

Papers in Evolutionary Economic Geography

16.17

Towards a theory of regional diversification

Ron Boschma, Lars Coenen, Koen Frenken, Bernhard Truffer



Utrecht University

Urban & Regional research centre Utrecht

Towards a theory of regional diversification

Ron Boschma, Lars Coenen, Koen Frenken and Bernhard Truffer

Abstract This paper aims to develop a theoretical framework on regional diversification. Combining insights from the evolutionary economic geography literature and the transition literature, we argue that a theory of regional diversification should build on the current understanding of conditions for related diversification but additionally start to tackle processes of unrelated diversification by accounting for (1) the role of agency (institutional entrepreneurship) and the dynamic interplay between agency and context; (2) enabling and constraining factors at various spatial scales. We propose a typology of four regional diversification processes by cross-tabulating related versus unrelated diversification with niche creation versus regime adoption.

Key words: evolutionary economic geography, transition studies, regional diversification, unrelated diversification, institutional entrepreneurship, institutional change

JEL-codes: B52, O18, R11

1. Introduction

In the last 10 years, scholars in economic geography have been preoccupied with the question how regions diversify into new industries (Neffke et al. 2011) and new technologies (Rigby 2015), how regions develop new growth paths (Martin 2010; Isaksen and Trippel 2014), and why regions differ in their ability to do so. The regional diversification literature has focused primarily on related diversification and regional branching, and has shown that related diversification is the rule, and unrelated diversification the exception (Boschma 2016).

However, scholars have argued that unrelated diversification is needed to secure long-term economic development, as the process of related diversification might eventually come to a halt due to a lock-in (Saviotti and Frenken 2008). Hence, attention for related diversification should go hand in hand with attention for unrelated diversification. Such true “New Combinations”, if successful, may provide a long-term source of competitiveness as other regions that do not share

the same specialized capabilities being recombined, will find it hard to copy such a success. Furthermore, in the recent more mission-oriented European policy frame of innovation and innovation policy to address wicked problems such as climate change, ageing, Internet crime and youth unemployment, the challenges are new, “grand” and complex (Coenen et al., 2015). Hence, solutions might be, to a considerable extent, unrelated to existing technologies and institutions.

While scholars have started working on the topic of unrelated diversification (see e.g. Neffke et al. 2014; Boschma and Capone 2015), insights from these studies have remained fragmented at best. The objective of this paper is to make a first step in filling this gap. In the current Evolutionary Economic Geography (EEG) framework on regional diversification, the role of agency has been poorly integrated (Neffke et al. 2014). The prime focus is on regional capabilities and on enabling conditions (embodied in relatedness) rather than constraining factors. A conceptualization of regional diversification has therefore to explicitly address agency who purposefully strives to overcome constraints to diversification. Such constraints stem both from interests and institutions at the regional level and from socio-technical regimes at the global level. The recent transition literature provides some inroads to address these issues. Radical novelty is understood to depend on experimental alignment process of heterogeneous social and technical elements into new socio-technical configurations (Rip and Kemp, 1998). In this perspective, actors are essentially forced to adopt a bricolage mode of innovation while having to cope with vested interests and technological and cognitive lock-in within established socio-technical regimes. As a consequence, the focus is more on experimentation and how institutional entrepreneurship enables or blocks institutional change (Coenen and Truffer 2012). Here, the transition literature provides complementary insights to EEG.

This paper builds on both bodies of literature to develop a theoretical framework on regional diversification. Discussing theories in EEG and transition studies, we propose a theory of regional diversification that consists of the following building blocks: (1) emphasis on agency (institutional entrepreneurship) and the dynamic interplay between agency and context in a co-evolutionary sense; (2) focus on enabling and constraining factors at various spatial scales. Our proposed framework defines how unrelated diversification differs from related diversification.

Section 2 discusses the EEG literature on regional diversification. Despite a few attempts, we argue that a comprehensive theoretical framework on regional diversification in regions is still underdeveloped. Section 3 discusses elements from the transition literature that addresses a number of weaknesses in EEG in this respect. Section 4 presents the main features of our proposed theoretical framework on regional diversification. Section 5 concludes.

