Innovation Policies and New Regional Growth Paths: A place-based system failure framework

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Abstract: Regional economies are increasingly facing the challenge to renew their economic structures and generate innovations that break existing development paths. This calls for new innovation policy approaches that are well equipped to foster the modernisation of existing industries and nurture the development of new ones. The aim of this chapter is to provide a comprehensive place-based system failure framework for an innovation policy design that is suitable to initiate and support economic renewal processes in different region-specific contexts. Our framework rests on three pillars. The first one draws a distinction between barriers that relate to rigidities of the current industrial, knowledge and institutional structures on the one hand and impediments that hinder the emergence of new development paths on the other hand. The second conceptual cornerstone differentiates between various forms of new path development, namely path upgrading, modernization, branching, importation and new path creation. Third, to capture varying regional characteristics, we distinguish between thin, thick and specialised and thick and diversified regions. Our conceptual discussion demonstrates that each region type suffers from particular combinations of barriers to structural change. This offers a sound basis for assessing which types of new path development are most likely to occur in thin, thick and specialised and thick and diversified regions and for identifying promising policy approaches to fashion regional structural change in various regional contexts.

Keywords: regional innovation policy; place-based system failures; regional structural change; new regional industrial path development

JEL: O 33; O38; R11; R58

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A place-based system failure framework

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1 Introduction

Fundamental and enduring changes brought about by recurrent economic and financial crises, the digital revolution and ongoing globalization processes of production and innovation activities are posing major challenges on regional and national economies to renew their industrial structures and develop innovations that break existing development trajectories. This calls for new innovation policy approaches that are well equipped to support transformation processes towards new industrial growth paths. This chapter aims to provide the conceptual underpinnings for such a reorientation of innovation policy. We take an innovation system (IS) perspective and develop a comprehensive place-based system failure framework for an innovation policy design that is suitable to promote structural change in different region-specific contexts.

Over the past ten years or so, the RIS concept has proven to be a powerful approach to inform policy makers and to legitimize their actions and interventions (Asheim et al. 2011; Coenen et al. 2016). A key point of departure in the innovation system policy literature is the notion of 'system failures'. Protagonists of the innovation system approach have convincingly argued that it is not only market failures (underinvestment in research due to the public good character of knowledge, spillovers and short time horizon applied by market actors in their investment decisions) that may lead to too low rates of innovation activities.

Structural failures (or deficiencies) at the system level, such as infrastructural, institutional, interaction (network) and capability failures (Woolthuis et al. 2005) might also result in severe barriers suppressing innovation. The system failure concept has also been applied to the regional level, foregrounding the role of three main types of regional innovation system

(RIS) deficiencies, that is, organizational thinness, negative lock-in and fragmentation (Tödtling and Trippl 2005). Recently, an attempt has been made to present an extended system failure concept by introducing a new focus on so-called 'transformational system failures', including directionality, demand articulation, policy coordination and reflexivity failures (Weber and Rohracher 2012).

These frameworks have offered many insights but they are only partially useful for identifying and conceptualizing key barriers to the emergence and growth of new development paths. The older structural approaches mainly focus on existing innovation systems and innovation activities in established sectors and are thus rather limited in their explanatory power of what hinders 1) innovations that are required for new development paths and 2) the transformation of the whole IS. The more recent accounts of transformational system failures reflect the adoption of a more dynamic approach but they suffer from several shortcomings. Not only are the identified failures strongly overlapping, one can also critically ask if they are exhaustive. Furthermore, research on transformational system failures does hardly go beyond a mere identification of deficiencies, that is, it remains relatively vague in clarifying under what circumstances they make their appearance.

In this chapter we propose a place-based system failure framework that provides an advanced understanding of how regional context conditions shape and impede industrial renewal and diversification processes into new fields. Our framework rests on three pillars. First, we offer a nuanced view on barriers to regional structural change by distinguishing between failures to break with existing paths and failures to develop new industrial growth paths. Our framework acknowledges that such failures may emerge in all subsystems that form a RIS and relates them to actors, networks and institutions, which results in particular exploration/experimentation and exploitation dilemmas. Second, building on recent scholarly contributions on forms and directions of structural change (Isaksen et al. 2016) we differentiate between various types of new path development, namely path upgrading, modernisation, branching, importation and new creation. Third, to capture varying regional characteristics we follow Isaksen and Trippl (2016b) and distinguish between thin, thick and specialised and thick and diversified RIS.

Our conceptual discussion reveals that each RIS type suffers from particular combinations of region-specific failures and barriers to structural change, which helps to assess which types of new path development are most likely to occur in peripheral, old industrial and core regions. We argue that insights derived from such a place-based system failure framework offer a sound basis for developing new policy approaches to fashion regional structural change in various regional contexts.

2 Regional innovation systems: static or dynamic?

A typical critique against the RIS approach flags its alleged static perspective. Holding true, this critique would strongly undermine the legitimacy of the RIS approach for understanding and analysing structural change in regions, and drawing adequate policy conclusions. On the one hand, the critique is comprehensible given that numerous empirical contributions to the RIS literature portray regional snap-shots, ill-equipped to inform about structural change processes as they unfold over time. On the other hand, we will show below that the RIS approach draws on concepts that are directed towards explaining socio-economic change processes. In this section, these conceptual underpinnings of the RIS approach are reviewed

with the aim to prepare the ground for discussing how the RIS approach can be extended to better conceptualise structural change processes.

