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Advancing Regional Innovation Systems: What Does Evolutionary Economic Geography Bring to the Policy Table?

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Abstract

The evolutionary turn in economic geography has shed new light on historically contingent regional preconditions for innovation and economic growth, which has the potential of improving the analytical input to regional innovation system approaches. Evolutionary economic geography has renewed interest in and sharpened the conceptual lens on firms, their organizational routines and knowledge bases as well as the long-term, self-sustaining development dynamics, which may arise from their co-location in regions. At the same, it has been pointed out that an overreliance on imported evolutionary frameworks (such as Nelson and Winter's theory of the firm and their lack of an explicit social ontology) may lead to a 'theoretical relegation' of institutions and agency. It seems also that the policy agenda of evolutionary economic geography has remained largely implicit. In comparison, regional innovation system has been developed in closer interaction with policy-makers and has been used widely as a framework for the design, implementation and evaluation of regional innovation policies in a variety of countries and regions. The purpose of this article is to critically investigate what evolutionary economic geography brings to the policy table, and how this potentially can advance a regional innovation systems approach. The article specially focuses on how this may improve the capacity of policies based on a regional innovation system framework to support new path development (i.e. path renewal and path creation) to secure regional resilience.

Keywords: *Evolutionary economic geography, institutions, regional innovation policy, clusters, regional innovation systems*

Introduction

The Regional Innovation Systems (RIS) approach has been developed in close interaction with policy-making and used widely as a framework for the design, implementation and evaluation of innovation-based regional policies in a variety of countries and regions. Well-known examples are the European Commission-funded RIS/RITTS initiatives (Landabaso and Mouton 2002), regional policies of VINNOVA, Sweden's Governmental Innovation System Agency (Coenen and Moodysson 2009) and the Norwegian VRI programme (Policies for Regional R&D and Innovation) funded by the Norwegian Research Council (Asheim 2012). Some scholars admit that the close relationship with policy has not been unproblematic, as it may have led to "a tendency to collapse levels of abstraction into simple narratives to render them digestible for politicians and policy-makers" (Morgan 2004, p. 873). Even though there has been much critique of a lack of a proper theoretical framework, the RIS approach lends itself well as a comprehensive umbrella framework that synthesizes notions, ideas, insights and lessons from a range of studies and literatures that deal with innovation in a regional context (Doloreux 2002), including a.o. various agglomeration theories on regional clusters and industrial districts as well as institutional theory and most recently evolutionary economic geography. Most importantly for the context of this article, it has demonstrated its value as a helpful boundary-spanner between academic analyses and policy practice. As an analytical focusing device, it has helped scholars and policy-makers alike to formulate and implement innovation policy that is sensitive to the specific conditions found in a region.

The evolutionary turn in economic geography has shed new light on historically contingent regional preconditions for innovation and economic growth. Evolutionary Economic Geography (EEG) has renewed the interest in and sharpened the conceptual focus on the firm level, their organizational routines and knowledge bases as well as the long-term, self-sustaining development dynamics which may arise from their co-location in clusters and regions (Boschma and Frenken 2006). It thus addresses the lack of micro level foundations often attributed to RIS studies (Uyarra 2010). In contrast to the RIS approach, however, the policy agenda of EEG has remained largely implicit. Rather than giving an explicit framework for policy-making, the policy purchase of EEG lies in providing novel analytical perspectives and underpinnings for regional innovation policy based on evolutionary concepts such as localized spillovers, related variety and path-dependence (Boschma 2009; Boschma and Martin 2010). These new insights may be particularly relevant for the capacity of policies based on a RIS framework to secure regional resilience by supporting new path development (i.e. path renewal and path creation). At the same time, EEGs reliance on imported evolutionary frameworks may lead to a 'theoretical relegation' of institutions and social agency (MacKinnon et al. 2009) and thus downplay the role and importance of policy-making in regional development. This is a critical tension given that policy has traditionally been part-and-parcel of the RIS approach.

In conjunction with the overall aim of this special issue to better understand and unpack policy complexities in current regional innovation policy debates, the purpose of this article is to critically investigate what evolutionary economic geography brings to the policy table, and how this potentially can advance a RIS approach. To do so, the article starts out by introducing the regional innovation systems approach and discusses how it is used as a framework for policy-making based on rationales for intervention and choice of instruments. In the subsequent section, the conceptual foundations of evolutionary economic geography are presented, the implications of this approach for the (re-)design

of regional innovation policies as well as the shortcomings that an overreliance on EEG may imply. It then concludes by discussing the consequences of re-thinking RIS in light of EEG.

Regional innovation systems as a framework for policy-making

In the bourgeoning innovation systems literature, which emerged at the start of the 1990s, the RIS approach has been most explicitly concerned with spatial dimensions of innovation and place-based innovation policies (Asheim and Gertler 2005; Asheim and Isaksen 2002; Braczyk, Cooke, and Heinderinch 1998; Cooke 2004; Lundvall and Borrás 1997). The approach is based on the notions that regional competitive advantage is increasingly innovation-based, and that innovations emerge when existing knowledge is continuously reconfigured into new combinations in local contexts. According to Cooke (2004), a RIS "consists of interacting knowledge exploration and exploitation subsystems linked to global, national and other regional innovation systems for commercializing new knowledge" (p. 3). By emphasizing the interplay of knowledge exploration and exploitation, the approach stressed interactions between industry and organisations involved in knowledge exploration such as universities and research centers. Later developments within RIS have increasingly emphasized the importance of inter-industry dynamics, and, correspondingly, how policy should support horizontal linkages (Cooke et al. 2007) based on the recognition that 'old' knowledge and technology from other sectors may be as important for innovation as 'new' knowledge and technology from within a sector or from academia (Katila and Ahuja 2002; Herstad and Brekke 2012).

