail. By its inherent nature it involves a substantial degree of risk or failure. While in contrast, public bodies tend to be risk-averse. Intermediaries such as JIC or JCMM are much more flexible and adaptable and better disposed to learn as the needs of the target group change.

However, the intermediaries can only operate in a flexible and adaptable manner as long as there is a high degree of trust from their funders combined with an appreciation of the risks involved and a tolerance of failure. The results of innovation policy in South Moravia and its gradually more sophisticated policy instruments indicate that this process has been in place.

Nevertheless, tremendous challenges still lie ahead, especially extending the cooperative and trustful relationships that have been formed so far in a few industrial subsectors across the whole innovation system. Obviously, the long-term development and evolution at the regional level depends primarily on political representation, which should have a long-term vision and should be able to openly engage with representatives of the corporate sector and universities (Sotarauta and Mustikkamaki 2015). Nowadays, luckily, there are such respected personalities in the region as well as in the city who have both the power (even though this is mostly of an informal nature only) and will to enhance the regional ecosystem. The S3 strategy contributed to this process mainly via a more intensive involvement of entrepreneurs in its preparation as well as during its implementation (Foray et al. 2012). Moreover, due to S3 requirements, completely new platforms have been set up (called "Idea Labs") to launch the entrepreneurial discovery process even though currently it seems that such activities are probably aiming beyond the scope of the current state of development of the regional innovation system of S. Moravia.

The experience of South Moravia shows that the role of trust among the stakeholders in the regional innovation ecosystem is critical, but it takes a considerable effort and time to develop. The development of trust can be facilitated by moderate initial expectations and the acceptance of low or minimal results in a short term. In other words, patience is indispensable in this phase. Likewise, clear result orientation is needed from the very beginning, however, excessive pressure on "hard" measurable metrics in early stages of the development of policy instrument is likely to be detrimental as the results are very hard to predict (this again necessitates trust among key stakeholders involved). Even more challenging is the readiness of key regional representatives and funders to admit failures, which are unavoidable in such a complex economic and policy context. In the case of South Moravia, the willingness of regional authorities to accept failures or even risk failures has been encouraged by a close interaction between policy design and implementation and via fast feedback loops allowing for quick adaptation in the policy concerned.

More generally, the case of South Moravia shows that despite an unfavourable institutional and policy framework persisting at the national level, significant positive results can be achieved at the regional level by targeted and sustained activity of committed and knowledgeable stakeholders utilising state-of-the-art policy approaches rooted in regional innovation system theory (Rodríguez-Pose and Di Cataldo 2015; Radosevic 2017; Martin and Trippl 2014; Manniche et al. 2017). In this context, the role of the factor time has to be emphasised as it took approximately 10 years to build professional intermediaries and trust among key actors and to deliver the first tangible effects. Thus, there is no quick fix for less developed regions, but the results can be achieved only after a period of sustained and concerted efforts of key regional stakeholders. Overall, the case of S. Moravia shows that the state-of-the-art concepts, esp. those developed within the regional innovation system theory, can improve the understanding of real challenges of particular stakeholders, provide inspiration for new approaches (e.g. related variety), enable the design of more realistic strategies and incentives and can also help to justify public support for the innovation sphere.

5.8 References

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6 Regional innovation systems in Portugal: an approach to the Centro Region case

Domingos Santos

6.1 Introduction

It is practically unanimous today, in the field of regional economics, that innovation is one of the nuclear vectors conditioning the dynamic of industrial and territorial competitiveness. It should be understood not only in the strict technological sense (product and process engineering) but also in its organisational (management, markets, etc.) and institutional (partnerships, cooperation networks, etc.) dimensions (OECD 2011; McCann and Ortega-Argilés 2013; Capello 2014). Furthermore, rather than being a result of a linear process developed both by the R&D offer (technology-push) and entrepreneurial demand (demand-pull), it should be understood as an interactive assemblage of characteristics in which the innovation dimensions associated with the institutional and territorial context are equally important.

It is also currently recognised that globalisation has deepened the change which occurred in business strategies, from a static competition based on price to a dynamic competition that favours the regions capable of (re)creating knowledge and specific know-how faster than their competitors. Now, the modern economy of knowledge and learning implicitly establishes the foundations of its competitive advantages in the systematic appeal to innovation.

From the systems of innovation perspective, innovation dynamics emerge from interactions between agents operating in the system, where the overall innovation performance largely depends on the quality of these learning interactions and knowledge exchanges among the diverse regional innovation stakeholders – firms, universities, research centres, etc. (OECD 2011; D'Allura et al. 2012). Within the scope of regional science, innovation is a process attached to a spatial context, a territory where the socio-institutional environment and economic structure characteristics enable the cooperation of firms and knowledge-creating and -diffusing institutions in innovation activities (Cooke 2008; Asheim et al. 2011; Camagni 2014). Therefore, the regional innovation systems approach is either a particularly useful methodological analytical filter to understand regional competitiveness, or a framework for constructing more adjusted strategies to cope with the challenges of entrepreneurial and territorial competitiveness.

This chapter examines the Centro Region innovation system in Portugal, trying to understand its state of deepening and maturation – this constitutes the main guideline of this

research. It comprises two fundamental sections: the first one, addressing the main characteristics of the Centro regional innovation system, pointing out some of its main structural features (RD&I infrastructure, the innovation incentives system, innovation barriers and innovation drivers) from a comparative perspective on an inter-regional, national and EU basis. The second one analyses the implications in terms of territorial innovation policy. Methodologically, the research is supported by a literature analysis, statistical data, fieldwork with the application of semi-structured interviews with regional innovation stakeholders, and content analysis.

6.2 The Centro Region innovation system

6.2.1 National and EU contexts

The Centro Region of Portugal is made up of 100 municipalities, covering an area of 28,199 km^2 (representing 30.6% of the total area of Portugal, being its second largest region), has an international land border with Spain of 270 km length and with an Atlantic coastline of 279 km. Its estimated population, for 2017, of 2,243,934 inhabitants – which corresponds to a demographic decrease of 3.6% since 2011 and highlights one of the main structural regional problems, an ageing population coupled with continuous flows of outwards migration. Coimbra is its most important city, with an estimated population in 2017 of 134,156 inhabitants, the territory is characterised by a network of well-distributed medium-sized cities, showing, however, a highly differentiated development pattern between the coastal and inland areas. It is, in general terms, a low demographic and economic density territory, with an urban hierarchy anchored to small to medium-sized cities (more S than M, by European standards).

Figure 6-1: The Centro Region and its NUT III sub-regions (inter-municipal communities)

Source: CEC (2018)

In 2016, the gross domestic product (GDP) generated in the Centro Region was 32.3 billion euros, representing 19.0% of national GDP, making it the country's third region , after Lisbon and the North, in terms of contribution to national GDP. The GDP per capita (15,677€/inhabitant, 2016) represented 87.4% of the country's average.

The majority of industrial activities that make up the most relevant specialisation areas in the Centro Region have a strong exposure to international markets when compared to the national average. The very strong concentration of exports in a limited number of specialisation sectors (pulp and paper manufacturing, plastics, mineral products, metal products and machinery and equipment) account for almost half of the Central Region's total exports, representing 20% of total regional gross value added (GVA). The most important sector in regional exports is the manufacturing of motor vehicles and components for motor vehicles. As mentioned above, the Centro Region has a diversified production structure in which traditional areas of expertise (ceramics, non-metallic minerals, forestry and resulting products such as pulp and paper) coexist with newer economic activities based on technology (metal mechanics, moulds, equipment) and also knowledge-intensive activities (information technology, biotechnology, renewable energy, new materials and health) (CCDRC 2016). The Centro Region also possesses

strong knowledge and innovation generation capacities relevant to several of these areas of expertise.

Table 6-1: Centro Region *vs* Portugal and the EU: a quick portrait

	Centro Region	Portugal	EU
Population	2,243,934	10,320,934	511,522,671
Population density per km^2	79.6	112.5	118.3
Ageing index	188.5	143.9	123.9
Share of the population aged 30-34 with tertiary education attainment (%)	32.7	31.5	39.9
Early leavers from education and training (%)	10.5	11.0	10.6
PhD's/1,000 inhabitants	2.0	1.8	1.1
Unemployment rate	6.9	9.8	7.2
Average monthly salary (€)	950.5	1,152.3	1,520
GDP p.c. (€)	15,677	17,934	27,700
Coverage rate of imports by exports	117.7	84.5	112.9
GVA share in medium to high-tech manufacturing	11.5	22.6	35.2
Share of enterprises employing fewer than 10 employees	96.5	95.7	94.9
European patent application per million inhabitants	98.0	14.1	111.97
Share of enterprises with innovation activities (2012-2014)	60.2	58.8	78.0
R&D expenditure (% GDP)	1.2	1.3	2.0
Share of the R&D expenditure by expending sector – Enterprises	47.6	42.7	55.3
Share of the R&D expenditure by source of funds – Enterprises	42.1	42.5	54.3

Source: INE, Pordata, Eurostat; Last year: 2017 or last available year

In 2017, the region's exports of goods amounted to approximately 10.7 billion euros, representing 19.3% of the national total, but showing a decrease compared to 2016 and 2015. Exports of goods continued to surpass imports (117.1%), although by a lesser margin than in the previous five years. This export-focused profile is, indeed, one of the main structural features of the industrial regional fabric and a sign of its global competitiveness. One of the economic traits of the regional economy is precisely this diversified manufacturing profile that has persisted over decades – in fact, even when suffering from

acute structural adjustments processes in some sectors (e.g., the downsizing of the textile and clothing industry), the Centro Region never really de-industrialised and has, on the contrary, over the years, diversified and extended its specialisation pattern to include new emergent productive areas (CCDRC 2018).

According to the RD&I indicators shown in Table 6-1, both the Centro Region and Portugal as a whole still struggle to translate their scientific excellence into economic value, and both the regional and the Portuguese business innovations lag behind their European peers in technological outputs achieved through their innovation efforts. This comparative perception of the framework at national level is important, as it is also important to realise the Portuguese framework in the context of the European Union – Table 6-2 shows a comparison, according to a selected group of indicators of the European Innovation Scoreboard.

Table 6-2: Centro Region Innovation Scoreboard indicators relative to Portugal and the European Union

	Data	Compared to	
		PT	EU
Tertiary education	29.6	91	72
Lifelong learning	9.5	99	92
International scientific co-publications	1,053	102	102
Most-cited scientific publications	9.2	102	109
R&D expenditures public sector	0.69	100	97
R&D expenditures business sector	0.65	105	68
Public-private co-publications	28.7	90	50
EPO patent applications	0.55	100	34
Trademark applications	4.31	87	85
Design applications	0.67	86	77
Employment in medium and hightech manuf./ knowledge intensive services	7.8	75	52
Exports of medium and high-tech manufacturing	38.0	104	70
Regional Innovation Index2017 (same year)	-	104.4	85.0

Source: Regional Innovation Scoreboard 2017

Table 6-2 illustrates some structural divergences between the Centro Region (a *Moderate + Innovator*), Portugal (a *Moderate Innovator*) and the European Union. Not surprisingly, it is particularly noticeable that the regional and the national innovation systems share many characteristics; they are very much alike in overall terms, the Regional In-

novation Index for the Centro Region being slightly better than the one for Portugal, however both lagging behind the EU index. Despite the efforts pursued in terms of R&D inputs (the public sector as the main source of funding R&D activities, the business sector still assuming a role well below the EU average), both Centro Region and Portugal still lack a proportional translation into innovative economic performance. The scientific-technological and economic systems results are observed in the low capacity for patenting, in employment created in medium and high technology manufacturing and in exports of products with medium to high technological content. Centro is the second-placed Portuguese region with the best performance in terms of innovation, but lower than the European Union average in 2017 (85.0%). In the total of 220 European regions it is in the 121st position, while in the group of the 85 moderately innovative regions it is in the eighth position. Variables such as innovation spending (except R&D), the proportion of SMEs with intramural innovation, the proportion of SMEs with product/process or marketing innovations or organisational structures contributed to this relatively good performance.

6.2.2 The Centro Region S&T system: inter-regional perspective

In 2016, investment in research and development (R&D) in the Centro Region was 447 million euros, which represented 18.7% of national R&D expenditure. Compared to 2015, there was an increase in R&D investment of 7.5%. Its share in gross domestic product (GDP) in the region also increased to 1.27% but was below the national average (1.29%). This figure remains well below the 3% target set for 2020. The proportion of regional investment in R&D borne by the private sector in 2016 stood at 52.6%, even surpassing the national average of 50.0%. The national and the regional research and innovation systems are largely driven by the business enterprise and higher education sectors. Over the last decade these two sectors built on their dominant position in the system as R&D performers, while the public sector concentrated on its funding role.

Table 6-3: The Centro Regional R&D system in perspective

	R&D investment, 2016 (thousands €)	Share of the R&D investment on the GDP, 2016 (%)	Share of the R&D investment on the national total, 2016 (%)	Share of the business sector R&D investment, 2016 (%)
Portugal	2,388,467	1.29	100	50
Norte	748,158	1.37	31.3	50.4
Centro	447,221	1.27	18.7	52.6
AM Lisboa	1,071,716	1.61	44.9	50.5
Alentejo	65,974	0.54	2.8	49.6
Algarve	29,930	0.36	1.3	16.4

Source: CCDRC 2018

It is worth adding that going with these characteristics, the national S&T system is geographically very unbalanced, since there is excessive concentration in the metropolitan areas, with a particular focus on the Lisbon region (Table 6-4). The Lisbon region is responsible for nearly half of the total public and private expenditure on R&D and about the same proportion of the total human resources dedicated to these activities.