2. Evolutionary Economic Geography and regional diversification

There is a rapidly growing interest in the question how regions develop new growth paths, and why regions differ in their ability to do so (Boschma and Frenken 2006). The recent EEG

literature on regional diversification looks at the presence of local related activities as an enabling factor. Studies show that existing local capabilities condition which new activities are more likely to develop in regions (Neffke et al. 2011; Boschma et al. 2013, 2014, 2015; Kogler et al. 2013; Colombelli et al. 2014; van den Berge and Weterings 2014; Tanner 2014, 2016; Essletzbichler 2015; Feldman et al. 2015; Heimeriks and Balland 2015; Quatraro and Montresor 2015; Rigby 2015) and countries (Hidalgo et al. 2007; Bahar et al. 2014; Boschma and Capone 2015). These studies conclude that relatedness is an important driver of regional diversification, despite the fact that studies employ different dependent variables (like new products, industries, technologies), relatedness measures (e.g. product-relatedness, technological relatedness, skill-relatedness, input-output relatedness), spatial units of analysis (countries, regions, cities, labor market areas) and time periods (Boschma 2016). So, related diversification is found to be a more common phenomenon in regions, but unrelated diversification also occurs, though more rarely.

From an evolutionary point of view, this finding of related diversification being more common in regions does not come as a surprise. Diversification in regions is a deeply uncertain process that can be reduced by relying on existing local capabilities when diversifying into new activities (Frenken et al. 2007; Boschma and Frenken 2011). For instance, it is less problematic for regions to move from motor cycles to trucks than from bananas to computers, as motor cycles and trucks require similar (engineering) capabilities. Unrelated diversification occurs when a region develops a new activity that requires very different capabilities than existing local activities (Neffke et al. 2014). This makes it harder to explain unrelated diversification. To date, the EEG literature lacks a comprehensive framework to explain unrelated regional diversification.

Having said that, scholars have started exploring conditions that favor unrelated diversification in regions. Castaldi et al. (2015) points to the importance of unrelated variety for technological breakthroughs, which might imply that regions with unrelated variety are also more likely to diversify into unrelated technological activities. Xiao et al. (2016) showed that more knowledge-intensive regions in Europe are more likely to move in more unrelated activities, as compared to more knowledge-extensive regions in the European periphery. Other scholars are exploring the role of national institutions on related versus unrelated diversification. Boschma and Capone (2015) found that liberal market institutions (as compared to coordinated market institutions) favor more unrelated diversification at the country level. Cortinovis et al. (2016) did not find an effect of regional institutions on the tendency of regions to diversify in related or unrelated activities. Scholars have also suggested that bridging networks and non-proximate links would favor unrelated diversification, but systematic evidence is still lacking (Crespo et al 2014). In sum, this emerging literature on unrelated diversification is still fragmented and underdeveloped, often singling out one factor, and not providing a comprehensive theoretical framework.

What is more, this regional diversification literature has primarily focused on the role of regional capabilities, without taking account the role of agency at the micro-level. In the late 1980s, the Window of Locational Opportunity (WLO) approach made an attempt to link human agency to new industry formation in place (Scott and Storper 1987; Storper and Walker 1989). This was

regarded crucial when it is impossible for new industries to build on locally available capabilities. In that case, new industrial activities create their own institutional conditions of support in place as to build regional capabilities, networks and regulations, or attract them from other places. In that sense, a favorable environment is more likely the result of, rather than a precondition for such an emergent process. This does not imply that local capabilities do not play a role: some new industries rely more heavily on local generic resources than other industries (Boschma 1997), but the emphasis in the WLO approach is clearly on the emergence process through which new industries create a conducive milieu, instead of the other way around. However, this WLO approach remained largely conceptual: it has not been subject to any systematic empirical research, nor did it specify in detail *how* and by whom institutional change comes about.

A key impulse to the development of a micro-perspective on regional diversification was given by Klepper in the 2000s. Klepper considered the role of agency as crucial for the study of new industry formation by looking at the importance of individuals (spinoff entrepreneurs) and firms (diversifiers) that make regions diversify (Klepper 2007; Buenstorf and Klepper 2009). Klepper contributed to an agency-based explanation of regional diversification by focusing mainly on entrepreneurs spinning from and incumbents diversifying from related activities. His agency-based perspective was focused entirely on firms, not on other types of actors that affect the tendency of regions to diversify in new activities. Klepper's theory also paid little attention to the local environment as conditioning factor, and how actors actively shape their local environment.