The systemic perspective implies that regional innovation systems can be conceptualized in terms of (1) system components, (2) system linkages and (3) system boundaries (Asheim, Lawton Smith, and Oughton 2011). The system components refer to the private and public organisations involved in innovation processes as well as to the institutions guiding their behaviour. The system linkages refer to the relationships between the components which are part of a localized innovation network that allows for interactive learning to take place (Cooke 1998). The boundaries of the RIS draw attention to the demarcation, overlap and relationships with extra-regional actors, networks and institutions.

For many years, clusters have been very influential in the theoretical development of RIS, which also influenced the policy implications of RIS. With regard to policy, RIS has also drawn substantially from insights and lessons derived from a systems perspective on innovation, firstly pioneered within National Innovation Systems (NIS) but shortly after extended to RIS. Below we elaborate how RIS has informed regional innovation policy, by looking at two related dimensions respectively: (1) the rationales for policy support, and (2) the design of policy support in terms of choice of instruments.

Rationales for policy support

To a large extent RIS follows the rationale for policy support in systemic approaches to innovation, which is to address system failures (Laranja, Uyarra, and Flanagan 2008). Here a rationale refers to a more or less formalised model implicitly or explicitly drawing upon academic theories or concepts that could inform policy design, implementation and evaluation. A system perspective on innovation goes beyond the neoclassical economic rationale that policy intervention is only legitimate and needed due to market failure because of sub-optimal resource allocation by firms. Rather, it builds on the notion that innovation processes are social learning processes that take place in a context of networks and institutions, and which can pro-actively influence the innovation capacity of firms, regions and nations. This implies that public intervention is legitimate and needed not only if the complex interactions that take place among the different organisations and institutions involved in innovation do not function

effectively, but basically to promote a dynamic, innovation based competitiveness trajectory or what is often referred to as a 'high road strategy' of competition. Various authors (Klein Woolthuis, Lankhuizen, and Gilsing 2005; Smith 1998; Weber and Rohracher 2012) have identified a number of structural system failures which inform and shape system-oriented public policy support for innovation:

- Capabilities' failure: The lack of appropriate competencies and resources at the firm and organisational level may limit and/or prevent the generation of, access to, and exploitation of knowledge.
- Infrastructural failure: Lack of physical and knowledge infrastructures due to large scale, long time horizon of operation and ultimately too low return on investment for private investors.
- Hard institutional failure: Absence, excess or shortcomings of formal institutions such as laws, regulations, and standards (in particular with regard to IPR and investment).
- Soft institutional failure: Lack of informal institutions such as social norms and values, culture, entrepreneurial spirit, trust and risk-taking that impede collaboration for innovation.
- Strong network failures: Intensive cooperation in closely tied networks leads to myopia and lack of infusion of new ideas.
- Weak network failures: Too limited interaction and knowledge exchange with other actors inhibits exploitation of complementary sources of knowledge and processes of interactive learning.

One of the main contributions of the RIS approach has been to specify what kind of innovation policy is needed to fit and address the specific regional characteristics and challenges. There is no single permanent 'best practice' policy, or mix of policy instruments, available for each and every situation, as regions and nations are very different. Thus, instruments and policy systems have to be context sensitive in being adapted to the needs and bottlenecks in different types of firms and regional circumstances. This context sensitivity is clearly articulated in the typology suggested by Tödtling and Trippl (2005) which builds on the above system failures found in different types of regions (see also Trippl, Asheim, and Miorner 2015). This typology distinguishes between problems related to organisational thinness often found in peripheral regions (i.e. soft institutional and weak network failures); problems associated with technological lock-in characteristic of specialized, old industrial regions (i.e. capabilities' and strong network failures); and, finally, problems connected with internal system fragmentation typically found in diverse metropolitan regions (i.e. weak network failure). According to Tödtling and Trippl (2005) these systemic problems require tailored policy support beyond 'one-size-fits-all'.

To cater for additional regional context sensitivity, recent contributions in RIS have started to increasingly emphasize the importance of differentiated knowledge bases in regions in addition to the above mentioned institutional and organisational contexts in RIS (Asheim, Moodysson, and Tödtling 2011). This has been translated to the policy notion of Constructed Regional Advantage (CRA). This approach makes a distinction between analytical (science-based), synthetic (engineering-based) and symbolic (based on intangible assets such as aesthetics, culture, symbols) knowledge bases (Asheim et al. 2007; Asheim, Boschma, and Cooke 2011). It advocates policy intervention that promotes economic competitiveness of regions through policies that are fine-tuned to the specific prerequisites in the RIS

(in terms of capabilities, networks and institutions) that follow from firms' knowledge bases (Martin, Moodysson, and Zukauskaite 2011). Furthermore it promotes economic diversification strategies for regions based on relatedness between industries and combination of knowledge bases in a context of public-private cooperation. Recent empirical studies have provided evidence that radically innovative firms typically rely on combinations of different knowledge bases. Particularly when applied to promoting regional diversification, Constructing Regional Advantage applies a more pro-active role to policy-making in stimulating innovation than assumed in the above system-failure rationale. It argues that policy should support innovation activities in the RIS that draw upon interdependencies and complementarities between different types of knowledge bases, and that facilitate the exploration and exploitation of linkages between scientific and experience based knowledge (Jensen et al. 2007). This in turn questions how support infrastructures and policy can serve this kind of new knowledge exploration and exploitation, which transcend the limitations of traditional roles such as contractual R&D support at arm's length and linear technology transfer (Herstad and Brekke 2012).