Table 6-4 S&T indicators by NUTS 2

	Human resources in science and technology (HRST), by NUTS 2 region	Employment in high-tech sectors (high-tech manufacturing and high-tech knowledge-intensive services), by NUTS 2 region	Patent applications to the EPO by priority year, by NUTS 2 region	Total intramural R&D expenditure (GERD), by NUTS 2 region	Researchers, all sectors, by NUTS 2 regions
	(% of economically active population, 2017)	(% of total employment, 2017)	(number of applications per million inhabitants, 2012)	(% of GDP, 2015)	(% of total employment, 2015)
Norte	31.2	2.5	7.23	1.35	0.79
Centro	30.9	2.0	11.72	1.22	0.72
Lisboa	45.3	4.8	8.63	1.51	1.38
Alentejo	28.8	2.1	7.83	0.53	0.30
Algarve	30.4	n.a.	3.74	0.37	0.34

Source: Eurostat (2018)

Nevertheless, regarding Centro Region, it should also be noted that the spatial distribution of the S&T and technology transfer organisations, under the influence of either the universities of Coimbra, Aveiro and Beira Interior, or, of the polytechnics of Viseu and Leiria, is a strong facilitation factor for implementing a regional innovation system policy. The locations of the research infrastructure (research labs, technological centres, S&T parks, incubators, etc.) industry show a noteworthy concentration around those higher education institutions and urban centres and should constitute a plus and a lever for the formulation of regional innovation strategies.

6.2.3 The RD&I infrastructure

The regional innovation ecosystem has been progressively consolidated through the existence of a number of higher education establishments (with around 80,000 students), a large number of research units (some of them recognised for their excellence, also internationally) and a wide range of institutions promoting innovation and technology

transfer (including three centres of the National Network of Technology Centres, 16 incubators of companies that constitute a regional network – with Instituto Pedro Nunes being a recognised international reference – and a network of seven science and technology parks, with Biocant in nearby Coimbra, standing out. It also includes three thematic clusters and five competitiveness poles based in the Centro Region, as well as a significant set of support structures for productive activities, which are a strong supporting tool for innovation (a particularly important aspect given the small average size of the nearly 70,000 companies in the Centro Region) (CEC 2018).

Table 6-5: The regional institutional infrastructure: an overview

Territorially embedded RIS operators	Regional clusters in activities with low capacity of generating new S&T opportunities (supplier dominated sectors)	Relevant local clusters of ceramics and construction materials, glass and crystal industry, metallic furniture
	Regional clusters in activities with capacity for the creation of new S&T opportunities	Moulds cluster, evolving into engineering activities; health cluster; energy cluster.
	Non-R&D professional and technical institutions supporting training, S&T inputs and other specialised services	Sectoral technological centres located in the region (glass, ceramics, moulds, agro-food)
	Knowledge-intensive business services	ICT cluster based on regional start-ups, linked to Univ. Coimbra and Aveiro; Health cluster – Univ. Coimbra and UBI
	R&D institutions (universities and other non-profit R&D units)	R&D institutions providing human capital and knowledge in all the scientific domains
		Critical masses of scientific resources in telecommunications, new materials, information systems and in health activities
	Regional interface/brokerage institutions (science and technologic parks, technology transfer offices, …)	Biocant, a specific industrial park for bio-firms already in place
		Emergent regional structures of interfaces academia-industry
		Regional network of NTBFs incubators (RIERC)
Regionalised external innovation system operators	External business investments in high-tech or R&D activities	Altice/Nokia/Siemens R&D centres in Aveiro
		IBM R&D centre in Viseu Altran R&D centre in Fundão
		Bosch R&D centre in Aveiro – thermotechnology

Source: Adapted from Almeida et al. (2008)

There is a large number of research institutions, some of them with a good scientific reputation and staffed with highly qualified researchers, nevertheless, the mechanisms of technology transfer to industry are still inadequate, although this situation has been improving generally recently due to policies oriented towards the creation of transfer instruments, the pressure on public institutions to self-finance their activities and the increased technological awareness of industry.

It is also important to emphasise the significant entrepreneurial orientation of the regional innovation policy that is being implemented, namely in terms of the institutional innovation support concerned with start-ups promotion. In fact, in 2007 Centro Region initiated the creation of the RIERC – Network of Business Incubators of the Centro Region - which sees itself as a regional network, integrated into the innovation ecosystem, which, apart from contributing to the regional (and national) policy formulation, basically is oriented towards the implementation of incubators to help promote entrepreneurship and innovation, with a strong connection to the regional scientific and technological system.

Figure 6-2: The Network of Business Incubators of the Centro Region

Source: www.rierc.pt

Currently, as mentioned before, there are 16 incubators spread all over the region that are part of the network and that, at different maturation stages and operative conditions, take an active role in promoting entrepreneurship and creating value and employment in the area where they are located, namely by supporting the creation of start-ups and academic spin-offs.

6.2.4 Enterprise incentives system

Within the framework of the incentive systems available in the NSRF and Portugal 2020, Centro Region focused heavily on the financing of research and innovation and made intensive use of the tools to support innovative business initiatives. The sectors most represented in the supported investments are the manufacture of pulp and paper products, the research and development of the physical and natural sciences, the manufacture of chemicals, metal moulds, tourism, the manufacture of motor vehicles (including components and accessories), glass and ceramics, plastic articles and information technology.

Table 6-6: Enterprise incentives system of the Operational Programme CENTRO 2020

Investment typology (%)	Entrepreneurial innovation (SI Innovation)	64.9
	SME qualification and internationalisation (SI SME qualification and internationalisation)	20.4
	Financial instruments	9.7
	RTD (SI I&DT)	5.0
Size of enterprise (%)	Small	40.8
	Micro	29.1
	Medium	18.0
	Large	2.4
	n/a	9.7
Sector of activity (%)	Manufacturing industry	67.6
	Services	9.8
	Commerce	5.3
	Other	17.3

Source: Centro 2020 (30 June 2017)

The business incentives system shows, in terms of the preponderance of allocation and commitment, that, of the overall European funds allocated to the instrument, 64.9% corresponded to approvals in the area of business innovation and entrepreneurship, while only 5.0% of the investment is related to R&D projects – medium low-tech/low-tech, are only about 20% of this.

The projects supported by SI Innovation are directed towards the promotion of innovation in the business fabric, either through the means of introducing innovation in the market (product innovation) or through innovation to be used by the company (process innovation). They should serve to increase innovative productive investment (incorporating new

technologies), strengthen the businesses' orientation towards international markets, and stimulate skilled entrepreneurship and structuring investment in new areas with growth potential. Basically, however, they are addressing the tangible innovation modalities of products and, mainly, of processes, neglecting other critical dimensions, such as organisational or market innovations. That said, it seems this is largely an effect of a still prevailing business model based on volume and scale, the competitive advantages of which are more due to labour costs than to quality, differentiation and innovation.

SI research and technological development projects finance research and technological development projects of companies, alone or in association. They aim to improve the ability of companies to produce, absorb and apply knowledge in order to increase the competitiveness of enterprises. As there are not many firms at such a mature stage in terms of their innovation strategies, this explains the reduced financial volume allocated to this end. The projects supported in qualification and internationalisation apply only to SMEs and are aimed at stimulating the competitiveness of SMEs by increasing productivity, flexibility and responsiveness and active presence of SMEs in the worldwide market.

Centro Region allocates a large share of structural funds to innovation objectives, along with the high public co-financing rate granted to EU convergence regions for investments in research projects – spanning from 50% for large companies to 70% for small ones. This context makes it attractive for enterprises to pursue their innovation activities in the region. It also signifies a solid incentive for extra-regional and multinational enterprises to proceed with research and develop innovative outputs in Centro Region, compared to EU 'Competitiveness' regions where co-financing rates are lower, such as, for instance, in the Lisbon Metropolitan Region.

6.2.5 Governance

It is important to note that Portugal is not a regionalised country, apart from two autonomous regions: Azores and Madeira. With those exceptions, regional affairs of public government in Portugal are typically consigned to the state's decentralised administration organisations: Regional Coordination and Development Commissions (CCDRs), regional directorates and groups of municipalities (inter-municipal communities that form the NUTS 3 regions). The design of science, technology and innovation policies is mainly the responsibility of the central administration, nonetheless it is partially delivered at regional level by the Regional Coordination and Development Commissions, the CCDRC for the Centro Region, which have financial and administrative autonomy and are entitled

to implement their own regional operational programmes in line with strategic state policies. The CCDRs manage the regional operational programmes, which include measures aimed at promoting innovation on a territorial basis.

Regarding particularly the RIS3 Centro, which establishes the strategic guidelines for the current programming cycle 2014-2020, it is being developed by CCDR Centro according to the governance model shown in Table 6-7.

Table 6-7: RIS3 Centro governance

Governance bodies	Functions
Regional Council	An advisory body of CCDR Centro that works as a forum of the regional RD&I ecosystem. It is responsible for the overall approval of the action plan and for ensuring wide institutional mobilisation and support for its implementation.
Coordinating Council	It is led by the CCDRC and composed of a group of regional entities that assume responsibility for the management of the RIS3 development and monitoring work.
Working Groups	Thematic groups whose aim is to support the process of entrepreneurial discovery, and to stimulate innovation and internationalisation, cooperation and networking. At present, there is one for each Innovation Platform (sustainable industrial solutions; natural endogenous resources appreciation; technologies for quality of life; territorial innovation).
Strategic Counselling Group	This institution involves well-known personalities who use strategic thinking about the region and/or smart specialisation and who can make a valuable contribution to the process.
Management Team	It is composed of members of the CCDRC and the external coordinators of the Working Groups; has executive functions and is responsible for streamlining work, promoting meetings and producing documents.

Source: own compilation

From a multi-level perspective, there is a Coordinating Council of ENEI (National Strategy for Smart Specialization), chaired by ANI (National Innovation Agency), which is responsible for ensuring the effective coordination and exchange between ENEI and the regional strategies, such as, in this case, the RIS3 Centro.

6.2.6 RIS main innovation barriers

Barriers associated with the private sector

Concerning the full exploitation of the Centro Region innovation system, there are several structural constraints that restrain its dynamics or even impede the RIS from following an easier upgrading trajectory.

The large majority of SMEs (more S than M), have structural deficiencies associated with the academic qualifications of their human resources. Most companies do not have qualified employees who may enable them to fully assimilate strategic cognitive resources and gain competitive advantages. This should put the recruitment of middle and senior staff among the main sources of competitive advantage of companies. Besides the large majority of the small and medium-sized entrepreneurs have attained no more than the basic education level and the RD&I infrastructure installed seems too far away from their needs and expectations.

It is no surprise that, in this context, there is a reduced entrepreneurial demand for dynamic competitiveness factors (product engineering, quality management, design) which is also not unconnected with the productive profile of more traditional and low-technology industries, low knowledge-intensity; a situation that embodies a fragile demand-pull. The existing technology transfer system still needs to be adjusted to the specific needs of small and medium-sized lower tech firms that account for the vast majority of the regional productive environment (Santos 2012). They have a specific kind of demand that needs to become explicit so that the innovation support infrastructures can conform to their requirements: most SMEs usually need know-how which is often lower than the scientific and technological levels of universities, technological centres or other public or private innovation support institutions. It must also be emphasised that non-innovative SMEs – that is the larger part of the regional productive fabric – are seldom taken as a priority target by those innovation support infrastructures (Natário et al. 2012).

Mostly, entrepreneurial strategies are more based on volume and scale than on differentiation and innovation. Innovations mostly follow dominant technological paths, based on already existing knowledge and mostly being incremental. Companies, in general, are bound by market pressures to take up a competitive position that consists mainly of the systematic and gradual renewal of production processes (gradual and partial automation of production lines, etc. ...) with the aim, for the main part, to increase productivity, improve delivery times (quick response) and reduce the need for labour. Resulting from *Fordist* strategies, they seek to optimise scale and volume: that is the reason why other key type modalities of innovation are inadequately addressed – little attention is being paid to the intangible dimensions of innovation. This seems a consequence of a predominance of a very restrictive notion of innovation among the vast majority of Portuguese entrepreneurs as they confuse modernisation strategies based on the renewal of physical capital goods with innovation.

So, there is an increased awareness concerning the need to change the basis for the competitive advantage of the Centro regional fabric. A vast majority of the research capabilities still lacks substantive interaction with firms and the intensity of technological

start-ups is still low (Santos 2012; Araújo et al. 2013; Gama et al. 2018). RD&I capabilities oriented towards the incorporation of knowledge in the qualification of endogenous resources are incipient, not well targeted and with no systematic interface with a vast number of SMEs that make up the backbone of the Centro regional economy.

In reality the demand-pull factors of innovation are quite modest. Three programming periods of the co-funded EU support, already involving competitiveness and innovation goals, resulted in few organisational learning results in targeted objective 1 territories. It seems, thus, that the extremely centralised and hierarchical architecture of the national innovation system, in fact, constitutes a bottleneck in establishing culture of proximity among entrepreneurial and institutional actors (Figueiredo 2007).