In sum, what is still underdeveloped in EEG is a comprehensive theory on related and unrelated diversification in regions that (1) incorporates the role of human agency, and non-economic agents (institutional entrepreneurs) in particular; (2) gives a full account to the role of constraining factors¹, besides enabling factors, as the diversification process in regions is often contested by vested interests at various spatial levels and in various socio-technical regimes; (3) moves beyond an exclusive focus on regional or national capabilities, to account for influences from the outside; and (4) follows a co-evolutionary perspective in which regional diversification is conceptualized as a process based on the dynamic interplay between agency and its changing (technological, institutional, spatial) context.

3. Transition theory: bricolage, systemic alignment and niche scaling

In our quest for a more comprehensive theory on related and unrelated diversification in regions, we argue that the transition literature provides useful and complementary concepts and insights. In that literature, there is an explicit micro-account of (unrelated) diversification that relies on

¹ When paying attention to constraining factors, the EEG literature tends to refer almost exclusively to the specific case of old industrial regions in which different types of lock-in are perceived to prevent them to shift into new activities (Grabher 1993; Hassink 2005; Wenting and Frenken 2011).

concepts like bricolage and institutional entrepreneurship (Section 3.1). Moreover, it proposes a meso-level account of diversification, as embodied in the creation of socio-technical trajectories through systemic alignment (Section 3.2), and it addresses how niches for experimentation are mindfully created and scaled in the context of regimes (Section 3.3).

3.1 Bricolage as a core mechanism in unrelated diversification

In order to explain unrelated diversification, we have to broaden the analysis and ask how other resources, strategies and actors get mobilized to interrelate proximate and distant knowledge stocks in the generation of novelty. A well-known study on unrelated diversification *avant-la-lettre* was presented by Garud and Karnøe (2003), contrasting the emergence of the wind turbine industry in Denmark and the US. In EEG terms, they argued that the US pathway represented a typical knowledge intensive (high-tech) strategy trying to optimize for related variety (Frenken et al. 2007), and following a policy approach oriented at technological breakthrough narrowly defined. In Denmark (and, more specifically, central Jutland), the wind industry developed through a process of trial-and-error collaboration and mobilization of various resources (knowledge, financial and institutional) that involved a broad set of local actors. They consisted of firms, farmers, policy-makers, public research organisations and NGOs, distributed across a wide spectrum of different (and, in terms of competences, unrelated) industries like mechanical equipment, electronics, farmers and energy utilities. Building on Levi-Strauss' work on resource scarce innovation processes (Levi-Strauss, 1967), Garud and Karnøe (2003) called this ideal type mode "bricolage". As they show, the Danish bricolage approach that begins with a low-tech design but ramps up progressively prevails over the US high-tech breakthrough approach.

The term bricolage alludes to the consideration of a multiplicity of actors embedded in networks who collectively draw on a broad set of distributed resources such as money, material components, discourses, knowledge, legitimacy and skills, organizational arrangements and political regulation in order to create new technological pathways through processes of mindful deviation (Baker and Nelson, 2005; Duymedjian and Rüling, 2010). The key ability of actors in bricolage is to enable the alignment of a heterogeneous set of actors, institutions and technologies in order to establish socio-technical "configurations that work" (Callon, 1998; Rip and Kemp, 1998). Through bricolage, path creation is understood as an iterative construction process where networks of distributed actors jointly create new market segments and user profiles, adapt regulations, lobby for subsidies, or define new technical standards and thereby ultimately create the conducive environment that helps a new industry develop and prosper in a region (Garud et al. 2010; Garud and Karnøe 2003). Thus, the notion of bricolage helps to further specify agency processes as mentioned in the WLO approach in Section 2. As a consequence, the generation of unrelated radical novelty is likely to be a messy, step-wise and experimental process. This requires entrepreneurship, not only to be proficient in the relevant knowledge fields but also to be capable of embedding new ideas in a wider social environment. This is exactly what Hughes

(1983) identified as “system builders” being a crucial factor in the emergence of infrastructure sectors like electricity in the early 20th century.