Operational design of policy instruments

The systemic perspective has been translated from a strategic to an operational level by focusing on instrument mixes or 'policy mix' (Flanagan, Uyarra, and Laranja 2011) that combines different types of measures. This mix can be conceptualized in different ways. Borrás and Edquist (2013) suggest a classic mix of regulatory instruments, economic and financial instruments and soft instruments following the popular distinction between 'sticks', 'carrots' and 'sermons' of public policy instruments (Bemelmans-Videc, Rist, and Vedung 2003). In an international analysis of different regional innovation policies across Europe, Nauwelaers and Wintjes (2002) have classified existing policy tools into four types (Table 1).

--Table 1 here--

However, while a focus on instrument mixes has received considerable attention from policy-makers in recent years, most innovation policy efforts are de facto limited to enhancing levels of public and/or private R&D expenditures (Borrás and Edquist 2013). A similar conclusion is drawn by Nauwelaers and Wintjes (2002) based on their review of regional innovation policies in Europe in which they find that most policies target resource-focused individual firm support in the form of R&D subsidies, rather than selecting policy instruments in relation to the actual problems identified in the innovation system. These problems are compounded by a tendency found among many empirical RIS studies in offering inventory-like descriptions of regional innovation systems, focused on a static landscape of actors and institutions, rather than of functions, roles and relationships (Uyarra, 2010). What is arguably lost is a deeper understanding of the dynamic and largely historically determined mechanisms played by existing actors and institutions (Howells 2005).

In sum, it seems justified to agree with the critique by Morgan (2004) that particularly in policy discussion RIS scholarship tends to reify the systemic character of regional innovation systems yet neglects the diversity and heterogeneity found in regions. Despite the development of a number of useful typologies reflecting context specificity of regions (Asheim and Isaksen 2002; Tödtling and Trippl 2005; Asheim, Moodysson, and Tödtling 2011), policy advice seems to mainly draw on ex-post generalizations of a limited set of exemplar regions.

Knowledge spillovers and path-dependent industrial development in EEG

EEG has made important advancements to our understanding of how regional economies evolve in directions that reflect the industrial capabilities and institutions already present. The main ideas of evolutionary economic geography have centred on two interrelated issues: (1) agglomeration economies, related variety and regional branching, and (2) path dependence and lock-in (Coe 2011; Hassink 2010; Boschma and Martin 2007; Boschma and Frenken 2006). In the following section, we present these contributions.

Agglomeration economies, related variety and regional branching

The theoretical advances in EEG on the relationship between agglomeration economies and regional development paths build on the classical notion of knowledge spillovers as determinants of economic growth[1] (Frenken, van Oort, and Verburg 2007). This is largely attributed to the degree of cognitive similarity, relatedness or distance between industrial knowledge bases and the organisational routines by which they are expressed. Essentially, knowledge diffusion is determined by localized labour market mobility (Cotic-Svetina, Jaklic, and Prodan 2008; Boschma, Eriksson, and Lindgren 2009; Malmberg and Power 2005) and informal networks between firms (Sturgeon 2003; Agrawal, Cockburn, and McHale 2006; Dahl and Pedersen 2004). The knowledge spillover dimension has received little attention by the RIS approach due to a strong emphasis on interactive learning through formalized value chain linkages and formal and informal collaborative ties (de Laurentis 2006). Moreover, EEG puts far greater emphasis on the actual content and composition of industrial knowledge bases.

The basic idea behind agglomeration economies is that firms derive advantage from locating close to each other, either because this provides privileged access to diverse knowledge and networks into very different industrial and technological domains (urbanization economies due to regional industrial and organisational diversity), or because it provides privileged access to the knowledge and industrial domains which constitute the core of individual firm activities (localization economies due to regional industrial specialization). Yet, urbanization economies come with cognitive distance constraints, and may therefore not materialize as benefits to the region due to fragmentation of collaborative linkages and segmentation of labour markets. Localization economies, by contrast, may be associated with both positive and negative technological locks-ins, leading to a situation where local knowledge dynamics become highly contingent on the complexity and dynamics of technological development specific to the sector in which the region is specialized. In the RIS literature, these constraints have traditionally legitimized policy intervention, e.g. in the form of lateral networking initiatives in urban regions (to compensate for fragmentation and allow new intersections between sectors to be explored) or the establishment of educational programs and research institutes in specialized regions (to reinforce positive lock-ins or break those that are negative) (Tödtling and Trippl 2005).