In an attempt to close the gap between university and industry, a number of interface institutions, such as the AdI, an innovation relay centre promoted under the framework of the STRIDE programme, were created in a context of central government initiatives. However, the majority of these innovation catalyst institutions belonging to the Portuguese innovation system seldom adopt a territorial focus – on the contrary, being vertically and strategically dependent, they have to fulfil national targets that sometimes inhibit the promotion of horizontal cooperative behaviours among the regional actors and the complete exploitation of regional synergies.

Mostly, knowledge sources are external both to the enterprises and to their territorial contexts. Thus, innovation dynamics are not sufficiently regionally embedded, there is a deficit of regionally rooted innovation networks, a fundamental characteristic of a mature territorial innovation system. In general, the business partners along the value chain are not located in these territorial spaces either and, consequently, the dynamics of innovation are not regionally rooted (Xavier and Vaz 2013). Moreover, a large share of the regional business community, including the vast number of SMEs that make up the backbone of the regional economies, remain unaware of the mechanisms of information transfer and knowledge in place, not being part of the local/regional innovation systems, because these are practically non-existent at a regional level or due to the fact that the national innovation system seems too far away from the real needs of this wide range of companies. Technical knowledge is shared on the basis of informal locally-based networks, in which information circulates and is shared. The vast majority of the productive fabric seldom establishes other links apart from those with their commercial partners, namely their suppliers and clients, which results in innovation dynamics that are not territorially embedded.

So, besides their dimensional handicap, as the vast majority of the Centro regional enterprises are small to medium-sized, the true critical bottleneck is their relative isolation,

i.e. not being connected to the information and knowledge flows or to the rest of the world, the so-called *loneliness syndrome* (Santos and Simões 2011).

Barriers associated with the public sector

Portuguese regions are, as mentioned before, *planning regions*, with no political statutory power. In this territorial and institutional context, the risks of crowding-out effects are high – for instance, the strategy of attracting FDI in knowledge-intensive activities and services is led by national agencies, with practically no receptiveness to regional innovation systems.

It must be added that Portuguese RD&I policy, as it is centrally defined and implemented (top-down), is specially targeted at the preparation of the economic fabric for the globalisation process although, paradoxically, in overall terms, it is not very market-oriented. Defined and implemented from a national level and perspective, this policy tends to deepen vertical hierarchical connections and even centralism, instead of aiming to fertilise regionally based innovation dynamics (Vaz et al. 2014). In Portugal, there are no regional innovation policies formulated on a regional basis and neither is there a territorially based regional innovation policy. The innovation policy, designed and implemented on a national level, has not, in fact, restrained disparities among the Portuguese regions, due to a logic that is largely conditioned by the volume and qualified entrepreneurial demand that particularly favours the most dynamic regions - Lisbon and Oporto.

Chronically, one of the handicaps which also still typifies this region is related to the fact that its technological patterns are characterised by a S&T system in the public sector (universities, R&D laboratories) that is over-represented relative to the effort employed by the private sector (Laranja 2009). This normally implies consequences for the direction of research activities that are carried out. In these contexts, guided mainly by internal academic logic, these research activities are directed more towards earlier stages in the innovation process, towards focusing on fundamental and applied research, moving away from the market needs (Santos 2000; Koschatzky 2003). Moreover, although there is a relatively dense array of RD&I public (or associative, nearly semi-public) institutions in the Centro Region they are often multi-function organisations whose contribution to, and impact on, the innovation ecosystem is achieved mainly as a by-product of their main functions and responsibilities rather than as their primary task.

6.2.7 RIS main innovation drivers

The regional innovation main drivers, as Isaksen and Trippl (2016) suggest, are connected to stakeholders and processes centred on exploring the logic and mechanisms that are, or can be, activated as a means to promote innovation and competitiveness –

in this case, within Centro Region – and, within this, across and within firms. Which are the means that can be activated for the construction of new pathways for the promotion of the regional innovation capability?

First, there has been a vast investment in RD&I infrastructures that has to be fully exploited, principally by the strategic mission reorientation, avoiding academic drifts that result in low fertilisation levels of the regional economy. Universities dominate the R&D and higher education activities: two in the coastal area, Coimbra and Aveiro and one in the interior (Beira Interior), accompanied by a network of polytechnic schools. The most important R&D labs were created in proximity of these higher education institutions and, they too, need strategic reconfiguration. This institutional endowment is critical: universities need to keep producing both skilled human capital but also an adequate level of applied research, both of which could then be suitably employed to satisfy industrial technological needs. These ingredients are a pre-condition rather than part of the place-based innovation policy. Thus, selectivity is needed in establishing an ambitious place-based innovation strategy that may respond to these challenges. To avoid regional lock-in, it is crucial that the strategy is open to newcomers and new policy experiments.

Secondly, it has to be underlined that foreign direct investment has had a significant positive impact on the overall regional innovation capacity. More recently, and this has become more pronounced in the region, investments also occur in the R&D sphere, with the implementation of competence centres, such as in Aveiro (Altice, Siemens, Bosch), Viseu (IBM) or Fundão (Altran). These are very relevant investments of multinational companies. The potential of this positive outcome is largely dependent on the availability of the absorptive competences and the presence of innovation-complementary assets in the Centro Region (Crescenzi and Gagliardi 2018). This seems strategic for the region and should constitute a priority in terms of policy design – the type and quality of FDI inflows, if well accommodated, has the potential to serve as a driver of a knowledge-based development strategy. Innovation is an evolutionary and accumulative process. Only with the necessary capabilities to identify, assimilate and integrate these useful and strategic sources of external knowledge can the host region, Centro, effectively be impregnated with the codified knowledge embedded in FDI. In this ambit, the need to deepen the understanding and obtain empirical evidence concerning the knowledge flows between RD&I foreign direct investments and the absorptive capacity at the firm level, namely in peripheral low-density areas, should be recognised.

Last, but not least, an important structural innovation driver might be associated with the gradual renewal of the firms' top management as well as the irreversible tendency towards equipping companies with more qualified human resources. The existent network of good quality higher education institutions is a guarantee that the flow will continue.

Together with a new generation of start-ups, some born of incubation centres, as university spin-offs, this is a vast structural movement that will make more new S&T-based firms emerge, a change that still has residual economic impact but a high potential for upgrading the regional competitiveness dynamics. It is foreseeable that the gradual emergence of new economic *filières* goes hand in hand with a relevant technological upgrading of the installed activities that are territorially embedded as local productive systems. The Centro case highlights that the regional innovation dynamics will profit if they continue to rely on industrial expertise. Strong industrial vocation activities in certain emergent sectors and an already well-established productive system, often developed in connection with a few large enterprises, are preconditions for the development of successful clustering dynamics (Isaksen and Trippl 2016). Some of these clusters are already evolving towards more diversified patterns of specialisation (automation and robotics, moulds, components for the automobile industry, ICT) and need to be closer linked to the potential associated with the knowledge-intensive business services (KIBS) sector. So far they do not meet the needs of their clients, but should establish codified knowledge bridges and points of innovation between companies and science (Strambach 2008).

6.2.8 The Centro innovation system – synthesis

In a nutshell, the Centro Region, in innovative terms, has performed above average in Portugal, lagging, however behind its European peers regarding the technological outputs of the innovation effort. It still has a long way to go to gain economic value from its scientific excellence. The regional innovation system possesses institutional thickness concerning, namely, the S&T infrastructure but it still lacks effective and systematic coordination in order to improve networking conducive to a higher innovation profile. Despite the emergence of new innovative sectors and firms, the majority of the entrepreneurial regional fabric, mostly SMEs, suffer from structural innovation handicaps. Nevertheless, the potential exists to gradually improve this situation and, accordingly, some regional innovation drivers were pointed out (the installed RD&I infrastructure, the RD&I foreign direct investment, the increasing qualification process of human resources) – they can be activated by the regional governance for the construction of new pathways to promote the regional innovation capability.

6.3 Public policy measures for a (possible) intervention

6.3.1 The need to avoid some misconceptions

The successful design and implementation of regional innovation systems face different challenges that, often, are omitted from the discussion about their effectiveness and impact. Moreover, it seems that, unless these issues are addressed correctly, it is probable that territorial-based innovation policies might suffer strategic drifts that policy instruments can hardly overcome. We are talking about the fundamentals that define the conceptual, theoretical, methodological and strategic RIS frameworks.

i) The technopolitan misconception or the Silicon Valley syndrome. This myth of an (almost) exclusive strategic bet on emergent sectors, which results from the allure of well-known successful case studies, implies that, sometimes, the specificities of the regional socioeconomic and institutional fabric are not duly taken into consideration. Strategic diagnoses lose importance as recipes are taken for granted and, if this happens, the whole planning process might be questioned, as this increases the likelihood of the regional innovation systems losing external and internal coherence. The reorganisation of traditional industrial sectors clearly constitutes, especially in remote areas with fragile economic structures, one of the main challenges that an innovation policy needs to equalise (Santos 2000).

Thus, regional development is a dynamic process in which we cannot simply imitate or copy other well-known successful regional development cases. Although, it is possible, to some minimal extent, to make use of some successful regional development strategies from one region and apply those to another region that possesses analogous geographical, institutional, organisational, and cultural features (Rune and Jakobsen 2018). However, a region can only develop and make long-term progress utilising its unique cultural traits and endogenous local capacities to enhance its innovation potential. Above all, it is important to avoid uncritical mechanical transfers of policies and instruments. Instead, having been adjusted to the idiosyncrasy of certain successful exemplar regions, these should not be replicated one to one elsewhere, but rather they should be regarded for policy-makers as case studies for learning but not necessarily for emulation (Koschatzky 2009; Capello 2014).

ii) The misconception of innovation or the technological determinism myth. Too often policy-makers, as well as entrepreneurs, seethe innovation challenge in a skewed way, often reducing innovation to a new product or a new production process, failing to incorporate innovation global strategies, and the other critical dimensions of the entrepreneur-

ial innovative output, consequently missing the potentialities of a more integrated approach. Besides, there is a clear predominance directed towards the promotion of "hard sciences" and engineering. In a time of new paradigms, such as open innovation or social innovation, all this is necessary but not sufficient. Innovation also requires social scientists, designers and managers. It requires innovation in the services sector. Moreover, it requires multidisciplinary teams that can combine their skills to come up with new products, develop new ways to produce them, find new markets, and develop new ways to learn from and respond to their customers. Thus, such a skewed and simplistic conception of innovation reduces the window of opportunities for the affirmation of new competitive solutions, both in the field of public policies to promote innovation and in the business sphere.

Low-tech industries especially still focus on the technical dimension of innovation and have great problems translating technological inventions into marketable products. As low-tech companies obviously need more advice in designing and marketing their products, a service supply in these fields should be developed (Fernández-Esquinas et al. 2017). Another critical dimension is related to the integration of emerging new technologies from the high-tech industries into the low-tech industries as a means to transform and renew existing areas of strength in these industries. This implies more intensive collaboration between the two sectors in innovation processes. Cooperation between high-tech and low-tech industries, however, is difficult to attain due to different cultural paradigms, academic profiles of human resources, etc. (Godinho and Mamede 2016; Boschma 2017).

iii) The misconception of the institutional thickness or "Too many cooks spoil the broth" *versus* "institutional sclerosis". The official orientation towards the widening mobilisation and participation of regional agents in the planning process is based implicitly on the idea that "the more, the better". Rodriguez-Pose (2013) has argued that the effectiveness of institutional arrangements is not necessarily a problem of having too many or too few institutions, rather it is a matter of having the right mix of engaged stakeholders. This angle is intuitively attractive, as both the theoretical literature and published case studies suggest that while some places are confronted with institutions that are too small or too few to facilitate growth, others have a multitude of actors, often resulting in cacophonic participative processes and in a tendency to crowd each other out (Hauser et al. 2007). Tomaney (2014) noted that, while there is inevitably an uneven geography to regional institutions, they, notwithstanding, contribute to the instrumental performance of regions, while, simultaneously, serve to affirm territorial identities.

From this perspective, in the absence of a portfolio of adequate key institutional innovation enablers, it is hardly unexpected that efforts to implement even the most coherently

designed innovation development policies are bound to have frequent failures and lack effectiveness. Amin (1999) had already signalled that institutionally thin regional milieux often end up dominated by elites in a process that was named *institutional sclerosis*, frustrating prospects for a more competitive and sustainable development trajectory. Institutional sclerosis spreads discontentment and distrust in the territorial public policy-making process, driving regional stakeholders away from what was intended to be a participatory process (Gertler 2010). Moreover, institutional lock-ins and path dependencies forming vicious circles further contribute to causing additional structural development problems, mainly in lagging regions, such as Centro Region in a European perspective.

6.3.2 Redesigning public policies conducive to innovation

Public policies conducive to innovation, at least in peripheral low-density areas, such as Centro Region, face different theoretical, strategic and methodological challenges. Peripheral regional innovation systems are, habitually, typified by being less innovative, in contrast to more central urban-metropolitan areas; they have a lower R&D intensity and less innovation, a less developed knowledge infrastructure (HEI and RD&I institutions) and a lower innovative performance, and also suffer from governance and organisational handicaps – overall, Centro Region confirms this assumption.