The RIS approach emphasises the role of innovation as key driver for the competitiveness of firms and regions. It follows thereby the evolutionary tradition emphasising what Schumpeter (1943) called quality competition over ordinary (static price) competition. Quality competition refers to novel combinations of knowledge and resources that create higher value through innovations (Asheim et al. 2015). The RIS approach recognises the variegated nature of innovation encompassing product, process, and organizational innovations at the level of the firm as well as social and institutional innovations at the level of the region or the industry (Morgan 2007).

Innovation explains industrial dynamics. Incremental innovations drive continuous upgrading processes and propel development along a technological trajectory. Incremental innovations, therefore, accompany path-dependent processes, which play an important role in the conceptual underpinnings of the RIS approach. Conversely, radical innovations are viewed to trigger structural change. Radical innovations devaluate existing knowledge bases, technologies and institutions. In a process of entrepreneurial discovery (Kirzner 1997) they lead to the reallocation of resources to more promising opportunities, contributing to the development of new knowledge, technologies and an adaptation of the institutional framework. In other words, incremental innovations reinforce development paths while radical innovations challenge them.

The RIS literature has dealt intensively with path-dependent processes, often associated with positive or negative lock-ins. On the positive side, lock-in processes describe an alignment of regional knowledge bases, collective resources, and the institutional framework. This alignment produces specialised suppliers, sophisticated demand, qualified labour, educational and research activities, and supporting services that are focused on a common theme or sector, thereby creating competitive advantage. The RIS approach emphasises the cumulative nature of localized learning processes embedded in an inert regional institutional context. The localized learning argument rests on the presumption that tacit knowledge plays a more important role in explaining competitive advantages than codified knowledge because the latter is more easily accessible globally (Maskell and Malmberg 1999). Furthermore, tacit knowledge is embedded in a social, cultural and institutional context, detached of which it quickly loses value (Gertler 2003). For these reasons, tacit knowledge is at best transferred or generated through interaction or practice (Polanyi 1958; Lam 2000) within a shared institutional context and through trust-based relationships. These "untraded interdependencies" (Storper 1995) underpin learning and innovation dynamics and explain at the same time their cumulative and path-dependent nature.

A recent contribution to the RIS literature differentiates between cumulative and combinatorial knowledge dynamics (Strambach and Klement 2012). Cumulative knowledge dynamics refer to the continuous development of a knowledge base while combinatorial describes the process of bringing together different knowledge bases. Firms that combine knowledge bases either through holding them in-house or sourcing them externally are more likely to produce radical innovations (Tödtling and Grillitsch 2015; Grillitsch et al. 2016). Hence, the extent to which regions promote or hinder combinatorial knowledge dynamics can be expected to have an important effect on their adaptability and the potential of new path development.

The negative side of path-dependency and lock-in is the failure of regions to adapt when existing development trajectories are challenged by for instance radical innovations or new socio-economic trends. The RIS literature has addressed negative lock-ins in relation to the study of old industrial regions or regions facing structural challenges (Hassink 2005; Trippl and Otto 2009; Hassink 2010).

The conceptualisation of negative lock-in draws on Grabher's (1993) seminal contribution in which he differentiates between cognitive, functional and political lock-in. Cognitive lock-in refers to a shared world view producing and reproducing similar interpretations of the environment. Homogeneous views limit the capacity to perceive environmental changes or draw adequate conclusions. Functional lock-in describes rigid, typically hierarchical inter-organisational relationships that limit the potential for individual players to reorient themselves and change strategy. Political lock-in captures efforts of established actors to protect vested interests and to resist change as well as formal and informal rules supporting the traditional sectors.

Hassink (2010) argues that economic-structural and political-institutional impact factors influence the renewal of clusters and regions. As regards the former, renewal is constrained by industrial mono-structure, and in particular if the leading industry is capital-intensive, has high-entry and exit barriers, exhibits above average company size, has an oligopolistic market structure, and is highly influenced by trade unions. Political-institutional impact factors encompass the regional, national and supra-national level. Hassink (2010 p. 465) argues that "it is of key importance when analysing regional lock-ins in old industrial areas to take the institutional context at all spatial levels, that is local, regional, national, and supra-national into account."

Linking economic evolution with the institutional context, it has been argued that institutional variety contributes to the potential for radical innovations and new path development (Boschma 2015). However, institutional variety alone is not sufficient, as it does not necessarily imply that actors from different institutional contexts interact and cooperate. Thus, also connectedness between different institutional contexts is required (Grillitsch and Asheim 2015). Institutional variety and connectedness together, for instance through individual mobility between variegated institutional contexts, double affiliations or positions, or networks are important explanatory factors for the potential of path-breaking innovations and entrepreneurial discoveries, as well as the coordination of interests and collective efforts in order to promote new development paths (Grillitsch 2015).