Current thinking in EEG focuses, by contrast, predominantly on the conditions under which *self-sustained* localized spillovers emerge independently from policy intervention. To capture this, the concept of related variety has been introduced (Frenken, van Oort, and Verburg 2007; Frenken et al. 2004; Boschma, Eriksson, and Lindgren 2009). It builds on the assumption that, due to cognitive characteristics of the industrial knowledge bases, knowledge spills inherently over more easily across some sectors than others. Such sectors therefore form a critical mass of industrial activities in the

[1] In addition to knowledge spillovers, agglomeration economies also consist of pooling effects in labour markets and scale advantages for suppliers. However, in the context of EEG knowledge spillovers is clearly the most relevant.

regional economy that are able to reproduce or diversify. Related variety describes an ideal state in which self-sustained spillovers most effectively feed into, and are fed by, the specific knowledge development efforts and routines of individual firms. This line of reasoning has also been linked to the maturity of the industry in question (Neffke et al. 2011) and the notion of regional 'branching' processes through which specialized yet related organisational routines and technological capabilities are transformed into new industrial activities. According to Boschma and Frenken (2011) branching into new activities can occur through knowledge-transfer mechanisms such as spin-off activities, firm diversification (e.g. within the firm in cases of setting up a new department), labour mobility or social networking. As in the case of inter-sectoral knowledge spillovers, branching processes are therefore to a large extent shaped by those organisational routines and technological capabilities which are i) already present, and ii) identified as (potentially) related by private sector actors, employees and entrepreneurs.

Path dependence and lock-in

A casual invocation of path-dependence may be interpreted as 'history matters'. A closer reading of evolutionary economics would however acknowledge the close relationship of this concept vis-à-vis (evolutionary) technological change (David 1985). In this model, new technological pathways are created because of "historical accidents", "chance events" or "random" actions. Subsequently, a combination of self-reinforcing effects and contingency leads to the selection of certain pathways. Characteristic for this model is that it opens up for the possibility that selected pathways may be based on sub-optimal technologies, institutional or organisational arrangements. Because of the self-reinforcing effects, pathways ultimately become locked-in, and the only way to break out of these is through exogenous shocks. Initial work in evolutionary economic geography on the path dependence of spatial industrial evolution has adopted a parallel model to explain long-term stability in the composition of regional economies. In a similar vein, initial location of first firms in an industry is determined serendipitously while self-reinforcing processes are explained by agglomeration economies, i.e. critical mass (see above).

However, the classical understanding of path-dependency in evolutionary economics lacks a satisfactory, more comprehensive explanation of path renewal and (especially) new path creation, resorting instead to exogenous shocks and serendipity respectively (Martin 2010; Simmie 2012). This critique is indicative of a wider concern that institutions and social agency are being relegated at the expense of an overriding focus on explanations grounded in the micro-foundations of individual firms and their routines. It seems, however, that this criticism has been answered in different ways by different 'schools' or directions in evolutionary economic geography. On the one hand, the Utrecht school seems to maintain a distinct divide between evolutionary and institutional economic geography and emphasizes an 'orthogonal' relationship between (territory-specific) institutions and organisational routines respectively. Boschma and Frenken (2009) assert, "we expect the effect of (territory-specific) institutions to be small as firms develop routines in a path-dependent and idiosyncratic manner" (p. 153). This position is further qualified in the context of path-dependent spatial evolution of industries: "we do not expect that the spatial distribution of institutions can explain where a new industry will emerge and develop. What is crucial, though, is that such institutions are created deliberately to support and sustain the further growth of the industry in question. These supportive institutions often come into existence where the specific demand for them has emerged, that is, in those places where the new industry started to develop" (p. 155). Thus, the 'Utrecht' school takes a clear point of departure in micro-level firm routines. In terms of policy strategies in light of

path-dependent regional development it primarily focuses on related diversification, and more recently also on unrelated diversification (Boschma 2015) as mechanisms for new path development. UK-based scholars in EEG, on the other hand, seem more inclined to include institutions in the conceptualization of path-dependency to steer away from deterministic accounts and to recognize a broader range of mechanisms for new path development. Martin (2010) suggests an alternative path dependence model for regional industrial evolution which incorporates concepts of layering (institutions change gradually), conversion (re-orientation of an institution) and structured diversity and recombination (agents learn from other institutions) (see also Gertler (2010) for a similar categorization of institutional change in regional economies). Simmie (2012) takes this a step further and calls attention to processes of collective agency to purposively create and steer pathways.

Re-thinking regional innovation systems

It follows from the above that the insights from EEG (re)-assert a greater emphasis on the industrial base of RIS. This has implications for RIS both in terms of the aforementioned (1) systems components, (2) system linkages and (3) system boundaries (Asheim, Lawton Smith, and Oughton 2011). At the same time, a critical reflection on what EEG brings to the policy table also reveals a number of shortcomings.