Can we talk about a Centro regional innovation system? Most of the elements that can constitute the core of an orthodox RIS already exist – but these basic prerequisites are only a point of departure. Nevertheless, it seems institutional thickness has no corresponding or systemic cooperative networking nor proportional institutional capability. We can argue, therefore, that the Centro Region innovation system is fundamentally still an embryonic entity, or a RIS in transition. The main diverse building blocks of its structure are there, along the knowledge-production, diffusion and absorption interactive process, yet there are no systemic collective learning dynamics. Innovation is an output that still results mainly from individualistic behaviours and ad-hoc initiatives.

Nevertheless, S&T incentives have strongly contributed to the consolidation of the public regional S&T system, with high efficiency levels in scientific outputs but with a limited direct contribution to the economic exploitation of results, which reflects the old Science Push dilemma. Even though RD&I incentives have contributed to a substantial increase in firms' R&D activities, including organisational additionality, and made an important contribution to an increasing articulation of the innovation system, this has only been attained by a relatively small number of the Centro Region enterprises, as mentioned before.

A first generation of public-push policies for the S&T subsystem (e.g. SAESCTN) coupled with a complementary support according to a demand-pull logic towards the technological needs of firms (e.g. SI I&DT) was important either as a vehicle for the reinforcement of the institutional infrastructure dedicated to RD&I by bringing additional (at least, public) institutional thickness to the RIS, or as an instrument for inducing preliminary learning behaviour.

Nonetheless, as we have seen, there is a lack of strategy and of collective dynamics, as institutional thickness and RD&I investments are not being translated into a proportional regional innovative capability. An increase in regional capability for innovation inevitably should involve new forms of organisations and institutional partnerships to help improve the structural competitiveness of the companies (Pinto et al. 2012; Santos and Simões 2014). Infrastructure is visible but requires efforts to generate spillover effects.

Laranja (2009) argues that this also should imply a change of focus from the allocation of resources for innovation to focusing on innovative learning, aiming for a behavioural value-added through the pursuit of a collaborative and pedagogical, even somewhat experimental, oriented perspective - thus reinforcing the mechanisms for horizontal coordination and partnership, as well as interface management, avoiding public interventions supported by sectorial logics or fragmented actions.

In this context, one can argue that a step forward is needed, for territorial innovation policy, merely understood as the chronic search for an adequate equilibrium between the science-push and demand-pull perspectives, seems not enough (Santos 2009; Uyarra and Flanagan 2010). Trying to prevent a more profound innovation gap within the productive fabric emphasises the need for a more platform- and system-oriented, as well as a more proactive innovation-based regional policy in order to construct regional advantages – changing innovation policies from being almost exclusively S&T and firm-oriented to a territorially-based system approach conducive to innovation.

6.4 Conclusion

This book chapter described the regional innovation system put in place by Centro Region and analysed the value added that can be attributed to such a system as far as innovation and economic development promotion are concerned. Its strengths and weaknesses were critically examined and discussed to produce lessons learned with hopefully more general importance.

Centro Region has a diversified production structure in which traditional areas of expertise coexist (ceramics, non-metallic minerals, forests and resulting products such as pulp and paper), with more recent economic activities based on technology (metal mechanics,

moulds, equipment) as well as knowledge-intensive activities (information technology, biotechnology, renewable energy, new materials and health). In this ambit, Centro regional innovation policy faces a double challenge: on the one hand, upgrading the competitive profile of the companies associated with the most representative sectors of the different industrialisation models of those territories and, on the other hand, contributing to the emergence, and reinforcement, of new vectors of productive specialisation, trying to create linkages to new and more demanding activities in scientific and technological inputs, providing a sustainable effective accumulation of technical knowledge (Santos 2012).

Overall, the research and innovation system has achieved the targets set out regarding improving its outputs in tertiary education and publications. Also the number of people who have strong knowledge and innovation generation capacities relevant to several of these resources allocated to the system has also increased. However, it was not able to reach the targets regarding the technological outputs and the technological intensification of the economy, or the level of financial resources invested in the system.

Chronically, one of the handicaps which also typifies these peripheral regions, and Centro seems to be no exception, is related to the fact that their technological patterns are characterised by a S&T system in the public sector (universities, R&D laboratories,...) that is over-represented relative to the effort employed by the private sector. This normally implies consequences for the direction of research activities that are carried out, which in these contexts, are guided mainly by internal academic logic, more directed to upstream activities, towards focusing on fundamental and applied research and moving away from market needs (Koschatzky 2003; Cooke et al. 2005). These circumstances are coupled with demand-side problems for which supply-side solutions continue to be proposed and prevail. Unless medium to highly R&D-intensive companies reach much greater scale in the regional economy of Centro, a lack of business receptors will eventually lead to frustrated supply-push policies. Nevertheless, a place-based innovation policy, merely understood as the chronic search for an adequate equilibrium between the science-push and demand-pull perspectives, seems not enough (Lagendijk 2011; McCann and Ortega-Argilés 2013).

Despite the wide spectrum of regional RD&I stakeholders, some aspects are not very pronounced such as regards the existence of territorially rooted cooperation networks, promoting innovative projects, which is, as we know, the essential distinguishing feature of the presence of an innovative environment. Similarly, what might be called a collective learning process is not institutionalised, since although an entrepreneurial culture based on empirical knowledge accumulated over generations exists, companies and institutional actors ultimately follow individualistic paths that do not enrich the regional context

in which they operate cognitively – what might be called a systemic culture of contact is not regionally established.

Yet, as described, Centro encompasses most of the necessary conditions to succeed in the implementation of its innovative upgrading strategy, regarding namely critical mass, industrial strengths, S&T capabilities, stakeholders' interaction potential, and internationalisation (for both business and scientific communities), among other requirements. The Centro regional innovation system needs to keep on focusing and fine-tuning its strategy towards more mature and qualified innovation dynamics.

6.4.1 References

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7 On the support of regional policy for firm innovation: the experience of the Emilia-Romagna region (Italy)

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7.1 Introduction

The role of policy evaluation is of upmost importance when it is directed at supporting innovation in firms, also and above all at the regional level. This is due to the fact that innovation represents a crucial driver of regional economic performance in different ways. Not only does innovation have an impact on income and (labour and total factor) productivity growth of regions, it also represents a leverage for regions to diversify over time, escape from the possible lock-in entailed by the path-dependence on their local capabilities, and embark on the trajectories of structural change triggered by the evolution of the socio-economic context in which they operate (Boschma et al. 2013). In this last regard, policy interventions directed at stimulating innovative behaviours at the local level can contribute to the transformation of the economic structure of regions and eventually benefit their structural change. One only needs to think of the policy support to open innovation practices (Chesbrough 2003), through which regional firms can tap into external knowledge and capabilities, which might be missing for such a structural change to actually occur[1] (e.g. Moso and Olazaran 2002). Similarly, the policy support for business-research cooperations within and across regions can also provide new opportunities for regional firms to renew their knowledge-base and to pave the way for the construction of new comparative advantages (Marzucchi et al. 2015; Boschma 2014). Speaking broadly, regional policy can "add" to the status quo of innovative inputs (e.g. R&D), outputs (e.g. inventions), and behaviours (e.g. investments in intangible assets), which can in turn stimulate additional patterns of transformative change at the local level (Schot and Steinmueller 2018).

Given the high potential of regional innovation policies, assessing whether and to which extent policymakers are capable of rendering firms more innovative is essential to make the regions reap their multiple benefits. Such an evaluation is particularly complex to implement at the regional level, at which innovation contributes to place-specific socio-economic objectives and at which firms innovate in the presence of agglomeration economies (Uyarra 2010), knowledge-bases, institutional set-ups and socially heterogeneous

1 On the role of policies to favour the transfer of green technologies that potentially trigger structural changes in the productive structures see for example the recent works by Fabrizio et al. (2017); Verdolini and Bosetti (2017).

milieus, on which the policy can also have an effect. Accordingly, innovation policy needs to be context-specific (Amin 1999) and a careful evaluation is also required to address the extent to which policies have been developed in a place-based manner (Neumark and Simpson 2015).

In general terms, irrespective the geographical level of analysis, innovation policy can be evaluated in the same way as any other general policy programme. Among the types of evaluation, we can distinguish, according to the chronological dimension: ex-ante, in-itinere and ex-post evaluation. The first one refers to analyses that try to anticipate the effect of a programme in order to compare costs and benefits and provide preliminary insights on the opportunity to proceed with the programme implementation as it is or to modify some programme characteristics. The intermediate type of evaluation is mainly used to assess the validity, efficacy and efficiency of the procedures implemented through the programme. The last type of evaluation assesses, at the end of the programme, whether or not the expected results have been achieved. Among these different typologies, in this contribution we focus on the ex-post evaluation of innovation policy programmes, in particular, on their quantitative "impact assessment".

Although the evaluation of innovation policy is a very differentiated research field, which can cover a wide range of topics, impacts, purposes and employ different methodologies (Edler et al. 2010), in the extant literature, its impact assessment is generally investigated by referring to the "additionality" of the policy. This concept allows the researcher to provide an objective and unbiased evaluation of the policy, by focusing on the net effects that would not have occurred in absence of the public intervention and thus by getting rid of, or at least attenuating, the so-called "economic background noise" of the evaluation. More precisely, the additionality evaluation aims at providing a comparison between the actual effects on the beneficiaries with the counterfactual situation, which describes what would have occurred in the absence of the public support.

As we will illustrate in the following (Section 7.2), when innovation policies are evaluated, their additionality can refer to three dimensions: i) input additionality, referring to the amount of innovative inputs – like R&D and other innovative intangible and tangible investments - that would not have been allocated without the intervention; ii) output additionality, referring to the amount of innovative outputs – such as innovations, patents, and publications that actually occurred – that would not have been achieved without the policy; iii) behavioural additionality, referring to the changes in the innovative behaviours of the beneficiaries – such as, for example, in their R&D cooperation – resulting from the policy intervention.

Along these three dimensions, a consistent amount of literature has been produced (see Dimos and Pough 2016; Becker 2015), with regard to which the present chapter aims to provide a twofold contribution. First of all, we will provide a specific update to the existing reviews of the literature on the additionality of innovation policy, which has two distinguishing features. On the one hand, following the research stream initiated by Buisseret et al. (1995), we will also focus on the behavioural additionality of innovation policy, by trying to counteract a certain bias in the literature on the analysis of output and, above all, input (especially R&D) additionality. On the other hand, we will mainly focus on the empirical studies on the topic, by reviewing the results that have emerged with regards to specific application contexts. In providing this first contribution, we will show that the majority of the latest works on the topic has followed a macro level of analysis, looking for the additionality of innovation policies displayed by samples of firms of selected countries. This reveals an unfortunate slow-down in the investigation of the issue at the regional level, on which the academic literature had been prolific in the recent past (Marzucchi et al. 2015). As a way to compensate for this asymmetry, the second contribution of the chapter consists of the deep analysis of a regional case of innovation policy that has attracted certain attention in the literature, that is, the case of the Emilia-Romagna (Italy) innovation policy programme called PRRIITT: Regional Programme for Industrial Research, Innovation and Technology Transfer (PRRIITT).

7.2 The additionality of innovation policies: an updated review of the literature

The concept of additionality is usually described in a clear and clearly circumscribed way in guidance books and reports on the impact assessment of public policies (e.g. HM Treasury 2011). On the other hand, as the research literature instead reveals, its conceptual simplicity does not pair with the complexity of its operationalisation and measurement.

In a nutshell, additionality can be defined as the additional benefit of a policy intervention, that is: the difference between the value of the outcome variable, on which the policy effect is measured, subsequent to the intervention and its value without the intervention.

We can express this net benefit as:

Additional Benefit = Y1 – Y0

Where Y1 is the value of the outcome variable of interest when the policy is implemented and Y0 is the value of the same outcome variable when the policy is not implemented (reference case). Simply said, we say we are in the presence of a benefit, that is, of additionality, in case Y1-Y0>0. On the other hand, should Y1 be equal to Y0, it is possible

to state that the policy did not produce any effect and did not lead to additionality. Finally, in case Y1-Y0<0, that is, the policy made the reference variable worse off relative to its absence, we say the policy has had a crowding-out effect on the reference case.[1]

Despite the simplicity of the previous statements, when we try to measure the additionality (or other) effect of a policy we come across several difficulties. A first general problem emerges from the fact that the implementation of the policy itself, leading Y to assume the value Y1, automatically makes Y0 unobservable with regard to the same unit of analysis: typically, one of the firms that has been subject to the policy. Such a problem requires the evaluator to resort to specific techniques, which generally consist of the identification of a proper "counterfactual" sample of non-affected firms, with regard to the firms "affected" by the policy.[2]

A more specific problem that emerges in measuring the additionality of innovation policy is the identification of the focal outcome variable, with respect to assessing its impact. Indeed, as the debate in innovation economics has brought out (Lundvall and Borras 2006), innovation is a complex process. Therefore the case for a policy intervention emerges along different dimensions, depending on the adopted theoretical approach. Accordingly, the effect of the policy can be identified with regards to different outcome variables, pertaining to these different dimensions.