The bricolage approach became very prominent in organization and management studies (Baker et al., 2003; Stinchfield et al., 2013). It has arguably been less developed for regional development and policy processes. Nonetheless, drawing on the work of Charles Sabel (1996), previous research on EU regional innovation strategies has conceptualized these as ‘regional experimentalism’ in which “the state, firms and intermediaries work in small-scale repeated interactions in an attempt to (re)define regional development support services and priorities in a collective manner, establish specific targets and responsibilities and monitor outcomes in a way that facilitates learning on the part of those in a position to respond (Henderson, 2000, p. 349; see also Morgan and Henderson, 2002). Similarly, albeit 15 years later, experimentalism and entrepreneurial discovery are emphasized in the policy framework of smart specialization. Here, the ability is crucial to combine and relate knowledge about science, technology and engineering with knowledge of market growth potential, potential competitors as well as the whole set of inputs and services required for launching a new activity (Foray et al., 2011).

What is highlighted in smart specialization, albeit somewhat implicitly, is that entrepreneurship is not just about ‘taking a technology to the market’ (Sotarauta and Pulkkinen, 2011). While traditionally entrepreneurship is considered key for experimentation in combinatorial knowledge dynamics for related diversification (Frenken and Boschma, 2007), what is equally emphasized through the notion of bricolage is the need for institutional entrepreneurship. Here, actors break with existing institutionalized rules and practices associated with the dominant institutional logics (see the concept of regime below) and institutionalize the alternative rules, practices or logics they are championing (Battilana, 2006; Garud et al., 2007). Institutional entrepreneurs are typically heterogeneous actors including but not limited to firms or individual entrepreneurs who mobilize resources, competences and power to create new or transform existing institutions (Battilana et al. 2009; Sotarauta and Pulkkinen, 2011).

In order to unpack how bricolage, experimentation and institutional entrepreneurship may give rise to new socio-technical pathways, the recent literature on socio-technical transitions proves to provide a number of relevant insights.

3.2 The initiation of new pathways through socio-technical alignment

Transition studies represent a scholarly field which has emphasized the role of distributed agency in the development of new industries and the crucial role of socio-technical alignment. Its key focus concerns transformative shifts in systems of production and consumption that unfold as disruptive technological change co-evolves with changes in markets, user practices, policy, discourses and governing institutions (Geels, 2002; Kemp et al., 1998; Markard et al., 2012; Rip and Kemp, 1998; Smith et al., 2010). Empirically, this literature has been primarily interested in

understanding and explaining historical examples of long-term yet disruptive technological change such as the transition from sailing to steam ships (Geels, 2002). Furthermore, this literature is well-known for its engagement in understanding and contributing to the more normative objective of radically improving societal systems of provision in order to comply with conditions of sustainability in for example energy, mobility, water, housing and food (Fuenfschilling and Truffer, 2014; Grin et al., 2011; Geels et al., 2012; Spaargaren, et al., 2012; Verbong and Geels, 2012; Frantzeskaki et al., 2016).

Transition studies emerged out of an evolutionary economics and a social-constructivist understanding of innovation processes (Rip and Kemp 1998), and emphasize that successful socio-technical configurations have to be actively constructed and stabilized. Drawing furthermore on the Schumpeterian notion of creative destruction, research on socio-technological transitions is specifically concerned with the role of emergent technologies that challenge and struggle against incumbent actors who dominate a particular sector (Bergek et al., 2015; Markard et al., 2012). In analyzing this process, transitions research is heavily influenced by the concept of path-dependency. Based on concepts from evolutionary economics, such as technological regimes and trajectories, routines or lock-in (Nelson and Winter, 1982), as well as sociological insights on agency and structure (Giddens, 1984), the concept of the socio-technical regime accounts for the persistence and rigidity of structures within a system (Fuenfschilling and Truffer, 2016). It is defined as the “coherent complex of scientific knowledge, engineering practices, production process technologies, product characteristics, skills and procedures, established user needs, regulatory requirements, institutions and infrastructures” (Rip and Kemp, 1998, p. 338). The ‘structuration’ of this complex, in terms of its internal alignment is high, providing stable rules and coordinating effects on actors. As a consequence, sectors that have a strong regime are considered as hostile selection environments for disruptive innovations and radical (technological) change. Instead they are prone to lock-in and path-dependency and largely geared to generate incremental innovations and gradual change.