System components: stronger emphasis on firms

A first implication for RIS is that the dichotomous understanding of knowledge exploration and exploitation subsystems can be criticized for underemphasizing firms as the primary sites of knowledge development and innovation. Instead a more firm-based, multi-layered perspective on knowledge production and diffusion is suggested. Within this, new combinations of knowledge originating in different cognitive domains and industry segments may be explored systemically. This leads to an important re-assessment for policy-making in terms of what can be realistically expected from universities and research institutes (Herstad and Brekke 2012). Rather than considering these kinds of organizations as principal components, as often is the case in regional innovation strategies and policies, it re-asserts firms and industrial sectors as principal components of a RIS. Specialized knowledge bases and organizational routines of the industrial base in the region should constitute the core of regional innovation systems, not university research, technology transfer schemes or individual (academic) entrepreneurs operating in isolation. Under the influence of the Triple Helix model, these roles of universities in RIS have perhaps been overstated, at the expense of the more basic function to provide training for skilled and qualified personnel (Bristow et al. 2011). Insights from EEG have on the one hand nuanced and, on the other, re-asserted more attention to this neglected role of universities.

This, in turn, points to the importance of acknowledging at an operational level that critical mass conducive to system (meso) level dynamics may have to be built bottom-up based on a set of complementary instruments and policies that target at the outset firms, and thus the domain of industry itself (Guerzoni and Raiteri 2015; Herstad et al. 2010). These include inward FDI attraction, the supply of public seed or venture funding, direct or indirect selective support for industry intramural R&D, demand-side intervention such as active public procurement policies and market regulation, dense coordination between private industrial owners and government, and direct public establishment and ownership of activities assumed to be critical for the transformative capacity of the economy. They extend into specialized educational programs supplying competences not yet used and thus provided by the labor market that surround the established industrial base (Herstad and Sandven 2015); university-industry collaborative linkages seeking to supplement the output of experience

based industrial (application-oriented) knowledge development processes with R&D-based (technological platform) knowledge which reflect their long-term needs (Asheim and Parrilli 2012). Lastly, such industry-oriented initiatives may also include instruments by which pre-existing local demand and knowledge resource constraints are overcome by linking regional firms to extra-regional markets and providers of competences (see also below). These types of policy intervention have been instrumental in the establishment of the technological development paths of the most advanced economies during the post-war period (Mazzucato 2013).

System linkages: From traded to untraded regional interdependencies

A second important strategic implication, in connection to system linkages and associated dynamics, concerns a clear departure away from the notion of regional innovation systems as sets of traded relationships dominated by cluster-based user-producer linkages or university-industry technology transfers, towards a stronger emphasis on the creation and exploitation of interdependencies that are *untraded* (Storper 1997) and thus localized because they are subjected to distance decay effects. Traded interdependencies are associated with organizational proximity, i.e. with shared relationships within a firm, or in networks that increasingly expand abroad (see below). In the context of innovation, it can be thought of as representing a continuum that spans from contractual sourcing of technology in the international marketplace (Hauknes and Knell 2009) (low organizational proximity), alliances and other forms of collaboration (Herstad, Aslesen, and Ebersberger 2014), through to the relationships that characterizes units within an enterprise or departments within a single firm (high organizational proximity) (Boschma 2005). For analytical purposes, this should be distinguished from cognitive proximity, which is associated with commonalities in the knowledge bases of firms; from social proximity associated with informal relations between actors at the micro-level, and from proximity in terms of similarity in the institutional incentives and constraints that actors operate under. In this perspective, proximity conducive to the formation of untraded interdependencies is not given, nor directly linked to geographical space as a result of co-location. Instead, evolving patterns of interaction are assumed to result in evolving proximities (Balland, Boschma, and Frenken 2015), leading to asymmetric knowledge diffusion within the regional system (Giuliani 2007; Giuliani and Bell 2005). This may lead to network lock-in and lockout at the level of firms and industries, and hinder experimental recombination of knowledge at the regional level.

The risk of local asymmetries and compartmentalization of knowledge flows becomes more apparent when evidence from EEG on the importance of labor market mobility to knowledge diffusion is accounted for. Mobility allows cognitive resources to flow intensively between co-located firms, and provide the basis for enduring personal ties through which valuable information is exchanged across organizational boundaries (Agrawal, Cockburn, and McHale 2006; Dahl and Pedersen 2004; Bouty 2000). Yet, it occurs most intensively within certain industrial segments (Timmermans and Boschma 2014; Eriksson and Lindgren 2009), thus bringing similar and related actors closer together and reinforcing the tendency of local knowledge networks to be 'uneven and selective' instead of 'collective and pervasive' (Giuliani 2007). Hence, when a dynamic view of proximities is combined with a theory of innovation that emphasizes inter-sectoral knowledge diffusion and exploration of new knowledge combinations as the basis for regional path renewal and new path creation, the role of RIS becomes one of linking *different industrial knowledge bases* to *complementary scientific research* for

the purpose of exploring *other combinations* of knowledge than those already explored and exploited through industrial networks and mobility flows (Herstad and Brekke 2012).

System boundaries: From closed to open system perspectives

A third strategic implication of re-thinking RIS in the wake of EEG concerns the formation and impact of extra-regional linkages generally, and global network ties specifically. In the RIS literature, some concern has been expressed over the tendency of firms to decouple from local partner relationships in their search for technology and complementary capabilities abroad (Asheim and Herstad 2005), thus undermining local traded interdependencies. However, extra-regional network ties are increasingly regarded as 'pipelines' adding novel ideas and insights into knowledge dynamics that are untraded and localized, and thus commonly referred to as the 'local buzz' of regional economies (Bathelt, Malmberg, and Maskell 2004). Yet, not all firms, industries and regions have equal access to global networks, and the 'buzz' that may surround international network nodes can be weak (Morrison 2008), and often unevenly distributed (Giuliani 2007) because it depends on other forms of proximity than co-location, and may have little impact on the surrounding economy unless supportive infrastructures are in place.