As we will illustrate in the following section, the largest part of the empirical literature on the effects of innovation policy follows a standard "market failure" approach and focuses on its input and output additionality. In brief, these are the effects that the policy is expected to have in counteracting the economic obstacles that make firms invest less in innovation (input) and obtain less innovation (output) than would have been socially desirable. The typical outcome variable used to account for input additionality is the R&D expenditure of the focal units – e.g. the firms in a region – but the spectrum of the observable relevant inputs is larger and encompasses, in addition to standard physical investments for the purpose of innovation, a number of intangible investments, such as in design, brand and marketing, human capital, and organisational competences (see Montresor and Vezzani 2016). Regarding output additionality, the outcome variables are even more heterogeneous, spanning from patents to innovation counts and innovative sales.

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1 To be sure, the policy could have an effect intermediate to that of full additionality vs. full crowding out and exert an only partial effect in both regards.

2 Although interesting as a topic, we do not enter into the technicalities of the econometric methodologies used to solve the estimation problems (e.g. endogeneity and selection bias) the empirical literature on evaluation encounters.

The number of relevant outcome variables increases when a "system failure" approach to innovation is adopted, focusing on those infrastructural and cognitive obstacles that prevent firms from behaving in a such a way as to make innovation systems (of actors and institutions) work effectively. The focus in this case is actually on behavioural additionality, with regard to which the heterogeneity of the outcome variables increases even more: ranging from measures of cooperation activities between firms and universities (see for example Marzucchi et al. 2015) to new human resource practices and employment forms (Radas and Anic 2013).

Table 7-1: Policy effects on input, output and behavioural outcomes

Input (e.g. R&D investments)	**Private R&D investments**	
S=0	Y0=Y1	
S>0 and A>0	Y1-Y0=S+A	Additionality
S>0 and A=0	Y1-Y0=S	No effect
S>0 and A=0	Y1-Y0=aS 0<a<1	Partial crowding-out
S>0 and A=0	Y1-Y0=-S	Full crowding-out
S>0 and A<0	Y1-Y0=-S+A	Over-full crowding-out
Output	**Innovation output; Patents; etc…**	
S=0	Y0=Y1	
S>0 and A>0	Y1-Y0>0	Additionality; no effect; partial crowding-out is not distinguishable
S>0 and A=0	Y1-Y0=0	Full crowding-out
S>0 and A<0	Y1-Y0<0	Over-full crowding-out
Behavioural	**R&D speed; cooperation; etc…**	
S=0	Y0=Y1	
S>0 and A>0	Y1-Y0>0	Additionality; no effect; Partial crowding-out is not distinguishable
S>0 and A=0	Y1-Y0=0	Full crowding-out
S>0 and A<0	Y1-Y0<0	Over-full crowding-out

Explanation: S: subsidy; Y0 outcome variable without the subsidy Y1: outcome variable when the subsidy has been received; A: potential additional effects.

Source: Own elaboration on Dimos and Pugh (2016)

In combination, it turns out that Y is an heterogeneous measure and its heterogeneity increases the more we move from the usually direct target of policy interventions (private R&D investment – innovation input) toward measures that are linearly linked to R&D investment (patents, new products or services – innovation output) and other measures that are likely not linearly linked to R&D investment (collaborations between firms and universities or research organisations – firms' behavioural changes).

Given the richness of outcome variables that could/should be used in the empirical analysis of the additionality (or non-additionality) of innovation policy, and the multiple effects that can be detected along each one of them, the picture of the possible effects becomes quite complex. The scheme proposed by Dimos and Pugh (2016) in Table 7-1, regarding innovation policies typically oriented towards supporting/increasing private R&D investments, can be helpful in organising such complexity.

On the basis of the previous conceptual framework, the next sub-sections provide an overview of the most recent empirical works carried out in its measurement and briefly place them in the theoretical approach to innovation that they follow. Although non-exhaustive, their analysis provides information on the most recent research questions and results of studies investigating the three types of additionality.

7.2.1 Input additionality

As we said, the largest part of the empirical literature on the additional effects of innovation policies has devoted its attention to the input dimension, mainly by considering what, according to the "linear model" (Godin 2006), should be regarded as its main driver, that is: research and development (R&D) (see for example Marino et al. 2016; Zúniga-Vicente et al. 2014; Clarysse et al. 2004; Georghiou 2002).

The focus on R&D (and input in general) additionality finds a theoretical motivation in the market failure approach to innovation policy, as introduced by the seminal works of Nelson (1959) and Arrow (1962). On the one hand, Nelson stressed the fact that, since basic research activities are characterised by radical uncertainty, private actors such as firms may underinvest in them relative to a social optimum, calling for a government intervention. On the other hand, Arrow pointed out that there is a systematic difference between private and public returns on innovation, due to the non-perfect appropriability, uncertainty, indivisibility and increasing returns of innovative knowledge: this difference would also generate underinvestments in R&D by firms in the market. For both reasons, a policy intervention to restore the optimal level of innovation (R&D) investments is deemed necessary and its input additionality can be retained as a reliable indicator of its effectiveness.

Subsequent work in innovation studies has delved deeper into the market failures that would make firms underinvest in R&D. The literature on endogenous growth models, in particular, has shed new light on the nuances of the difference between the private and social returns on R&D investments, pointing to additional kinds of failures (apart from knowledge externalities) – e.g. surplus appropriability, duplication, rent transfer, location externalities - which could, in some cases, lead to the opposite problem of overinvestments in R&D. Table 7-2, taken from Montmartin and Massard (2015), provides a synoptic illustration of each of these failure categories.

Table 7-2: Sources of market failure related to R&D investments

Market failure source	Description
Knowledge externalities	Knowledge generated through R&D mainly connotes the public good nature of the R&D itself: knowledge externalities are assumed to be generally positive and, hence, contributing in a positive way to future R&D productivity. Since the firm does not take into account this positive effect when it decides to today invest in R&D, its investment is then likely to be lower than the socially optimal one[1].
Surplus appropriability	It has to do with the commercialisation of R&D "fruits": innovations. Firms are not able to fully appropriate the gains generated by the commercialisation of their innovations. As a consequence, the private investments in R&D tend to be lower than the socially optimal level.
Duplication	This source of market failure may lead to overinvestments in R&D in the private sector: e.g. if in an industry several firms are engaged in a race to innovate regarding the "same" product or process, but only one will be the first and eventually will patent the new product or process then it might be that private R&D investments in that industry are above the level that is optimal for society.
Rent transfer	When an innovation is introduced, the rent generated by this innovation is transferred from the incumbents (old innovators) to the entrants (new innovators). The old innovators are driven out by the market or experience a reduction in their demand. In any of the two cases there are negative consequences for the incumbents which are not taken into account by the new innovators, leading to a potential overinvestment in R&D.
Location externalities	The geographical localisation can affect the incentives to invest in R&D. As for knowledge externalities, in this case the externalities may also be positive or negative from a theoretical point of view: as reported by Montmartin and Massard, if the concentration of firms in the market outcome is higher (lower) than the concentration in the optimal outcome, then externalities related to location choices generate a market failure that leads to overinvestment (underinvestment) in R&D.

Source: Adapted from Montmartin and Massard (2015)

1 Montmartin and Massard (2015) in their detailed analysis do not neglect that knowledge externalities also have a negative component (fishing in the same lake effect), which, when it is larger than the positive one, produces an overinvestment in R&D.

Given their heterogeneous nature, the market failures that inhibit R&D investments might require different kinds of support. For example, R&D subsidies and/or grants to R&D could work better at dealing with some of them, while R&D tax credits could work better with others. One line of intervention or the other can be chosen in accordance with the policy objective, without excluding the possibility of their combination in a policy-mix. The policy instruments can also be chosen in accordance with the willingness of having an impact in either the short or in the long run: as an example, the tax credits seem to be more effective in the short run, while for a medium- to long-term effect the support of R&D via subsidies seems to be preferable (Becker 2015). As we will argue in the following section, this issue poses the problem of an accurate mapping of failures and instruments and affects the outcomes of additionality exercises.

In spite of the grounded theoretical arguments for expecting private underinvestments in R&D, motivating a policy support for their remedy, and expecting its effects in terms of additionality, the empirical evidence on its occurrence has provided only mixed evidence so far. This is the main result of the survey of the empirical literature carried out by Zúniga-Vicente at al. (2014), who ascribed these mixed results to the heterogeneity in a number of factors retained by the focal studies, like: firms characteristics; alternative measures of R&D; differences in the populations under investigation; varieties of public schemes; periods and countries considered, among other things. The mixed evidence also stems from the different methodologies applied and from the (im)possibility of dealing with certain methodological issues due to data shortcomings.

As far as these methodological issues are concerned, Becker (2015) has recently illustrated that empirical studies on input additionality are affected by a number of problematic issues. A first one is presented by the adopted measure of R&D investments, which can be either a direct monetary variable – with a favourable homogeneous characterisation – or an indirect measure in terms of patents or innovations produced, based on the hypothesis that a linear relationship between R&D and innovation output exists – a measure that of course suffers from heterogeneity. A second issue is down to the R&D equation adopted by the models, which not only needs to capture as much heterogeneity as possible (e.g. firm fixed effects in the cases where the individual firm is the unit of analysis), but also to retain its uncertainty and the intrinsic dynamic nature of R&D investments. This last issue leads to the third one, which is the endogeneity of the lagged dependent variable: an issue that can be treated in several but always imperfect ways, such as instrumental variables and generalised method of moments (GMM) approaches. The subsequent issue is presented through the heterogeneity of the parameters, which might make it more convenient to use subsamples of firms in order to analyse more homogeneous firms. Finally, according to Becker (2015), there is the linearity assumption concerning the effects of the policy, made by several studies. This hypothesis can

be misleading, since some recent evidence points to a non-linear, inverted U-shape relationship between subsidies and private R&D.

Although to a variable extent, the previous issues do also mark the latest studies on input additionality, which we will briefly review in the following. Although many of the studies reported below jointly investigate input and output additionality, in the rest of this section we will focus on input additionality, deferring the discussion on output additionality to the next section.

Several works on input additionality carried out regarding European countries use Community Innovation Survey (CIS) data. Among these, Bodas Freitas et al. (2017) conduct an analysis on firms in Norway, Italy and France and find that a tax credit on R&D has different additional effects for firms, depending on the characteristics of the sectors they belong to. In particular, firms operating in sectors with a strong orientation towards conducting R&D show a higher level of input (and output) additionality. Czarnitzki and Delanote (2017) rely on the CIS for Flanders (Belgium) to extend the Crepon-Duguet-Mairesse (Crepon et al. 1998) model – featuring an R&D, an innovation and a productivity equation in a simultaneous manner – and introduce an R&D subsidy into it. Their evidence points to the presence of input additionality, while potential crowding-out effects are not detected. Evidence of additionality is also found by Hottenrott and Lopes-Bento (2014), who detect it by examining the effects exerted by R&D subsidies on the investments in international R&D projects carried out by firms located in Flanders (Belgium) from 2002 to 2008

A different data source that has been used in studying input additionality is the Mannheim Innovation Panel (MIP), which concerns German firms. Among these studies, Czarnitzki and Hussinger (2018) focus their attention on a direct R&D subsidy programme in Germany for the period 1992-2000, concluding the existence of input additionality. Another work by Czarnitzki and Delanote (2015) compares the subsidy additionality on R&D investments between young independent (they are not linked to any parent firm) high- and low-tech firms and their non-independent (they are linked to a parent firm) counterparts. For all the different measures of R&D input they retain (ratio of internal R&D expenditures to turnover, level of R&D expenditure, number of R&D employees, number of R&D employees over the total number of employees) and for all the different types of firms considered, a full crowding-out effect is excluded, pointing to the presence of additionality instead. Still using the Mannheim panel, Hud and Hussinger (2015) show the impact of R&D subsidies on the R&D investments of small and medium-sized German enterprises during the great recession of 2009. Using patent and economic data from 2006 to 2010, the authors find no crowding-out effect before the crisis, but evidence of it right in 2009.

Quite interestingly, the crowding-out effect suddenly disappears as the economy starts to stabilise and recover in 2010.

A final batch of recent studies on input additionality is based on primary and secondary data other than CIS and MIP. Henningsen et al. (2015) provide evidence of such an additionality of R&D subsidies for a unique dataset of firms in Norway (2001-2007). The authors find only modest evidence of input additionality. However, they deem it underestimated because of a possible problem of measurement errors in the subsidy variable. Different results are obtained by Marino et al. (2016) when investigating the input additionality of the combination of R&D subsidies and R&D tax credits revealed by a sample of French firms over the period 1993-2009. Using different methodologies for determining the optimal amount of the subsidy, a crowding-out effect is found in the form of a substitution effect, when it is estimated after the introduction of a tax credits regime. In particular, the recipient firms of a medium-high subsidy seem to be those with the largest substitution effect, while an additional effect seems to be limited to a few top recipients (above 10 million euro). On this basis, the authors claim that an appropriate policy-mix has to be chosen in order to avoid the potential misallocation of public money in incentivising R&D investments.

In concluding the survey of the most recent contributions on the topic, it is interesting to return again to the results of the meta-regression analysis conducted by Dimos and Pugh (2016) on 52 studies on the evaluation of R&D subsidies effectiveness over the period 2000-2013. After having investigated the possible reasons for the mixed results of the investigated studies, the authors conclude that, while the potential crowding-out effect of R&D subsidies can be excluded, their additionality effect is almost negligible: "Indicatively, a doubling of subsidy would yield an increase in private R&D of less than one per cent." (Dimos and Pugh 2016, p. 811).