Here, transition studies provides useful insights. Even though it emphasizes how (radical) novelty is constrained and contested by a regime, it specifies at the same time how such radical novelty emerges. This is mostly conceptualized through the notion of niches (Geels and Raven, 2006) or through work done in the field of technological innovation systems dealing with emergent (sustainable) technologies and industries (Bergek et al., 2008; Hekkert et al., 2007). Similar to previous work on bricolage and path creation (Garud et al. 2010; Karnøe and Garud, 2012; Sydow et al., 2012), it subscribes to the notion that new paths do not emerge from external shocks but from the strategic agency in heterogeneous actor groups that jointly act upon locked-in structures and mobilize resources to create a new industry (Simmie, 2012).

Due to its strong focus on socio-technical alignment, transition studies have been, until recently, rather silent about the spatial structure and preconditions for these processes. Truffer and Coenen (2012) proposed three conceptual platforms where transition studies could address this shortcoming by engaging with the regional studies and economic geography literature: i)

emphasizing the local embedding of new technologies by an integrated view on the joint alignment of socio-technical and socio-spatial structures, ii) the consideration of multi-scalar factors of transitions like trans-regional actors networks and institutions and iii) an attentiveness to power relationships in these processes. Since these early proposals, a sizable number of studies have emerged which further elaborated the geography of transitions field (Hansen and Coenen, 2015; Murphy, 2015; Truffer et al., 2015). A recent review (Hansen and Coenen, 2015) has shown that the majority of case-studies dealing with the geography of transitions has zoomed in on the importance of place-dependence for transition processes. This has helped to specify that niche formation in emergent clean technologies are contingent on place-specific factors such as local related variety, local natural resource endowments, local market formation, urban and regional visions and policies, and local informal institutions. While a higher level of sensitivity concerning the importance of place-dependence is gained in these studies, it may have come with a bias towards emphasizing particularities found in single case studies of distinct places. Another insight of this work holds that regimes, even though they can be considered as global structures, these may nevertheless exhibit a high degree of local variation (Späth and Rohracher, 2012). And, niches on the other hand are not bound to the local scale, but often consist of globally interconnected sets of activities (Binz et al., 2014; Quitzow, 2015; Sengers and Raven, 2015).

Proposing a more systematic framework regarding unrelated diversification, Binz et al. (2016b) suggested how the emergence of new industrial pathways in regions can be framed as a process of bricolage by mobilizing and aligning different resources, like knowledge, markets, investment and legitimacy. Rather than assuming that markets for new industrial pathways pre-exist, it treats (niche) markets as a resource for radically new technologies, products and services that have to be actively created through for example lobbying, regulation and standardization (see also (Dewald and Truffer, 2012). Similarly, financial investment requires active mobilization through networking between entrepreneurs, investors and intermediary organization. Legitimacy, finally, is emphasized as a key resource for new industry formation as new products and processes are often not aligned with existing regulative, normative and cognitive institutions resulting in initial skepticism and lack of user acceptance (Aldrich and Fiol, 1994; Binz et al., 2016a; Yeung and Coe, 2015). Therefore actors promoting unrelated diversification have to engage in considerable institutional work to either adapt the industry to existing institutional structures or adapt these structures to better match the industry's needs (Bergek et al., 2008; Fuenfschilling and Truffer, 2016). Drawing on a case study of industry formation for on-site water recycling in Beijing, Binz et al. (2016b) found that such processes of resource mobilization and alignment are not confined to local interactions but depend on a complex interplay between local and global configurations.

3.3 Establishing pathways by scaling of niches

While the notion of bricolage on the one hand broadens the set of resources considered for new path creation, it also stresses the highly experimental nature of new path creation. Interestingly, experimentation is mentioned by Martin (2010) as a critical process for new path creation in

regions but this is not further elaborated. In contrast, research in transition studies has foregrounded the role of experimentation, particularly in connection to the concept of niches which are conceived as ‘incubation spaces’ for radically new technologies and/or practices characterized by high technological, institutional and market uncertainty. Such niches protect radical innovations against market selection and institutional pressures from a regime and allow actors to learn about these novelties and their uses through experimentation (Coenen et al., 2010; Geels, 2002). When niches gather sufficient momentum so that these relatively loose configurations become institutionalized they create capacity for emergent technologies and practices to challenge and substitute a regime and induce transitions.