The RIS literature can be criticised for the frequent simplification of a static institutional framework, which applies in particular for empirical 'snap-shot analyses'. However, this does not per se obstruct a co-evolutionary perspective of RIS where institutional and economic change are inherently linked. Sotarauta and Mustikkamaki (2015) show that institutional entrepreneurship is an important driver for institutional change and new path development. Grillitsch (2015) relates the adaptability of regional institutional contexts to structural characteristics such as institutional variety and connectedness as well as the position and power of actors within it.

Iammarino (2005) relates RIS to Dopfer's (2004) evolutionary micro-meso-macro framework implying that the interdependencies between the three levels (upward and downward causation) determine the paths of regions. The macro level encompasses institutions erected at the national and supra-national scale while the meso level relates to the socio-institutional embededdness of regional innovation and knowledge linkages. Grillitsch and Rekers (2015, p.

167) argue that 'the shifts in behaviour of economic actors can be traced back to institutional changes at multiple scales. In other words, frequent opportunities for face-to-face interaction and the development of long-term trust-based relationships are not automatically available to firms that are located in close geographical proximity to competent partners. These localized assets are only assets when they are supported by the multi-scalar institutional environment in which organizations operate'.

Recent literature has reflected about the types of structural change in RIS (Trippl and Otto 2009; Tödtling and Trippl 2013): i) incremental innovation-based adjustment processes of clusters towards new higher-value market niches, ii) diversification of firms into established industries that are new to the region, iii) the emergence of clusters in new industries based on knowledge-intensive activities. The importance of academic leadership and university spin-offs is highest for the third type of structural RIS change leading to radical change. As the allocation of public funds to academic fields is to a large extent a political decision, often requiring long-term investments before economic results realise, policy plays an important role in the emergence of research-based industries. Nevertheless, also more incremental forms of structural change depend on access to new knowledge and resources. Thus a reconfiguration of the knowledge infrastructure, institutional changes and policy support contribute to new path development in RIS (see, for instance, Morgan 2007; Tödtling and Trippl 2013).

Moreover, RIS 'with stronger social capabilities and a stronger knowledge base will tend to also be better equipped to exploit new technological opportunities, to adapt existing activities to emerging business environments, and to learn faster about how to build new regional advantages' (Iammarino 2005, p. 501). This can be reflected in different types of RIS. Isaksen and Trippl (2016b) specify organisationally thick and diversified RIS (e.g. metropolitan areas), organisationally thick and specialised RIS (e.g. specialised clusters and old industrial regions) and thin RIS (typically peripheral areas). Accordingly thick and diversified RIS offer the best pre-conditions for new path development while thick and specialised RIS and particularly thin RIS provide a more constraining environment for the rise and further evolution of new growth paths.

3 Towards a new understanding of barriers to and forms of regional structural change

RIS consist of actors (individuals and organisations such as companies, cluster organisations, research institutes, educational bodies, knowledge transfer organisations, science parks and so on) that are connected through networks whereby the actors' behaviour and interactions are shaped by institutions, the cumulated knowledge base and technologies (Tödtling and Trippl 2005). From a RIS perspective, barriers to structural change can thus be related to actors, networks and institutions that result in – as will be explained below – various forms of knowledge exploration-exploitation dilemmas.

3.1 Disentangling barriers to regional structural change

Structural change results from a combination of breaking with existing structures (overcoming negative lock-ins) and growing new development paths (creating positive lock-

ins) as illustrated in table 1. These two essential processes of structural change face different types of barriers, which we address below.

A major barrier to breaking with existing paths relates to strong capabilities of RIS actors. Strong capabilities become a problem if changes in technologies or markets diminish the relevance and value of existing capabilities, inducing the classical cognitive lock-in (Grabher 1993). Similar worldviews and routines for perceiving, searching, and interpreting new information leads to myopic behaviour, which is reinforced through localized learning within industry clusters (Maskell and Malmberg 2007). Typically, this is the case in mature industries, which are characterised by incremental innovations that often aim at cost-cutting or minor product adaptation (i.e. path extension). Strong capabilities have been built through investments into knowledge, organizational routines, and infrastructure, which in the face of decline become sunk costs. Incumbents have strong vested interests to protect their past investments and profit opportunities.

In contrast, developing new growth paths is typically constrained by weak capabilities, which resonates closely with the organisational thinness argument (Isaksen 2001; Tödtling and Trippl 2005). Organisational thinness can be further differentiated in a quantitative and qualitative dimension (Grillitsch and Asheim 2015). The quantitative dimension refers to the existence or number of relevant RIS actors while the qualitative dimension captures their level of capabilities. Weak capabilities also exist if the knowledge profiles of actors are incompatible, meaning that interactive learning is hindered due to a high cognitive distance (Boschma 2005).