Combined with the mixed evidence that emerges from the studies we have reviewed previously, this last conclusion confronts policymakers with a non-trivial puzzle. Indeed, the tendency of policymakers, at different levels (e.g. national or regional) of analysis, to rely on a theoretically expectable input additionality and to settle for policy programmes in support of R&D appears at least questionable.

7.2.2 Output additionality

The presence of market failures in the unfolding of innovation also motivates the focus on the output additionality of the policy programmes intended to support it at the firm level. If a linear model of innovation is adopted, in which R&D investments are supposed to lead to more inventions, and this is to be commercially exploited into more innovations,

a policy intervention that addresses the suboptimality of the former is expected to also cure the suboptimality of the latter. In brief, market failures can make underinvestment in R&D translate into "an underproduction of innovation. Hence, innovation policy is eventually aimed also at increasing the amount of innovation outputs produced by private actors." (Antonioli and Marzucchi 2012, p. 126). Accordingly, it is reasonable to assume that the same policy instruments as mentioned above can generate additionality or crowding-out effects in terms of innovation output in addition to innovation input.

While input and output additionality are arguably linked following the linear model, searching for both is far from redundant. Additionality in the innovations that firms introduce may not emerge even in the presence of input additionality, when we consider that the larger R&D investments that firms are helped by the policy to undertake may not linearly yield more innovations: for example, because up-front fixed costs in R&D projects could make the relative investments unproductive under a minimal threshold of R&D investments and R&D subsidies. Similarly, output additionality could emerge in the absence of additionality in terms of invested inputs, such as when the policy has positive effects on other informal learning processes and innovation drivers than R&D investments, such as the absorption of externally acquired knowledge. What is more, even by assuming a linear relationship between innovation inputs and outputs, the time span between the provision of subsidies and the 'production' of innovation output could be very long and several confounding factors may intervene making the relation between subsidies and innovation output difficult to detect and analyse.

Due to the reasons mentioned above, the majority of the works that investigate input additionality, usually by considering R&D investments as an outcome variable, jointly search for the presence of output additionality, by looking at different kinds of outcome variables, such as patent applications and number of introduced innovations declared by the affected firms.

The work by Czarnitzki and Hussinger (2018), for example, also looks for the output additionality of the R&D subsidies provided to German firms in the period 1992-2000. As a measure of innovation output the authors in particular use the number of patents as well as patents citations, since they are also interested in the patent quality of the 'technological progress' potentially induced by the policy. The patent production function returns results that support the hypothesis of output additionality, increasing the technological performance of the targeted firms.

The paper by Czarnitzky and Delanote (2017), containing the Crépon-Duguet-Mairesse (CDM) extension we illustrated in the previous section, also investigates the potential

direct and indirect effects of R&D subsidies on innovation output. As stated, their evidence points to a positive effect of subsidy-induced R&D and of purely private R&D, in particular. As for output additionality, the authors cannot reject the hypothesis that subsidised and private R&D have equal marginal productivity. An output-additionality analysis is also contained in the other study by Czarnitzky and Delanote (2015) that we reviewed above, which, as we explained, focused on young, small and medium-sized enterprises belonging to high-tech sectors. In this case, the authors are able to single out the indirect effect of subsidies on innovation output using a patent-production-function framework. For this kind of firm there also seems to be an output gain in terms of patents: "Results […] reveal that due to increased R&D input that was found in a first step, also higher R&D output is achieved by the subsidized firm" (Czarnitzky and Delanote 2015, p. 483).

A last study that deserves attention is that by Radicic et al. (2015), who examine output additionality from a particular perspective, by focusing on the regional support for small and medium-sized enterprises in traditional manufacturing industries. Quite interestingly, this is among the few studies, among those published in the last few years, that narrow down the geographical lens to the regional level of analysis, by referring (over the period 2005-2009) to seven EU regions marked by a remarkable concentration of traditional manufacturing, these being: West Midlands (UK); North Brabant (Netherlands); Saxony-Anhalt (Germany); Emilia-Romagna (Italy); Comunidad Valenciana (Spain); North/Central (Portugal); and Limousin (France).[1] Looking at a wide range of innovation output variables (product, process, organisational and marketing innovations), the authors find a positive effect of the support in question, although on a quite small scale: participants increase their probability for innovation and of commercial success of the innovation by around 15% compared to non-participants. A crowding-out effect in terms of innovation output is then excluded. However, because of data shortcomings, namely lack of information concerning the subsidy amount, the study is unable to calculate any additionality. In spite of this gap, in comparing the average treatment effect for the affected with the average treatment effect for the non-affected firms, the authors come to an interesting conclusion: the selection procedure generally undermines the full potential of the programmes. The 'cream-skimming' (or cherry-picking) procedures of selection for the participation in the programmes could be replaced by a random selection in order to increase the impact of the policy programmes.

When concluding the review of the recent literature on output additionality, the results of the meta-regression analysis by Dimos and Pugh (2016) to which we referred above,

1 As we said, other regional studies will be reviewed in the second part of the chapter regarding the Emilia-Romagna region.

deserves consideration. In spite of the heterogeneity of the output measures used by the studies examined, and the lack of distinction between the presence of additionality, the absence of it, and the presence of partial crowding-out in some studies, there seems to be evidence supporting the exclusion of full (and over-full) crowding-out of the subsidies also in terms of innovation output. Similarly, to what emerged in terms of innovation input, whether this absence of crowding-out effects can turn into actual output additionality is however hard to assert. What is more, as we said, the empirical literature on the additional innovation output generated by R&D subsidies is comparatively smaller than that focused on input additionality. Accordingly, the theoretical rationale that often also motivates the policy support for the introduction of more innovation needs to be carefully considered.

7.2.3 Behavioural additionality

Looking for the additionality that innovation policy could reveal in terms of innovative behaviours – e.g. policy-induced internal human resource management and additional external research collaboration – is a kind of evaluation that relies on a different approach than market failures for policy justification, which rather invokes the presence of system failures. According to an evolutionary interpretation (Nelson 1993; Lundvall 1992), innovation would actually occur through actions and interactions that are not limited to markets populated by optimising agents, as the neoclassical theory assumes, but are rather hosted by 'innovation systems' whose shaping these agents contribute to. In a nutshell, innovation systems are constituted by firms and by all those organisations – e.g. universities, research organisations, patent offices – through whose institutionally embedded actions and interactions innovation takes place (Edquist 2005). Indeed, the actors involved in the innovation process are bounded rational and heterogeneous. In particular, firms behave differently according to their capabilities, competencies, and routines, relying on a historically rooted and location-specific institutional set-up (e.g. laws and regulations), which enables their interaction (e.g. in the form of cooperation and collaboration). This specificity brings forth systems of innovation at the national, regional and sectoral level, on which academic literature has cumulated in the last twenty years (e.g. Groenewegen 2006; Rodríguez-Pose and Crescenzi 2008; Fagerberg 2017).

While the supposedly seeding environment of innovation, in practice innovation systems could fail in making innovation emerge, diffuse and contribute to economic development. As Metcalfe (2005) argued in a seminal work on the issue, this might occur for different reasons. Innovation systems could be missing essential constitutive components (e.g. trained and specialised human capital), lack essential interactions (e.g. loosely coupled science and technology) and have overlapping functional and/or geographical bounda-

ries (e.g. redundancy between regional and national innovation policies). These problems could generate two main macro-categories of system failures (see Antonioli and Marzucchi 2012). The first type hampers the capacity of the system to create knowledge and to engage in the process of learning and capabilities accumulation through which innovation occurs (Smith 2000; Malerba 2009). The second type of failures affects the institutional configuration of the innovation system (Metcalfe 2005; Malerba 2009) and hampers those actions and interactions that also drive innovation.

As in the case of market failures, system failures also require an innovation policy intervention to be remedied. However, this is different than those classified as input and output additionality and is expected to generate different additional effects. On the one hand, innovation policies extend beyond the support for the functioning of the linear model – that is to R&D and its innovation outputs – and extends to the functioning of the system itself, its components, interactions and institutional set-up: increasing competition between firms to have more variety in knowledge generation and to escape lock-ins in the extant technologies; favouring university-industry cooperation to overcome the mismatch between science and technology; supporting the organisational capabilities of the firms to help them deal with change; are just few examples of innovation policies that the market failure approach would have not considered as such. On the other hand, both standard and system-based innovation policies are expected to induce other restorative changes than in the investments and innovative products of the supported firms. In particular, policy affected firms are typically expected to change their innovative behaviours in a way that make them better equipped to restore the adequate functioning of the innovation system: adopting more innovation inducing practices of human resource training and management, interacting with research organisations more deeply and/or widely, are just two examples.

As the policy induced changes in the innovative behaviour of the firm gained importance in the last decade, although more limited compared to those regarding input and output additionality, a stream of research also emerged concerning the empirical measurement of the behavioural additionality of the policy (e.g. Falk 2007; Autio et al. 2008; Clarysse et al. 2009). Since the beginning this literature faced the problem of how to define and account for the behavioural changes to be considered in the impact assessment of the policy. In the seminal contribution by Buisseret et al. (1995, p. 590), behavioural additionality was initially defined as "the change in a company's way of undertaking R&D which can be attributed to policy actions." In a later study Georghiou (2002, p. 7) took a wider perspective and defined behavioural additionality as "the difference in firm behaviour resulting from the intervention." Indeed, the focal behavioural changes can be more or less closely related to R&D activities: as an example, a measure of behavioural change related to R&D is provided by Falk (2007), who considers the acceleration of

innovation activities of the subsidy recipients. While looking at the variety of innovative behaviours represents a natural implication of the system approach to innovation, its retention obviously entails a high level of heterogeneity in measuring the behavioural effects, which can in turn imply a high level of ambiguity in the results. Indeed, this is also what emerges from the examination of the latest work on the issue, to which we will turn in the following.

A first recent contribution on the topic is that by Radas and Anic (2013), who investigate the different additionality dimensions that tax credits and R&D subsidies have had on a sample of 700 Croatian small and medium-sized enterprises (SMEs) over the 2005-2010 period. In addition to different input and output dimensions, the authors also look at the effects on the focal policies on firms' collaboration in R&D and on different aspects of the firms' absorptive capacity. In particular, the hypothesis that the joint presence of tax credits and subsidies could positively impact these firms' behaviours to a larger extent than when firms receive R&D subsidies only is tested. Through different econometric techniques the study finds only limited traces of behavioural additionality. While subsidies, either alone or together with tax incentives, support R&D collaborations (and R&D intensity), regarding absorptive capacity (and other dimensions of innovative activities and output) the obtained results are not unambiguous. Moreover, the addressed policy mix also seems to have limited "additional" additionality with regard to subsidies alone, in the sole exploitation of the firms' absorptive capacity.

A different kind of behavioural additionality, of more managerial than organisational nature, is addressed in recent work by Chapman and Hewitt-Dundas (2018), who investigate the effect that an innovation voucher has had on the senior managers' attitude toward innovation in a sample of UK firms between 2012 and 2015. Developing the hypothesis that innovation policy could contribute to an organisational climate favourable to innovation activities - "by shaping interpretation, attitudes significantly influence firm innovation strategy, behaviour and performance" (p. 29) – and that this could, in turn, translate into more innovative manager behaviours, the authors test for its validity in an additionality framework. Using a survey of micro and small and medium-sized firms which received a voucher, the authors show that the policy in question has had a positive impact on managers support for innovation, in terms of their risk tolerance and also of their openness to external knowledge.

A different approach to the analysis of behavioural additionality is adopted by two more studies, which do not (simply) look for its existence but rather (also) investigate its determinants, moving a step forward in its understanding. In a first study, Wanzenböck et al. (2013) refer to a sample of 155 Austrian firms belonging to the transport sector over the period 2002-2006 and search for the determinants of 'three dimensions' of behavioural

additionality: project, scale and cooperation additionality, as revealed by the survey data. A self-reported variable of behavioural additionality in these three respects is regressed against a set of independent variables like the firms' R&D capacity (e.g. R&D intensity), their collaboration strategies and their technological specialisation. Quite interestingly, R&D capacity seems to negatively influence the realisation of project additionality; technological specialisation has a positive effect on project additionality, but a negative one on scale additionality; previous international cooperation, on the other hand, does not seem to influence any type of behavioural additionality among those measured by the authors (with the exception of cooperation additionality).

A similar research question is addressed in another study, by Neicu et al. (2016), who look for the potential moderating effect that R&D subsidies can exert on the behavioural additionality generated by R&D tax credits for a sample of Belgian firms (2006-2010). In doing so, the authors investigate how the 'policy mix' used to sustain the R&D activities of firms can affect their behavioural additionality. Results actually suggest a potential reinforcement effect of the behavioural additionality of tax credits exerted by R&D subsidies. In particular, firms seem to adjust their involvement in R&D projects differently: "[…] the combination causes firms to speed up their research projects, but also orient their R&D proportionally more towards research (versus development) activities" (p. 231).

Overall, while more limited than the analysis of input and output additionality, the investigation of behavioural additionality seems to have moved along more original lines of research. Not only has the impact assessment extended to the policy effects on new kinds of organisational and managerial innovative behaviours, but the analysis has also been enriched with the examination of the determinants of these additional behaviours: a stream of research that could possibly contribute to reducing the ambiguity that characterises the analysis of input and output additionality.