In the transition literature, the Strategic Niche Management elaborates how heterogeneous experiments can be managed in order to support socio-technical alignment (Hoogma et al., 2002; Schot and Geels, 2008). Three processes are distinguished for successful development of a niche: shielding, nurturing and empowerment (Smith and Raven, 2012). All three processes essentially enable different actors to try out new alignments between institutions, technologies and actors. Shielding refers to those activities that hold at bay selection pressures from a regime and that afford the protective space for path-breaking innovations to emerge. Nurturing refers to those activities that then support the development of path-breaking innovation (Schot and Geels 2008) such as the processes of anchoring elaborated by Binz et al. (2016b).

Experimental projects in real-life contexts are seen to be critical by bringing together actors from variation and selection environments in shared networking and learning activities. In these experiments, firms, research institutes, universities and governments search and explore the best possible combinations of innovations and their social and institutional embedding (Bulkeley and Castan Broto, 2013). A key challenge that these niche experiments are facing concerns how to upscale successful innovations and practices beyond their initial niche (Geels et al., 2008). Whereas initial attention has been paid primarily to the roles of ‘shielding’ and ‘nurturing’, Smith and Raven (2012) argue that more focus should be given to the ‘empowering’ role of niches. Empowering involves processes that make niche innovations competitive within unchanged selection environments (fit and conform) or processes that change mainstream selection environments favorable to the path-breaking innovation (stretch and transform).” (p. 1034).

Summing up, we suggest that transition studies provide a suitable framework for analyzing processes of unrelated diversification in particular. In unrelated diversification, agency in the form of bricolage, institutional entrepreneurship or policy action comes more heavily to bear and successful attempts rely on experimental activities, strategies of resourceful actors, capabilities of “system building” and partly also serendipity (Dawley, 2014; Dawley et al. 2015). Transition studies have so far been less strong in formulating hypotheses about which individual actors, technologies, networks or institutions are more amenable to successful path creation. What the literature suggests however, is to be attentive of which constellations of factors might be more or less amenable for conducting successful bricolage processes. Moreover, the transition literature has only started to look at the geography of niches and regimes, and what are the implications for

(related and unrelated) diversification in regions. We argue that regimes tend to be global though not equally present and institutionalized in all regions, while niches might emerge regionally though often in parallel with global networks connecting them.

4. Towards a theory of regional diversification

In the foregoing, it has become clear that EEG and transition studies have in common the interest to understand the nature, loci and radicalness of novelty. Their perspectives viz. units of analysis are different, however. In EEG, the notion of novelty is spatially defined and treated: looking from the perspective of a region, scholars distinguish between related and unrelated diversification. The more a new industry is unrelated to the capability base already built up in the *region*, the more a new industry marks a radical departure from a region's own past. The transition perspective, by contrast, looks at the construction of niches that challenge an existing socio-technical regime that is globally dominant in a particular *sector*. Here, the radicality lies in the extent to which the niche differs from the globally institutionalised regime.

The notions of unrelated diversification and niche creation, thus, should not be confused. Unrelated diversification is defined with reference to a particular region with certain capabilities ("place"), while a new niche is defined with reference to a particular regime following a certain technological trajectory ("path"). Put differently, place dependence and path dependence are two distinct logics (Martin and Sunley 2006; Heimeriks and Boschma 2014). *Place dependence* stems from the local reproduction of territorial institutions and vested interests embedded in places, which tends to hamper processes of unrelated diversification of a regional economy. *Path dependence* stems from shared cognitive frames, standards and skills embedded in socio-technical regimes, which tends to hamper the development of new niches and their further development into alternative socio-technical regimes. So, place and path dependence relate to socio-spatial and socio-technical embedding respectively (Truffer and Coenen 2012).