The role of diversity introduced through extra-regional linkages have yet to be incorporated into the theoretical framework of EEG, in spite of the current drive towards globalization of innovation and production. Still, this framework provides a means for research to systematically address the question of how international ties are enabled or constrained by specific regional histories and characteristics. For instance, overall 'thinness' or strong industrial specialization may increase the need for regions to access cognitive resources developed externally (Chaminade and Plechero 2015; O'Farrell, Zheng, and Wood 1996), yet at the same time constrain their ability to do so due to overall peripherality (Johanson and Vahlne 2009) and lock-in effects at the level of firms (Narula 2002; Ebersberger, Herstad, and Koller 2014). Moreover, by demonstrating how the diffusion and impact of spillovers is generally associated with the history and composition of regional industrial structures, EEG also relates to, albeit implicitly, the question of whether and when spillovers from global network nodes are transformed into impetus for regional innovation. This, in turn, points back to the issue of latent growth impetus that do not materialize due to fragmentation of local networks and segmentation of labor market mobility leading to asymmetric, if not generally limited (cf. Morrison 2008), diffusion, exploration and exploitation. Against this background, it is evident that RIS should provide contact points to extra-regional networks that are complementary to those maintained by regional firms (Graf 2010), or compensating for those which do not hold such contact points. This role is particularly important in 'thin' or specialized regions. Regions that are diverse both in terms of industry composition and in terms of extra-regional ties (Simmie 2003), on the other hand, further underscores the need for RIS to operate as an additional layer that stimulate knowledge exploration and exploitation at the intersection between industries and their respective extra-regional ties (Herstad and Brekke 2012).

Limitations of EEG

Even though EEG adds substantial understanding of the mechanisms in which different agglomeration economies and path dependencies shape the ways in which regional contexts matter for regional development, it has a number of limitations in terms of policy making. Following the above logic, these relates to 1) system components, 2) system linkages, and 3) system boundaries. First, in terms of system components, it assumes that the population of firms in a region, i.e. the main components in the regional innovation system, are 'given'. New firm and industry formation and, consequently new

regional development paths, are primarily ascribed to historical accidents, serendipitous events or external chocks or seen as a result of historically contingent, place-specific processes of branching within the confines of a specific path. This rules out that policy and institutions, through direct or indirect intervention, can influence the actual build-up of critical mass in new technological or industrial areas, and may thus legitimize 'laissez faire' industrial policy.

Second, in terms of system linkages, it assumes that 'relatedness' between the system components is pre-determined and treated as 'given'. Empirically it either draws on given statistical industry classifications (Boschma, Eriksson, and Lindgren 2009; Frenken, van Oort, and Verburg 2007), patent classes (Nooteboom et al. 2007) or revealed labour mobility patterns (Neffke and Henning Forthc.). Substantially, it assumes some 'inherent' degree of difference or relatedness between the knowledge, technologies and routines contained within the region. Implicitly, this view rests on an assumption that firms through their recruitment decisions and local networking behaviour are able to collectively identify and exploit the potential for growth and structural change associated with the resources that are available to them locally. This view ignores that the continuous exploration of novel – not-yet-identified – combinations of knowledge, new intersections between industries and the subsequent redefinitions of related and unrelated technologies that continuously occurs, is part and parcel of innovation and technological change itself (Katila 2002; Katila and Ahuja 2002; Bugge and Øiestad 2014). Moreover, in contrast to RIS, it ignores the role and importance of institutions and policy in conditioning and mediating knowledge spillovers.

Third, in terms of system boundaries, it assumes that conditions for knowledge spillovers and related variety are fed primarily by knowledge, technology and routines developed locally, by regional firms. In this way, EEG fails to acknowledge explicitly how global network linkages in their various forms can contribute substantially to the extension, renewal or even transformation of regional development pathways (Ebersberger, Herstad, and Koller 2014). This becomes problematic in a context where such networks are growing in importance to innovation for individual firms (Kafouros, Buckley, and Clegg 2012; Herstad, Aslesen, and Ebersberger 2014; Fitjar and Rodríguez-Pose 2012). Moreover, it misses how broad international ties could come at the expense of local linkages, which may act as an important rationale for policy intervention in the region. Again, this points back to the potential role of RIS institutions as mediators for local knowledge diffusion between global network nodes and in providing support for further international network expansion to diversify the regional resource base (Herstad and Ebersberger 2015).