7.3 On the evaluation of innovation policy at the regional level: the experience of PRRIITT in Emilia-Romagna (Italy)

As we said at the beginning of this chapter, the impact assessment of innovation policy has special importance at the regional level. All of the dimensions along which the effects of such a policy can be evaluated – as stated, input, output and behavioural – actually intersect with those along which innovation takes place at the spatial level, involving, among others: the occurrence of knowledge spillovers of different kinds (e.g. from specialisation rather than from variety), the effects of various forms of local clustering and networking processes, and the trade-off between place dependence and new paths creation in the development of new technological trajectories (e.g. Tödtling and Trippl 2005).

The possible 'overlapping' between the effects of innovation programmes undertaken at different levels of government – i.e. sub-national, national and international – is another aspect that makes their evaluation particularly important.

While certainly marked by a great amount of specificity, dating at least back to the identification of the 'Emilian model' of regional development (Brusco 1982), the focus on Emilia-Romagna can however be expected to have general implications in the analysis of innovation policy at the regional level. According to the last Regional Innovation Scoreboard (Hollander and Es-Sadki 2017), Emilia-Romagna is actually in the non-small cluster of European regions characterised as "Moderate+ innovative". In Italy, it is one of two leading (NUTS2, Eurostat) regions, along with Lombardy. This situation was somewhat similar in 2004 and 2006 (Hollander et al. 2009), when the region was however ranked among those classified as "Medium-high innovators", because of its medium-low performance in terms of innovation enablers (e.g. public expenditure on R&D, population with tertiary education aged 25-64, etc. ...).

Dedicated research studies on its innovation performance have shown that Emilia-Romagna represents a typical case of "informal learning" regional innovation system (RIS), in which innovation is mainly driven by non-R&D based activities and non-institutionalised internal and external innovative behaviours. This RIS is also marked by an industrial structure consisting of a heterogeneous set of industrial districts, mainly specialised in traditional industries and made up of SMEs (Cooke et al. 1997; Marzucchi et al. 2015). All of these features turn standard market failures in innovation into bigger obstacles than elsewhere: consider the inefficiencies due to the sub-optimal scale of SME's R&D projects in relatively low-tech industries. Furthermore, they also make Emilia-Romagna feature among the regions naturally exposed to a specific class of system failures – e.g. informal and inward-looking innovation strategies – that typically cause technological lock-ins (Uyarra 2010).

In light of these shared specificities, the analysis of the specific regional innovation policy in question could provide general insights about the policy capacity to mitigate, not only the market failures occurring in the region, but also and above all those failures that impede the RIS from working effectively. Based on this, in the following section we report the results of those studies that, have focused on the different additionality dimensions of the PRITT.

7.3.1 The Regional Programme for Industrial Research, Innovation and Technology Transfer (PRRIITT)

Innovation policies have always played an important role in the Emilia-Romagna RIS in the last decades (Bianchi and Giordani 1993).

A remarkable example of innovation policy in Emilia-Romagna is represented by the 'Regional Programme for Industrial Research, Innovation and Technology Transfer' (PRRIITT), a complex regional level programme, which aimed at fulfilling the actions planned by the Regional Law n.7/2002. Launched for the first time in 2003,[1] the general objective of this programme was to mitigate the RIS weaknesses and to support its strengths. More precisely, the programme was composed of four measures, each of which is, in turn, split into actions (see Table 7-3), addressing a specific aspect of the regional innovation strategy, that is: 1) the development of industrial and strategic research in the region; 2) the establishment of high-tech entrepreneurship; 3) the impulse for knowledge and technological transfer; 4) the diffusion of networks.

In order to accomplish the different measures and actions described in Table 7-3, a broad range of agreements were concluded with both universities and research organisations based in the region. More generally, the beneficiaries of PRRIITT ranged from firms and consortia of firms up to universities, passing through research organisations and temporary associations of small and medium-sized enterprises.

For all of the identified measures, the allocation of specific grants was undertaken in supporting the costs of the related projects. The allocation of the funds was based on the evaluation of the beneficiaries of the projects and on the quality of the projects themselves, undertaken by a committee of experts with proven scientific and entrepreneurial experience in relation to scientific and technological issues and to policies for the promotion of applied research and technology transfer.

As Table 7-3 reveals, PRRIITT covers a wide range of actions, aiming at addressing the identified weaknesses of the RIS (see above) and at stimulating the development of its strengths, which – dating back to the years of the programme's implementation – can be seen in: firm activity in the innovation field and innovation output (Hollander et al. 2009). This wide coverage of actions translates into the involvement of all those actors that typically represent the constituents of a RIS: firms, universities, research organisations and institutions.

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1 Following we refer to this first implementation of the programme, over the period 2003-2005. Although it also had a second implementation, from 2012 to 2015, the majority (if not all) of the studies on the impact assessment of PRRIIT actually focused on the first one.

While all of the measures and actions are thus relevant, one among them appears more directly amenable to an innovation additionality evaluation of the kind we discussed in the previous section: measure 1 – action A.

As Table 7-3 shows, this is actually the typical case of a regional subsidy for R&D projects that aims at providing them with regional co-financing. While this kind of policy has a long tradition in the region, the action A in question – projects for industrial research and pre-competitive development – had some novel characteristics that are worthwhile recalling. It was addressed to firms – also clustered in consortia - that based their economic activities within the boundaries of the region. They could apply for co-financing projects lasting from 12 to 24 months. The extent of the regional contribution to the project was up to 50% of the admissible costs for industrial research projects and up to 25% for pre-competitive development projects, with an additional 10% for projects presented by SMEs. The projects submitted needed to have a minimum size, in terms of costs, of 150,000 euro, with the region covering up to 250,000 euro of the project costs. Firms were supposed to be provided with funds either at the end of the project, or in two parts, at the completion of the first half of the project and at its end. The types of admissible costs were numerous and differentiated in accordance with the typology of project – industrial research or pre-competitive development (see Table 7-4 for details).

Table 7-3: PRRIITT scheme of the Emilia-Romagna region

Measures	Actions	Synthetic description
Measure 1 – Actions for the development of the regional productive system towards industrial and strategic research	Action A - Projects for industrial research and pre-competitive development	The region supports projects for industrial research and pre-competitive development proposed by companies and to be carried out with the contribution of personnel and facilities of the universities, research bodies, professional societies or individual professionals in the technological field.
	Action B – Development of industrial laboratories	The region supports the development by single or associated companies of industrial laboratories able to offer research and development services, on subjects of significant interest for the regional territory, also in collaboration with universities, research centres, laboratories and innovation centres.
Measure 2 – Establishment of new entrepreneurial and professional activities with a high level of technological content	Action A – Programmes aimed at creating new entrepreneurial and professional activities	The region supports programmes and projects promoted by universities, research institutions or other specially established entities, aimed at supporting the creation of new high-tech entrepreneurial and professional activities, originated by the exploitation of results of research activities conducted by departments, institutes, research centres, etc. ...
	Action B – Financial support for the start-up of entrepreneurial initiatives	The region promotes the creation of new companies with a high knowledge content, enhancing collaboration with universities and research centres.
Measure 3 – Actions for knowledge and technological competencies transfer		The region supports programmes promoted by universities and research institutions concerning the transfer to companies of knowledge and technical skills in specific research or technological fields. The modalities can be: consulting, training, technical assistance, etc. ...

Measures	Actions	Synthetic description
Measure 4 – Network development	Action A – Research and technology transfer laboratories	The region supports programmes for industrial research and pre-competitive development promoted by research and technology transfer laboratories, newly established or well established. The programmes presented by the laboratories must be aimed at enhancing the research activities carried out at the regional level, developing, where possible, regional excellence in terms of applied research and potential industrial spin-offs.
	Action B – Innovation Centres	The region intends to support programmes for the transfer and dissemination of technological knowledge, promoted by newly established or well established "Innovation Centres". The programmes presented by the centres should be aimed at promoting and sensitising companies, local systems and regional production chains regarding the various topics of innovation, supplying services for innovation and finding specific sources of knowledge.
	Action C – Services to promote the development of the research network	The region supports activities to promote the development of the regional network of applied research and technology transfer.
	Action D – Address, evaluation and monitoring activities	The region organises a committee of experts with proven scientific and entrepreneurial experience regarding scientific and technological issues and policies for the promotion of applied research and technology transfer, with the task of promoting and supervising the evaluation procedures and, in the case of negotiating actions, directly participating in the selection of projects. The region also activates, on the indications of the committee of experts, a network of project evaluators.

Source: first.aster.it; Regional Law n.7/2002; RER (2003)

Table 7-4: Types of admissible costs by project typology

Projects for industrial research	Projects for pre-competitive development
Services related to the use of university and research institutions' laboratories and instruments; services by laboratories accredited by the Ministry of Education, Universities and Research, by industrial research and technology transfer laboratories and by innovation centres	Costs for the purchase of patents and licenses
Collaboration agreements and/or consultancies with universities and research centres that foresee a temporary secondment of researchers	Costs for instruments and technological and computer equipment (limited to the amortisation costs or to the cost of the lease for the duration of the project)
Expenses for new graduate staff, to be assigned to research activities of the projects presented (also on a fixed-term basis for at least one year)	External costs for the construction of prototypes (up to 20% of the total cost of the project)
Contracts for professional collaboration, including costs for the protection of results	
Consultancy for feasibility studies concerning access to community, national and private funding programmes (up to a maximum of 10,000 euro)	
Expenses for internal staff assigned to research activities (up to 30% of the total cost of the project)	
Overheads (up to 10% of other expenses)	
Costs for instruments and technological and computer equipment for the realisation of the industrial research activities of the project (limited to the amortisation costs or to the cost of the lease for the duration of the project)	

Source: RER (2003)

The policy measure in question has a number of desirable features also in terms of evaluation. As Bronzini and Iachini (2014) recognise, "[o]ne important characteristic of the program is that firms cannot receive other types of public subsidy for the same project. This helps the evaluating process given that the impact of the regional program cannot be confused with that of other public subsidies" (p. 106). Another positive feature was that the assignment of the grants to the firm occurred only after an evaluation procedure conducted by a committee of independent experts, as briefly referred to above.[1] Last but

[1] More precisely, for the sake of evaluation, priority was given to projects that: dealt with themes considered relevant for regional interests (as indicated in the PRRITT programme); follow the scheme of industrial research, pre-competitive development, protection of intellectual property; involved universities, public research institutes, laboratories accredited by MIUR; planned the recruitment of new R&D personnel. In accordance with such priorities, a score was assigned to each of the following characteristics (Bronzini and Iachini 2014): (i) technological and scientific (max. 45 points); (ii) financial and economic (max. 20 points); (iii) managerial (max. 20 points); and (iv) regional impact (max.15 points). In order to obtain

not least, as also stressed by Bronzini and Iachini (2014), the regional programme was devised in such a way that the likelihood of being funded did not depend on the size of the subsidy requested.

This set of features possibly made the evaluation of measure 1 – action 1 of the PRRIITT particularly desirable. Indeed, its impact assessment was accomplished by a set of studies which yielded results concerning additionality, which we in turn will look at in the next section.

7.3.1.1 The PRRIITT input additionality

The first study we refer to is that by Bronzini and Iachini (2014), which focuses on the input additionality revealed by PRRIITT.

To start with, the authors illustrate the advantages of focusing on policy programmes at the regional level in general. This level of analysis allows the evaluator to 'remove' much of the heterogeneity that normally exists among the investigated firms at the country level. The comparison between subsidised and non-subsidised firms is actually made by referring to firms that are more similar, as they share a techno-economic and socio-institutional embeddedness. The authors then focus on the desirability of evaluating the innovation policy of a region (Emilia-Romagna) that accounts for a non-negligible share of the total Italian GDP, for more than 10% of Italian patents and for around 11% of R&D generated by enterprises at the national level. A third reason for the interest in evaluating the input additionality of PRRIITT concerns the chance of adding evidence to the still sparse literature on the effectiveness of "local innovation policies" [1] (Asheim et al. 2007). Indeed, after a survey of the empirical literature on local innovation policies, the authors conclude that the literature is not conclusive about the crowding-in or crowding-out effects of R&D subsidies.

Arriving at their evaluation, Bronzini and Iachini (2014) consider the first two rounds of applications of PRRIITT in February and September 2004. In particular, among the data about these rounds, they focus on the information concerning the score assigned by the committee of experts to each firm's project. Using the scores of the projects that were

funding the project had to rank 'sufficient' in each characteristic and the total score had to be at least 75 points (out of a total of 100).

1 We are not using the concept of "place-based policy" since, according to Neumark and Simpson (2015) it is not directly applicable in a case like our policy in question, because it is not the national government that targets a specific jurisdiction with a specific policy, but it is the local government itself that applies a local policy on its whole jurisdiction. Regardless of these details we can state that PRRITT policy can be considered among those policies that "seek to enhance even further the economic performance of areas that are already doing well" (Neumark and Simpson 2015, p. 1198).

just below and just above the threshold level for receiving the subsidy, the authors are able to apply an original, unconventional method to single out the effect of the policy in terms of innovation inputs (see below): the regression discontinuity. According to the authors the regression discontinuity design is "preferable to other nonexperimental methods to control for the endogeneity of treatment because, under rather general conditions, it is possible to demonstrate that it is equivalent to a randomized experiment." (Bronzini and Iachini 2014, p. 107).