As regards networks, relevant barriers for breaking with existing structures are strong connectedness and interdependencies in old paths. As industries mature, strong interdependencies between actors in the value chain emerge, creating functional lock-ins (Grabher 1993). These interdependencies might play out at the local scale in for instance industrial districts (Pyke et al. 1990; Asheim 2000). More often, however, they are realised in global production networks (Henderson et al. 2002; MacKinnon 2012) and are a powerful stabilising force for existing structures. These interdependencies are manifested in stable and thus relative rigid core-periphery network patterns, which develop due to preferential attachment to leading firms, the higher probability of weaker firms to exit the market, and the tendency to collaborate with partners known from previous collaborations (Ter Wal and Boschma 2011).

While path breaking struggles with strong connectedness and interdependencies the opposite is true for growing new paths. Weak connectedness and interdependencies may exist at the regional and global level hampering interactive learning and innovation related to the newly emerging fields. At the regional level, weak connectedness or fragmentation may exist between RIS sub-systems, for instance between universities and firms, as well as within the subsystems (Isaksen 2001; Tödtling and Trippl 2005). The latter is typically the case when a lack of social capital and highly competitive behaviour restricts interactive learning between firms. However, also a too strong regional focus hinders innovation (Fitjar and Rodríguez-Pose 2011). Innovative firms tend to combine regional knowledge sources with such on the national and international scale (Grillitsch and Trippl 2014; Tödtling and Grillitsch 2015).

Turning to institutions, it is interesting to note that the RIS literature has discussed negative institutional lock-ins at length as fundamental failure especially for old industrial regions (Isaksen 2001; Tödtling and Trippl 2005; Hassink 2010). Institutions co-evolve with industries and technologies (Nelson 1994; Murmann 2003; Schamp 2010). Old industrial

regions are characterised by a mono-industrial structure to which institutions are aligned. Regional actors that focus on the leading industry and protect vested interests, a national-political system where the regional actors can influence industrial policy and supra-national institutions that support the existing industry are key drivers of institutional lock-in (Hassink 2010). Geels (2004) argues that the alignment of institutions from different domains stabilise regimes, which is an argument that resonates well with the literature on institutional complementarities (Aoki 1994; Vitols 2001; Hall and Gingerich 2009). Hence, strong institutional alignment for existing paths is a significant barrier for structural change.

In contrast, growing new paths is constrained by weak institutional alignment and integration across institutional domains. Sotarauta and Mustikkamäki (2015) show that new path creation in an innovation system requires institutional entrepreneurship, i.e. deliberate action to make an institutional change (Garud et al. 2007; Battilana et al. 2009). A classic example is also the work of Zelizer (1978) showing that the diffusion of the life insurance policy was contingent to institutional change. Relating to this, diversity in the institutional framework reduces the risk of lock-in (Strambach 2010; Boschma 2015; Grillitsch 2015) while institutional integration captures the extent to which institutions promote or constrain interactions between different social groups and consequently learning between institutional domains (Grillitsch 2016).

Table 1: Barriers to breaking with existing paths and growing new paths

	Barriers for breaking with existing paths	Barriers for growing new paths
Actors	Strong capabilities in existing paths	Weak capabilities in new paths
Networks	Strong connectedness and interdependencies in existing paths	Weak connectedness and interdependencies in new paths
Institutions	Strong institutional alignment for existing paths	Weak institutional alignment for new paths

Source: own compilation

3.2 Types of regional industrial path development

The distinction between existing paths and new paths outlined in the previous section serves as a point of departure for identifying basic types of failures preventing regional structural change to take place. As the development of new paths, however, can take on many shapes, partly contingent on the barriers developed above, this subsection introduces a fine-grained typology of path development.

Drawing on previous work (Martin and Sunley 2006; Tödtling and Trippl 2013), recent scholarly contributions have clarified and enriched the concept of path development by differentiating between five key forms (Isaksen et al. 2016), namely path extension, modernisation, branching, importation and creation. We extend this typology by the notion of path upgrading (Table 2).

Path extension occurs through incremental product and process innovations in existing sectors. It reflects continuity of regional industrial structures, path dependence and positive lock-in (see above). This may, however, lead to stagnation, decline and path exhaustion in the

longer run due to weakly developed renewal capacities. Regional industries then suffer from negative lock-in. They become locked into innovation activities along well-established technological paths and practices, constraining their opportunities for experimentation and capacities to generate radical innovation.

Path upgrading describes transformation processes of a regional industrial path related to an improvement of its position within global production networks. This could occur through processes of value enhancement based on developing more advanced functions and more specialised skills, technological upgrading, and so on (Coe et al. 2004; MacKinnon 2012).

Table 2: Types and mechanisms of path development

Forms of path development	Mechanisms
Path extension	Continuation of an existing industrial path based on incremental innovation in existing industries along well-established technological trajectories
Path upgrading	Major change of a regional industrial path related to enhancement of position within global production networks; moving up the value chain based on upgrading of skills and production capabilities
Path modernisation	Major change of an industrial path into a new direction based on new technologies or organisational innovations
Path branching	Development of a new industry based on competencies and knowledge of existing related industries (related variety)
Path importation	Setting up of an established industry that is new to the region (e.g. through foreign firms)
Path creation	Emergence and growth of entirely new industries based on radically new technologies and scientific discoveries or as outcome of search processes for new business models, user-driven innovation and social innovation

Source: adapted from Isaksen et al. (2016)

Path modernization denotes fundamental intra-path changes, that is, transformation processes of established paths into a new direction. Such changes leading to a renewal and upgrading of existing paths may be based on the 'injection' of new technologies (e.g. the use of laser technology in the forest industry, Foray 2015) or organizational innovation (e.g. introduction of project organisation in creative industries, Grabher 2001).