A closer integration of evolutionary and systemic elements in RIS

Mindful of various warnings that EEG may run the risk of relegating the role and importance of institutions, it is crucial not to conflate EEG's contributions with an exclusive focus on agglomeration economies. Its emphasis on path dependence in regional development allows, in principle, for a greater analytical appreciation of the role of institutions and institutional change in RIS. Here EEG adds a deeper understanding of the inherently historically shaped factors and conditions influencing regional development and RIS. In this context, there is however a need to go beyond the traditional focus on continuity, stability and restrictive lock-ins that dominates the literature on path dependence. To do so, new research (Isaksen 2014; Trippl, Asheim, and Miorner 2015) suggests a distinction between path extension, exhaustion, renewal and creation. The ability of the RIS to continuously adjust to changing environmental conditions based on the existing industrial base and established behaviour can be conceptualized as path extension (Hassink 2010). However, this may in the long run lead to

stagnation and decline due to a lack of renewal as witnessed in many old industrial regions (Trippl and Otto 2009). Regional industries are then locked into innovation activities that predominantly take place along existing technological paths limiting their opportunities for experimentation and space to manoeuvre into new directions. Ultimately, this erodes regional competitiveness when firms are unable or slow to respond to new markets, competition or technologies elsewhere (Martin and Sunley 2006). In response to the long term risks associated with such path exhaustion, scholars have recently started to argue for the need to consider and think about regional pathways concerned with change rather than continuity, distinguishing between path renewal and path creation (Isaksen 2014; Tödtling and Trippl 2013).

Path renewal takes place when existing local firms and industries switch to different but contiguous sectors, much in line with the notion of regional branching (see above). New path creation, on the other hand, refers to the establishment of firms in new sectors, or firms that have different variants of products, employ new techniques, organize differently in ways that depart from the dominating set of innovation activities (Isaksen 2014; Trippl, Asheim, and Miorner 2015). Tödtling and Trippl (2013) further qualify this by making a distinction between, on the one hand, the rise of established industries that are new to the region and, on the other, the rise of totally new industries of which only the latter qualifies as new path creation. Moreover, they stress that path renewal and creation tend to demand building of new knowledge organisations and institutional change.

Given the inherently *historical* perspective applied by EEG, it is surprising to find that building of new knowledge organizations and institutional change are either overlooked altogether or written off under the header of serendipity. Boschma (2015) maintains that related variety normally will be the key resource for regional renewal, but adds that 'it might be beneficial to have unrelated variety in a region as well to protect the combinatory potential of a region against shocks'. He continues asking the question whether relying on recombinations between related industries in the long run would be sufficient, or if diversification into more unrelated activities will be necessary to secure regional resilience. Boschma recognises that 'as regions have a tendency to diversify into related activities and shake off new unrelated activities; one could argue that regions need to develop new unrelated activities to increase their variety' (Boschma 2015). This is not the least important as research has demonstrated that unrelated variety in regions are more likely to generate technological breakthroughs, i.e. to secure adaptability while related variety primarily produces incremental innovations, i.e. adaptation (Castaldi, Frenken, and Los 2015). Thus, he concludes that 'having both types of variety then would make a region truly resilient' (Boschma 2015). However, it is not discussed how, in the wake of the missing supportive environment, an unrelated diversification can be achieved. This, it is our contention, requires active policy intervention consisting of concerted, long-term efforts at both firm, system, organisational and institutional as well as agency levels which accepts that these paths cannot be predetermined.[2]

Conclusion

The EEG approach may improve our understanding of RIS dynamics along three distinct dimensions.

First, in relation to core system components, RIS thinking should increasingly incorporate the basic evolutionary idea that cognitive resources created as externalities of existing regional industry

[2] For an exemplification of the design, implementation and impact of such concerted, long-term policy efforts, see the OECD review of Swedish Innovation Policy (OECD 2013). For other examples of the strategic importance

configurations condition industrial development (Martin 2010; Neffke, Henning, and Boschma 2011). This provides a basis for a shift in research and innovation policy attention away from university research and technology transfer schemes as the primary drivers of industrial development. Rather, increased attention should be directed towards the opportunities and constraints associated with the broader, continuously ongoing processes of knowledge generation, human resource formation and capability development in industry; both in themselves, but also in interaction with public research and education organisations.

Second, with respect to system linkages, EEG has revealed how these processes should be seen in relation to the knowledge available to individual firms and as reflections of the regional industrial structure. The empirical work that unambiguously has revealed the importance of access to 'related' competences originating in the domain of industry itself is thus nuancing the emphasis of much RIS thinking on the importance of formalized university-industry linkages. Yet, it also underscores the relevance of proactive intervention into regional knowledge diffusion processes in order to allow novel combinations to be explored between industries and beyond the labour market segments that form around them. New combinations of knowledge originating at the intersections of different industries and clusters, and not the least new knowledge generation at universities, are rarely identified and explored systematically on a large scale by industry itself. This points to the lasting importance of regional innovation policies as a stable, committed and inclusive infrastructure, but which reflects and addresses the needs of the established industrial knowledge portfolios and labour market linkages at the level of the region (Herstad and Brekke 2012).This infrastructure can be provided by regional R&D and higher education system actors. However, EEG has thoroughly established that this broader knowledge diffusion and recombination role is radically different from that of linear technology transfer based on advanced research. As such, it emphasizes policy's room to manoeuvre as primarily conditioned by the prevalent industrial structure of the region.

Third, in relation to system boundaries, RIS policies should increasingly acknowledge how extra-regional linkages mirror the structure and composition of the industrial firm-base within regions, and address how such linkages are often unevenly spread across industries and networks regionally. Consequently, RIS policies should provide contact points to extra-regional networks that are complementary to those maintained by firms within regions, and also seek to include and enable actors without such contacts to access extra-regional knowledge inputs and circuits.