In situations in which agents, firms in this case, cannot manipulate the forcing variable, that is the score assigned by the evaluation committee, the regression discontinuity design is thus appropriate. In fact, such a method depends on the continuity assumption about the outcome variable of interest: typically, the firms' R&D expenditure. Such a variable is potentially the same around the cut-off variable (the threshold level of the score for getting subsidised) under the same funding experience. The continuity assumption is satisfied in cases in which the "treatment depends on whether a (forcing) variable exceeds a known threshold and agents cannot control precisely the forcing variable" (p. 107) and it implies that the variation in the treatment around the cut-off variable is randomised. In doing so, the endogeneity of the assignment into the participating group is solved.

To be sure, the authors do not have at their disposal a direct measure of R&D to which to apply the method in question, and this poses to them an additional problem. The workaround used by the authors is that of considering intangible investments as a proxy of changes in R&D expenditure. In addition to intangible investments, the study also considers total and tangible investment, along with labour costs, employment, wages and service costs, which are all used as R&D outlays: for example, labour costs may increase due to the fact that it is necessary for recipient firms to hire more employees or to substitute lower skilled with higher skilled ones.

The results obtained with the methodology explained above concerning PRRIITT indicate that there is no evidence of additionality for the whole sample of firms. However, given the heterogeneity of the firms in terms of size, the authors also separately conduct their estimates on small firms and large firms. Quite interestingly, this reveals traces of input additionality for the former, but not for the latter. The explanation provided by the authors is that, regarding small firms, project financing is harder than for large ones, for different reasons: higher information asymmetries, which may hinder access to the capital markets; lack of collaterals; less diversified production and strategies, which make their earnings more volatile (Bronzini and Iachini 2014). On the other hand, lacking or being less exposed to these problems, large firms show that a crowding-out effect prevails.

In conclusion, the first block of evidence on the local policy examined here for the Emilia-Romagna region shows the importance of firm heterogeneity in the evaluation of a policy directed at their common context.

7.3.1.2 The PRRIITT output additionality

As far as the output additionality of PRRIITT is concerned, the work by Bronzini and Piselli (2016) offers interesting results. In terms of project applications and firms analysed nothing changes with respect to the above work on input additionality, except that a tender in 2005 is also included in the analysis. Similarly, no relevant variations are introduced regarding the regression discontinuity design that we have described above.

Of course, the main novelty of the work in question with regard to Bronzini and Iachini (2014) concerns the choice of the dependent variables, that is, the number of patent applications and the probability of applying for a patent, subsequently to the end of a programme. It is well known that patents are far from an optimal measure of firm innovation output, as they refer rather to inventions. Even so, and lacking reliable alternatives, patents can be considered an acceptable proxy of an output dimension of additionality. Indeed, as highlighted in the review section of this paper, such a dimension suffers from a potential high level of heterogeneity in the 'outcome variable' definition and choice.

The authors used three datasets to investigate the effect of R&D subsidies on patents: the first is provided by the Emilia-Romagna region, and contains the information on the participant (to the calls) firms; the second is the patent statistics PATSTAT dataset, containing data on patents; the third one is the database compiled by Cerved Group S.p.A., containing accounting data of the focal firms. Merging the three sources of information, the authors then conduct the analysis using the regression discontinuity design methodology.

The results of the study show evidence of output additionality: the policy has a positive effect on the innovative capacity of the recipient firms (affected). In particular, the marginal effect (statistically significant) of the subsidy for affected (unaffected) firms is around 0.87 (0.61) on the number of patents: firms receiving the subsidy increase their patent number by as much as nearly one unit. At the same time, the probability/capacity of patenting is also higher for the affected than for the unaffected firms. The significant effect of the subsidy is maintained also when, similarly to the previous study, two subsamples of small and large firms are considered, with a larger effect for the former than for the latter: this is still consistent with the explanation provided above.

Considering that the array of robustness checks used by the authors consolidates the evidence, an important conclusion can be drawn on the effectiveness of the policy in

question: while small firms only benefit from it in terms of inputs, the benefit in terms of output is more ubiquitous, although larger for small firms.

7.3.1.3 The PRRIITT behavioural additionality

The behavioural additionality dimension for the PRRIITT programme has been investigated under different angles by the works of Antonioli et al. (2014) and Marzucchi et al. (2015).

Both of the two works are based upon the utilisation of three main sources of data: administrative regional data on the subsidy provision to the firms for the first two calls in February and September 2004; information coming from an ad hoc, unique questionnaire administered to a representative sample of regional manufacturing firms and accounting data extracted from the AIDA-Bureau Van Dijk database.

In the first publication the authors look at behavioural additionality by analysing whether the "subsidy can be expected to make it possible for firms to implement actions to increase internal human capital and organizational competencies through training programmes and to reduce the costs of acquiring external knowledge through regional and extra-regional business cooperation agreements" (Antonioli et al. 2014, p. 65). The combination of the three datasets allows the authors to implement a propensity score matching procedure in order to compare the realisation of the outcome variables for beneficiaries (affected firms) and a suitable counterfactual group of non-beneficiary firms (unaffected firms). These two groups of firms are deemed to be similar since they are aligned according to the propensity score and, thus, the assignment into the participating group (subsidy) can be thought to be random, under certain conditions (Rosenbaum and Rubin 1983). Hence, the differences in the outcome variables can be thought to be due only to the participation.

The evidence provided in this work is mixed. On the one hand, the investigated policy seems to be able to induce a change in firms' internal innovative behaviour, given that beneficiaries are more prone to increase skills and competencies of their workforce compared to the other firms: "[t]he regional financial support to R&D can make firms more active as learning organizations, allowing them to be more efficient in terms of extension and/or upgrading of competencies" (Antonioli et al. 2014, p. 75). On the other hand, external innovative behaviours, as measured in the work (cooperation with other firms internal and external to the regional borders), are influenced by the policy only to a limited extent. In this respect, the policy might have influenced the trade-off between knowledge protection and sharing: the firms tend to avoid some kinds of behaviours, such as business cooperation, when implementing their funded R&D projects in order to avoid knowledge leakages.

The second work investigating the presence of behavioural additionality (Marzucchi et al. 2015) relies on the same three sources of information, but it applies a methodological development of the propensity score matching: generalised propensity score matching (GPS). The possibility to apply GPS stems from the availability of data concerning the monetary amount of the subsidy allocated to each project together with the monetary volume of the project itself. The 'continuous treatment' approach that is implemented through the GPS method allows testing for the 'monetary' effect of the subsidy: it is possible to distinguish the additional effect of the subsidy for given amounts of the subsidy. In this work the outcome variable that measures a change in innovative behaviour concerns the cooperation decisions of the firms and are ordered thus: no cooperation, cooperation with a regional partner, and cooperation with an extra-regional partner, with the partner being a university or a research organisation.

Also, in this work the firms need to be classified according to observable characteristics that influence both the probability of the assignment into "treatment" (being a subsidy beneficiary) and the outcome variables (firms' decisions to cooperate). The objective of the paper is not only to assess a potential behavioural additionality on the decision to cooperate, thus identifying the capacity of the policy to spur research/industry cooperation, but also to show whether the policy induces the firms to cooperate with extra-regional partners. The main tenet of the paper is that the regional setting provides an environment characterised by manifold proximities (geographical, cognitive, social and institutional) that favour firms' research cooperation over extra-regional cooperation. Then the authors hypothesise that in order to induce firms to cross the regional boundaries in search of R&D partners, overcoming knowledge stickiness, potential technological lock-ins and loss of opportunities emerging outside the regional border, the subsidy has to exceed a certain monetary threshold.

Simply receiving the subsidy induces an additional effect on the cooperation with regional partners, thus it strengthens the industry/research cooperation at the regional level. However, in order to foster extra-regional cooperation, the subsidy must reach a certain monetary threshold, beyond which an additional amount increases the firm's propensity to engage in research activities with extra-regional partners, overcoming the 'costs' caused through the lack of proximities: geographical, cognitive, social and institutional. A potential side-effect, however, consists in the substitution of region-internal partners with region-external ones, making regional research organisations or universities less pivotal for regional development.

The results of the papers investigating the behavioural additionality point to the presence of changes in firms' innovative behaviour due to PRRIITT, which contributes especially to increasing competencies in the recipient firms and to supporting firms' cooperations

with universities and research organisations, with the specific details illustrated above. This set of results calls for the careful design of the local innovation policy in order to foster the expected behavioural changes.

7.4 Concluding remarks

This chapter has provided a critical survey of the most recent empirical literature on the additionality of innovation policies. In particular, looking at the latest studies on the additionality of policy programmes (mainly) at the national level, we aimed at building an interpretative framework in which to position the results obtained in investigating the effects of a regional policy like PRRIIT in Emilia-Romagna.

A general result stemming from the literature review of the first part of the chapter is that, overall, innovation policies directed at supporting R&D do not crowd out firms' private investments. However, that the same policy can have a significant and substantial additionality effect does not appear to be a general result (Dimos and Pugh 2016). Place-based, local policies are also more amenable to evaluations than the national ones, given that in regional or local contexts the units of analysis are less heterogeneous than on a national scale. For example, a regional study like that by Radicic et al. (2015) comes up with an interesting result: a 'picking-the-winner' strategy for financing R&D projects appears less effective than a strategy based on a random allocation mechanism. Last, but not least, the empirical studies that we have reviewed concerning the additionality of innovation policy in general appear to be marked by a high heterogeneity in the variables used as outcome indicators, in all three dimensions considered: input, output and behaviour. As some meta-reviews have shown, this is partially responsible for the non-fully conclusive results that the evidence reveals in some regards.

When we analysed the empirical evidence provided by different studies on the PRRIITT project, some interesting results emerged for the three dimensions of additionality. As for its input additionality, the results appear mixed: the programme does not seem to generate additional investments for the overall sample of firms, but it does for the small ones, which are also the main target of the project, given their more severe financial constraints. On the output additionality side, on the other hand, the effect of the policy appears to be wider spread, although in this case again the major effect is on small enterprises rather than large ones. Finally, the case of behavioural additionality adds another piece to the additionality puzzle and supplementary evidence on the effectiveness of the PRRIITT programme. The internal behaviours of the recipient firms significantly change compared to the non-recipients' ones: for example, the programme helps the former in getting an additional advantage in terms of skills and competencies. As for the external behaviours of the focal firms, although the programme is not able to foster

business cooperations among firms in the regional environment, it is able to do so in the industry-research cooperation domain. Recipient firms actually appear more engaged in cooperations with universities and research organisations than non-recipient ones, also located outside the regional borders. Quite interestingly, this also entails a shift from cooperating with regional partners to extra-regional ones, although this seems to depend on the amount of subsidy received. In combination, not only does the PRRIIT address market failures, but it is also capable of dealing with the systemic failures of the Emilia-Romagna region. This is a particularly important result if we consider that this last category of failures also encompasses the frequent local occurrence of lock-in situations, which prevent regions from following more remunerative paths of local development. Indeed, by addressing these system failures, regional policies like PRRIITT could enable regional firms to put in place a set of innovative behaviours, which could contribute to the structural change of the region itself.

Some of the reasons behind the effectiveness of the policy in question presumably lie in the fact that this is a "place-based", regional level policy. As Bronzini and Piselli (2016) suggest, "first, regional programs are more closely aimed at smaller firms, for which public support proved to be more effective on the whole. Second, regional policy makers may well have a better knowledge of the local economic environment and of regional firms' activity, which could facilitate policy design and implementation" (p. 456). On the basis of these arguments, additionality effects are more likely to emerge, and the policy is more likely to be effective at the regional than at the national level. We agree with this explanation and we also dare to say that the PRRIITT policy could be even more effective than currently, if the cherry-picking strategy of beneficiaries' selection was abandoned in favour of a random selection procedure, as suggested by the evidence presented by Radicic et al. (2016).

Finally, it can be seen that extensive analyses have been carried out by several researchers concerning the policy design for supporting innovation and its implementation to be effective. Still, there is a considerable amount of work to be conducted in order to understand the proper functioning of the programme. For example, there is a need to determine the factors behind the heterogeneous results of PRRITT or to investigate the presence of spillover effects, which may generate a positive impact on firms that were not subsidised. An additional research question that is worthwhile investigating in future is the broader "outcome additionality" of PRRIITT. In particular, though more longitudinal data should be collected for that, it would be interesting to look at the extent to which the policy has contributed to making the Emilia-Romagna region benefit by the removal of its system failures – for example a mainly informal regional innovation system (Evangelista et al. 2002) – and to achieve new degrees of freedom in terms of structural change.

7.5 References

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This edited volume focusses on innovation-based regional change at the European level. The contributions deal with change in different European types of regions, innovation opportunities outside agglomerations, regional case studies from England, the Czech Republic and Portugal as well as with the additionality effects of an Italian regional funding programme. This thematic spectrum describes and explains various facets of regional change in Europe.

The Fraunhofer ISI analyzes the framework conditions for innovations. We explore the short- and long-term developments of innovation processes and the societal impacts of new technologies and services. On this basis, we provide our clients from industry, politics and science with policy recommendations and perspectives for key decisions. Our expertise lies in a broad scientific competence as well as an interdisciplinary and systemic research approach.

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