Path branching represents a more radical form of regional structural change. Branching implies that new paths grow out of existing industries and capabilities (Boschma and Frenken 2011) often fuelled by related variety (Boschma 2015). A core mechanism of such processes is the diversification of incumbent firms into new fields and sectors based on the redeployment of existing assets and capabilities. Branching, however, can also take place through the establishment of new firms based on competencies in existing industries. Spin-offs from incumbents in related industries have been shown to play an important role for path branching (related diversification) processes (Klepper 2007).

Path importation means that established industries are transplanted to regions, in which they have not existed before. Arguably, they are new to the region but not new to the world. Importation of paths can occur through the settlement of foreign firms, arrival of qualified

individuals and entrepreneurs with competences not available in the region or extra-regional networks (see, for instance, Trippl et al. 2015). Foreign direct investment is often seen to be a particularly important mechanism of path importation. It hinges on the condition that incoming firms perform high value-added functions in the region and establish linkages to regional actors to enhance their embeddedness in the regional economy.

Path creation in new industries represents the most radical form of regional structural change. It refers to the rise and growth of entirely new industries based on new technological and organisational knowledge assets. Creation of new paths may be the outcome of chance, contingent events, serendipity or historical accidents but more often than not new paths rest on pre-existing assets, resources or competencies in the region, such as an excellent scientific base (Tanner 2014) or the availability of highly skilled workers (Martin 2010). The rise of new high-tech and knowledge-intensive industries is nurtured by the formation of new companies and spin-offs (Frenken and Boschma 2007). Path creation in new industries requires a substantial transformation of the regional knowledge and support infrastructure and institutional change.

There are strong reasons to argue that regions differ substantially in their capacity to induce the forms of new path development outlined above due to the prevalence of various types of barriers to structural change identified in section 3.1. In a next step, we elaborate on this argument and discuss the policy implications following from it.

4 Regionalization: RIS types and policy approaches

Our point of departure is Isaksen and Trippl's (2016b) distinction between three main RIS types, that is, organisationally thin RIS, organisationally thick and specialised RIS and organisationally thick and diversified RIS. Thin RIS are often found in peripheral regions, whilst thick and specialised RIS are typical for old industrial areas. Finally, thick and diversified RIS tend to prevail in advanced core areas such as larger cities and metropolitan regions.

These RIS types suffer from particular combinations of barriers to breaking with existing and nurturing new paths, which helps to explain which forms and directions of structural change (that is, types of new path development) are likely to take place in each of the three region types considered in this chapter. This allows for a nuanced discussion of adequate policy strategies for peripheral, old industrial and core regions (see Table 3).

4.1 Thin RIS: Peripheral regions

Peripheral regions are by definition characterised by a lack of a critical mass of strong actors in related or unrelated fields. On the one hand, it can be argued that for this reason barriers for breaking with existing paths are weaker as compared to the other two regional types. Simmie (2012, p. 770), for instance, argues that the introduction of wind power technologies in Denmark occurred in rural areas because "the dominant urban, centralized and grid-connected electricity generation and supply system did not exist". On the other hand, peripheral regions may be locked-in global patterns of production and consumption. This is the case if transnational companies exploit basic, low-cost resources in the periphery, in particular cheap labour. MacKinnon (2012) argues that strong power asymmetries between the transnational firms and regional authorities, and a lack of local linkages with other firms imply a high degree of dependence and lock-in low-value creating development paths.

Thus actor related barriers for structural change in peripheral region concern mainly weak capabilities of local actors in a broad sense. The competences of firms are essential for overcoming locational disadvantages (Grillitsch and Nilsson 2016). This directly relates to providing adequate educational and training facilities in the region. Peripheral regions typically lack universities and higher level education. Furthermore, the capacities of regional policy makers are essential to promote the growth of economic development paths, for instance through securing support and funding on the national level or encouraging regional embedding of key firms.

Due to the low number of relevant actors, innovation and production networks tend to be weakly developed in the periphery. However, a problem exists if one or few strong regional actors monopolise the networks in an effort to protect vested interests. This could be the case, for instance, if one firm (or subsidiary) provides a large share of the jobs in the region, thus being a source for strong dependencies. A key question is then how to balance the power and position in the network, to allow other regional actors to be part in the network, and to open the network to complementary sources of knowledge and resources outside the region. Apart from this lock-in problem, actors in peripheral regions will – due to a lack of internal resources – always be in need of linking up to strong partners located elsewhere.

On the institutional side, peripheral regions may be characterised by a distinct regional culture. Westlund and Kobayashi (2013) argue that rural areas due to a relative homogeneous world view and strong bonding social capital tend to be less inclined to engage in extra-regional networks. Too much region-mindedness has been identified as hampering factor for innovation (Fitjar and Rodríguez-Pose 2011; Malecki 2011), thereby constraining structural change processes. Peripheral regions have the advantage, in contrast, that institutions are not aligned to a specific type of economic activity (given a lack of specialisation in the regional economy), thus implying a relatively low degree of respective lock-in.