--Table 2 here--

Table 2 summarizes the potential tools of the regional innovation system policy palette, which are conditioned by type of region and context specific development paths. Firm-level intervention seeking the build-up of critical mass in new industrial and technological areas may be necessary as a supplement to the system-level intervention traditionally emphasized by RIS, in particular if the objective is new path creation. This objective lies even farther away from what can be achieved through basic scientific research, technology transfer schemes and university-industry linkages

of actors, agencies, institutions and politics in promoting path renewal and new path creation, see the cases of development of sustainable energy production (wind mills) in Denmark in the 1990s (Garud and Karnøe 2003; Simmie 2012), the 'energiewende' in Germany in the mid 2000 (Dewald and Truffer 2011), the promotion of offshore wind in North East England and Scotland (Dawley 2014), and the regional innovation strategy in South Moravia, Czech Republic in the 2000 (Blažek et al. 2011).

(Karlsen, Isaksen, and Spilling 2011; Herstad, Sandven, and Ebersberger 2015), and calls for more broad based policies to supplement but not substitute what today is regarded as the domain of research and innovation policy. This includes demand-side initiatives that collectively mobilize firms into building capabilities in new technological and industrial areas (Guerzoni and Raiteri 2015), in spite of current territorial knowledge conditions that initially may work against success in this respect (Binz, Truffer, and Coenen 2015; Herstad, Sandven, and Ebersberger 2015).

The most direct policy notion derived from wedding EEG with RIS, has been the Constructing Regional Advantage (CRA) concept (Asheim, Boschma, and Cooke 2011). This approach advocates policy intervention to promote economic diversification of regions through tailor-made policies based on relatedness between industries and on combining knowledge bases in a context of public-private cooperation in much the same way that has later been advocated on a more operational level by the Smart Specialisation strategy. This operational level, it is our contention, can be further developed through a clear focus on the *complementarities* which arises from the marriage between RIS and EEG; between committed, long-term efforts providing direct support for firm formation and diversification, the build-up of broad, multi-dimensional regional infrastructures that allow cognitive resources to diffuse beyond the confines of individual labour market mobility and the segments in which this occurs, *and* the linking of local systems to extra-regional, even global, innovation networks.

Even though the systemic contextualization provided by the RIS approach and the historical-cognitive contextualization provided by EEG represent in our opinion complementary perspectives on regional development, they both lack explicit attention to the politics of regional innovation policies. Greater awareness is needed for issues related to institutional change to avoid that regional policy initiatives remain isolated islands of innovation (Haughton and Morgan 2008). Both approaches are well-equipped to do so, by taking an evolutionary view on institutional change. While various calls have been made previously in this direction (e.g. Gertler 2010) few studies have dealt with it empirically (though see Coenen, Moodysson and Martin, 2015). Therefore, future research on regional innovation policy, at the intersection of RIS and EEG, needs to better engage with the experimental, and some may say entrepreneurial (Morgan 2015), nature of such policies and, as a consequence, its deviations from orthodoxy in regional policy making. To our understanding, notions of variety creation, adaptation, selection and retention will provide helpful analytical tools to analyse how regional innovation policies may fuel institutional entrepreneurship, especially in the (more disruptive) context of path renewal and path creation. However, such policies must - as has been argued in this article - transcend the limitations of the evolutionary view. In this perspective, the question becomes not so much whether institutions pre-exist or follow from development paths already established, as a question of how agency and institutions influence positively or negatively on what is inevitably a process of co-evolution between institutions and industrial knowledge bases.

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Tables

Table 1 Two-dimensional classification of main policy instruments in RIS

	Aim of innovation support	
Target level of support	**Assign lacking resources to actors:** **Support the accomplishment of innovation ideas / re-active**	**Learning to innovate:** **Change organisational behaviour / pro-active**
Single actor oriented	Type A: R&D subsidies and loans Risk capital	Type B: Business innovation centres Loans for competence development Mobility schemes
(Regional) system oriented	Type C: Subsidy for co-operative R&D	Type D Cluster policies Regional Innovation Strategies

Source: Nauwelaers and Wintjes (2002)

Table 2 RIS policy palette conditional to type of region and regional development path

Context	*System components*	*System linkages*	*System boundaries*
The relevance of the policy palette tools will be conditioned by: 1. **Type of region** a) Peripheral/thin b) Specialized c) Diverse/Urban 2. **Development path** a) Path extension b) Path renewal c) Path creation	Supporting regional firm base through: a) Support for entrepreneurship; b) Risk capital; c) Supply of seed or venture funding; d) Inward FDI attraction; d) Support of absorptive capacity of firms; e) Support for intramural R&D (e.g. R&D subsidies and loans); f) Innovative public procurement policies; g) Market regulation; h) Loans for competence development; and i) Educational programs	Supporting regional knowledge spillovers / Mediation between research based and experience based knowledge / Mediation between regional and extra-regional knowledge through: a) Industry networks; b) Exchange schemes; c) Cluster policies; d) Business innovation centres; e) Industry associations; e) Labour market mobility; f) Subsidy for co-operative R&D; g) /linking firms to R&D/HEIs or h) support absorptive capacity of firms (e.g. through upgrading of internal R&D capacity)	Establishing and mediating knowledge interlinkages across regional and extra-regional actors / Enabling and linking regional firms to extra-regional markets through: a) Regional R&D institutions; b) Exchange/mobility schemes; c) Attraction of international business partners or d) Supporting interlinkages/ collaboration between firms with and without extra-regional contact points