Policy strategies

Due to the pervasive weaknesses of the innovation system in peripheral region, viable policy strategies are limited to path importation and path upgrading. Typically the available competencies in peripheral regions are too limited to create new paths even though exceptions may prove the rule (e.g. Simmie 2012). Furthermore, branching is not an option as it requires a strong basis in at least one industry, which typically does not exist in peripheral regions.

Path breaking policies play a role if existing players such as one strong firm or subsidiary monopolises regional networks and policies. Due to the dependency from the lead firm, this will most likely work in subtle ways. At the level of actors, the lead firm can be encouraged to engage more with other local actors while programmes to strengthen the capacities of the local actors will over time lead to an upgrading of the regional environment. As regards networks, policy makers may broaden their networks and engage new actors in regional decision making. On the institutional side, policies that encourage more openness towards the outside world can facilitate extra-regional knowledge linkages.

New path development policies shall focus on path upgrading and path importation. Path importation aims at attracting organisations including firms, universities, research institutes, educational facilities, or public services, as well as individuals to the region. Isaksen and Trippl (2016a) show for instance how the arrival of several research institutes has led to the growth of the software industry in Mühlviertel, a peripheral Austrian region, or how two

pioneering firms in the electronics sector stimulated a regional development path in Arendal-Grimstad, in Southern Norway. Such a policy should always include the commitment of upgrading the regional environment in an attempt to create positive self-reinforcing processes. This implies strengthening the competencies of organisations located in the region through (vocational) education and training as well as incentives to invest in innovation, creating support services, and promoting networks within the region and with extra-regional sources of knowledge and resources.

4.2 Thick and specialised RIS: Old industrial regions

Thick and specialised regions face major challenges to renew their economic structures and innovation systems. Both barriers related to breaking old paths and creating new ones tend to loom large and need to be overcome for structural change to occur. Breaking old industrial paths is pivotal and appears to be more in demand than in other regions due to the strong specialisation of these areas in a few, often traditional, industries and the prevalence of various forms of negative lock-ins (Hassink 2010). At the same time, assets for creating new paths are hardly available at the regional level as a result of the concentration of resources in well-established paths. Consequently, these regions have often been portrayed as 'centres of continuity', offering favourable conditions for path extension but not for new forms of path development (Isaksen and Trippl 2016b). However, some of these regions may take advantage of a sufficiently large generic competence in their area of specialisation, which could provide the basis for path branching. Strengthening the research infrastructure to widen the exploration capacity of the region, building links to non-local sources of expertise and combining inflowing knowledge with the highly specialised competences residing within the region could essentially trigger such branching processes (Trippl et al. 2016). Diversification of oil and gas firms into offshore wind activities in Scottland (Dawley 2014) and Mid-Norway (Steen and Karlsen 2014) serve as a good example in this regard.

Actor-related barriers found in thick and specialised RIS are the outcome of long-standing, historically accumulated capabilities and experiences in traditional economic activities, which are difficult to abandon even if changes in markets and technological progress render existing competences obsolete. More often than not, actors' responses to changing environment conditions are characterised by cost-cutting measures or the adoption of incremental innovation strategies. Arguably, such responses and strategic orientations as well as the power of vested interest players are among important factors that explain why thick and specialised RIS face difficulties to break existing paths (Morgan 2013). At the same time, these regions tend to be short of capabilities that could provide the foundation for entirely new paths, that is, they lack the variety of capabilities and novel knowledge assets that often forms the basis for new path creation (Isaksen and Trippl 2016b).

Network-related barriers to structural change are well documented for thick and specialised regions. This RIS type often suffers from what Grabher (1993) has called 'the weakness of strong ties', that is, rigid, closed networks between well-established players, which underpin and further stabilise existing paths. Breaking existing paths will thus often precondition the dissolution of such network configurations, since they blind their members to seeing needs and opportunities for intra-path changes and new path development.

Finally, failures resulting from a strong alignment of institutions at various spatial scales to the dominant industries, lack of diversity in the institutional environment and low levels of institutional integration are salient features of thick and specialised RIS, reinforcing existing paths and bedevilling the rise of new ones.

To summarise, thick and specialised regions appear to be burdened with failures and rigidities found in the actor, network and institutional dimensions of their RISs. Their interplay provides a strong basis for expounding why path extension – and in some cases path branching – are often the dominant form of path development in these areas and why more radical forms of structural change are held down by too much exploitation and too little exploration.

Policy strategies

As elucidated above, thick and specialised regions face the challenge to overcome barriers to breaking existing paths and developing new ones. This calls for a policy approach that combines measures that help to destabilise and break with old paths and nurture the creation and growth of new ones. In other words: both path breaking policies and new path development policies are required for structural change to take place.

Path breaking policies range from withdrawal of public support for old industrial paths and technologies (removal of R&D and innovation funding, cutting subsidies, withdrawal of other institutional incentives, etc.), to breaking up close networks between government and private vested interest players, and so on. In essence, such policies are about weakening conditions that are favourable to the status quo.

New path development policies may cover a wide array of strategies and policy instruments, depending on the type of path development under consideration. Both path modernisation and path branching should rank high on the policy agenda. The former will entail to support firms to search for and create connections to providers of new technological and organisational knowledge and to strengthen their capacity to absorb new knowledge assets and combine them with their existing capabilities. Promotion of path branching might also be a suitable policy strategy to foster regional economic renewal and structural change in thick and specialised RIS. This calls for a proactive policy approach that supports the diversification of firms into new but related fields. Path branching will also benefit from policy actions geared towards a broadening of the specialised knowledge base, support of linkages outside the dominating path at the local – and even more importantly – at the non-local level and the introduction of new players in the RIS (e.g. establishment of research and educational bodies, nurturing local and attracting foreign firms that focus on new but related fields; see, for instance, Morgan's (2016) analysis of policy actions employed in the Basque country).

4.3 Thick and diversified RIS: Core regions

Thick and diversified regions often display multiple forms of regional industrial path development, that is, paths at later stages of their development co-exist and sometimes co-evolve with younger and emerging ones. Diversity in industrial structure (Boschma 2015) and the presence of a large number of different firms, knowledge and support organisations point to the availability of a large heterogeneity in competences and resources (Essletzbichler 2015) that can be used to initiate new paths. Beside favourable actor constellations, structural change in these areas is supported by diverse and geographically open networks and institutional heterogeneity, that is, the presence of both bonding and bridging social capital (Simmie 2003; Isaksen and Trippl 2016b).

This should not imply, however, that challenges to new path development are absent in thick and diversified regions. Their nature, however, differs substantially from those observed in other RIS types. Barriers to grow new paths may be found in unbalanced exploration-

exploitation capacities. These areas host actors with strong capabilities in experimentation and novelty generation (universities, young research-based firms, etc.). Actor-related barriers may mainly arise from comparatively poorly developed capabilities to exploit new knowledge for new path development. For instance, weak capacities of and little support for firms and universities to commercialise findings from the locally available excellent scientific base have hampered the rise of a new biotech path in Austria's capital city Vienna (Trippl et al. 2015).

Focusing on the network dimension, weak connectedness and interdependencies may hinder new path development. At the regional level, fragmentation has been identified as a potential barrier to innovation and new industrial activities in thick and diversified regions (Tödtling and Trippl 2005). Fragmentation may stem from weak university-industry linkages, resulting in a poor commercialisation of new knowledge, which constrains new path creation based on scientific discoveries. Furthermore, cognitive and other barriers that prevent diverse firms and industries to connect might be sources of fragmentation, impeding processes of path branching.

Barriers to path creation and path branching may also be related to the institutional dimension of diverse regions. Institutions tend to adapt slowly to emerging paths. Failures to align institutions to new industrial activities could lead to a loss of momentum in their development. Positive lock-in required for further path evolution of new industries may not take place.

One might also find barriers to breaking existing industrial paths, since diverse regions may also host traditional industries. In this case, too much exploitation and too little exploration – reflected in actors' capabilities, long-established networks and well-aligned institutional set-ups – may constrain structural change in parts of diverse innovation systems.

Policy strategies

Diverse regions are regarded as centres of continuous change, offering favourable conditions for path creation and path branching. However, as discussed above, there might be 'partial' failures that call for policy action.

Path breaking policies might be on the policy agenda in order to avoid or escape from negative lock-in in traditional sectors. Withdrawal of support for traditional activities and other measures to break up old paths that bind resources that could be used for new development paths may thus be of vital importance.

New path development policies in thick and diversified regions should take into account the variegated nature of development paths in the region. In the case of mature industries, path breaking policies can be complemented with activities to promote path modernisation. A good example is the food industry in Scania, a diversified region located in the South of Sweden. Injection of new scientific knowledge has led to the rise of functional food activities, i.e, to substantial intra-path changes in a long-established industry (Zukauskaite and Moodysson 2016). Strengthening the exploration capacity might be an essential policy goal in this regard. This should include a variety of measures. Fostering the creation of networks to sources of new science-based and other forms of knowledge, boosting the absorption capacities of traditional firms, and provision of institutional incentives for path modernisation are important policy elements of exploration enhancing strategies.

The main policy orientation, however, should be to support path branching and new path creation. This may best be achieved by enhancing the exploitation capacities and by targeting

the sources that cause fragmentation. Active support for commercialisation of research-based knowledge and platform policies that bring together different (but related) firms and industries, allowing for an integration of dispersed knowledge and combination of resources should rank high on the policy agenda. Finally, adapting institutional structures to newly emerging paths to support them going beyond the early path creation or branching phase is of vital importance.

Table 3: Place-based system failure framework for structural change in RIS

Regional type	Barriers to structural change		Implication for new path development	
	Path breaking	Path development	Most promising types:	Policy implication:
Thin (Peripheral regions)	Possible monopolisation of networks and policies through by key firm.	Pervasive failure due to weaknesses in whole innovation system	Importation Upgrading	Path breaking: • Broaden local and global networks • Promote openness to external sources of knowledge Path development: • Attract investments • Strengthen capabilities of regional actors • Promote inter-regional linkages
Thick and specialised (Old industrial regions)	Pervasive failure due to the existence of one dominant path	Partial failure due to strengths in exploitation but weakness in exploration	Modernization Branching	Path breaking: • Reduce public support for existing activities • Break up tight night networks between incumbents and policy Path development: • Increase variety in knowledge base • Support linkages outside the dominant industry (global and local) • Introduce new players
Thick and diversified (Core regions)	Partial failure due to the existence of multiple paths at different stages of development	Partial failure due to strengths in exploration but weakness in exploitation	Modernization Branching Path creation	Path breaking (for "old" paths in the region): • Reduce public support for existing activities • Moving resources from old to new paths Path development: • Increase regional connectedness between industries and sectors • Increase exploitation capabilities (in relation to the commercialisation of research-based knowledge) • Support institutional alignment and integration for newly emerging paths

Source: own compilation

5 Conclusions

The regional innovation systems approach has been criticized for being rather static while we argue that its theoretical and conceptual foundations capture dynamic processes such as innovation and learning. Hence, it provides a framework to analyse structural change of regional economies, contributing especially to understanding respective barriers in relation to region-specific conditions. The chapter shows conceptually why the regional context has far-reaching effects on the type of new path development that is most feasible and promising, leading to concrete policy recommendations for different types of regions.

A place-based system failure framework is proposed that combines three conceptual cornerstones. The first one differentiates between barriers that relate to rigidities of the current industrial, knowledge and institutional structures on the one hand and constraints that hinder the development of new growth paths on the other hand. The second conceptual cornerstone captures different forms of new path development, comprising path upgrading, modernization, branching, importation and new path creation. The third cornerstone relates to regional characteristics. We differentiate between organizationally thin, organizationally thick and specialised and organizationally thick and diversified regions.

Our discussion shows that each region type is prone to a certain combination of barriers to structural change, which has profound implications for the most promising types of new path development and policy options. In organizationally thin regions (peripheral regions), a relative low degree of negative lock-ins is expected, although a strong firm or subsidiary may monopolise regional networks and politics. However, new path creation is difficult due to the weaknesses in knowledge exploration and exploitation and branching is unlikely because of the lack of specialisation in an industry. The most promising path development strategies, therefore, are to upgrade or import existing paths. This is best achieved by strengthening basic capabilities through attracting investments, enhancing capabilities of regional actors, and promoting inter-regional linkages. In case of one or few actors monopolising regional networks and politics, path destabilisation policies that broaden local and global networks as well as promote openness to external sources of knowledge are recommended.

Organizationally thick and specialised regions suffer most from rigidities erected by the current industrial structure, knowledge assets and institutional configurations. Due to the specialisation in one or a few industries cognitive, functional and institutional lock-ins loom large. This is combined with barriers to new path development that relate to a lack of exploration capacities, in particular the capability to create novelty by combining knowledge from different domains. On the positive side, the accumulated knowledge and resources in the respective specialisation can be a basis for new path development. Accordingly, path modernisation and branching are the most promising development options. A combination of policies to destabilise the existing path and strengthen exploration capacities is recommended. Path destabilisation includes the reduction of public support for existing activities and the breaking up of tight night networks between incumbents and policy. Knowledge exploration can be strengthened by increasing variety in knowledge bases, supporting local and global linkages outside the dominant industry, and introducing new actors.

Organizationally thick and diversified regions are considered as core centres of new path development. Diversity in industrial and institutional structures, a large variety of knowledge assets and geographically open networks provide a fertile ground for path creation and path

branching activities to occur. Nevertheless, 'partial' failures originating from unbalanced exploration-exploitation capacities may make their appearance, suppressing structural change. Too much exploration and experimentation may hamper positive lock-ins in newly emerging paths, whilst too much exploitation might prevent path modernisation to take place in more traditional industries. Consequently, diversified regions will benefit from a policy approach that enables mature paths to undergo major intra-path changes by building bridges to new knowledge sources and new paths to emerge and achieve positive-lock in by supporting exploitation activities in new fields. The latter targets path branching and new path creation and includes enhancing the regional connectedness between different industries, strengthening of the commercialisation of research-based knowledge and supporting institutional alignment and integration for new paths.

This chapter provides a conceptual discussion that contributes to a place-based system failure framework. It adds to traditional RIS failures by focussing on structural change and new path development, thus introducing a more dynamic perspective. Furthermore it advances the recent debate on transformative failures by linking it to the challenges different types of regions face. This chapter therefore translates the rather abstract thoughts on system transformation and structural change to place-specific conditions, which allows for a more concrete formulation of policy recommendations. Future research efforts will, however, need to empirically examine and test the proposed place-based system failure framework. In the real world, regions often deviate from the ideal types discussed in the chapter, which implies that the configuration of barriers and potentials for new path development may differ as well, and that consequently policy implications need to be adapted.

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