In many instances, place and path dependence may work together and mutually reinforce each other. Indeed, a regime tends to be globally organized and hence present in many regions. In regions where a regime is both dominant and strongly aligned with territorial institutions, a change of regime will be very unlikely, as niche actors have to aim at changing both the regime and the regional institutions. However, regimes are not monolithic nor fully globalized. A regime may be strong in some regions and weaker in other. That is to say, regions differ in the extent to which a regime is adopted and the degree to which the regime is regionally institutionalized. And, looking from the regional angle, in some regions, a sector can be dominated by a single regime, while in other regions this sector may be characterized by co-existing regimes. Think for example, of cities dominated by cars versus cities where cars, bikes and public transport co-exist and may be even made complementary. Hence, one can expect windows of opportunity to exist in regions where the regime is less dominant and only weakly institutionalized.

The distinction between place and path dependence thus implies that the two processes of unrelated diversification at the regional level and niche creation at the sectoral level do not necessarily coincide. This is what we depicted in Table 1, where we distinguish radicality along the regional dimension (related vs. unrelated) and along the sectoral dimension (regime versus niche). In the case of regional diversification, a new industry is *new-to-the-region*, while in the case of a niche creation it is *new-to-the-world*.

A region creating a new niche may do so via unrelated diversification or related diversification. For example, Danish regions specialized in agriculture diversified into an unrelated niche of wind turbine production. An example of related diversification leading to a new niche would be Silicon Valley specialized in ICT industry currently creating a niche for self-driving cars. In both examples, a new-to-the-world niche was created through regional diversification.

The same possibilities of related and unrelated diversification hold when a region becomes active in an existing regime technology. That is, a region may diversify by entering a regime through related or unrelated diversification. For example, it may diversify in a related manner from operating in the oil regime serving the transport sector into the plastics regime serving the packaging industry. However, a region may also enter a regime that is unrelated to the capabilities already present in the region, like a desert region specialized in tourism that discovers oil and enters the oil regime. For each new industry created in a region, one can thus assess whether the industry is related or unrelated to the region’s existing capability base and whether the industry is constituting a new niche in a particular sector, or whether it extends an already existing regime in a sector.

Table 1. A typology of regional diversification

		REGION	
		Related	Unrelated
SECTOR	Regime	Replication	Transplantation
	Niche	Exaptation	Saltation

One can thus derive a typology of four different regional diversification processes.

Replication stands for the most conservative development logic in which a region develops related industries by adopting a technology that is well embedded in a global regime. In this diversification logic, a region replicates to a large extent its existing capability base by branching out into related activities and at the same time replicates existing knowledge and institutions embedded of an existing socio-technical regime. This strategy can be very successful since the region can become readily competitive in an existing global regime as it can leverage its experience in related industries (Boschma and Frenken 2011).

Transplantation stands for a development trajectory in which a region develops an industry unrelated to its knowledge base and institutions, yet based on adopting a regime technology from the global system. Our use of the term transplantation is in line with Martin and Sunley (2006), who mention transplantation as a primary mechanism of creating a ‘new pathway of regional growth’. This diversification logic is a more risky one as a region cannot build on its existing knowledge base and regional institutions while it has to compete with many other regions where the regime is already present. Hence, this strategy can only be successful if resources other than knowledge and institutions can be leveraged, such as location, connectivity, a critical natural resource, or low labor costs. The latter two conditions are often present in developing countries that catch-up through imitation of established technologies, that is, by diversifying into regimes that are unrelated to their pre-existing capability base.

Exaptation refers to a development logic where new applications are discovered for existing knowledge or technology (Dew et al. 2004; Andriani and Cohen 2013). The canonical example in biology are wings which initially evolved for insulation purposes but later developed into a means to fly. Similarly, many technologies find applications that were not foreseen when first developed. For example, technologies like the laser, the computer and plastics have continued to find new applications in very diverse sectors. Exaptation thus refers to a development logic where a region builds on a single knowledge base and succeeds in entering many sectors by creating new niches. Silicon Valley and its ICT knowledge base is a perfect example, branching out in many sectors by developing new niche technologies with some of these successfully growing out into a new global regime (personal computers, online advertising, mobile telephony), while other (still) having a niche status (self-driving cars, home-sharing platforms, smart homes).

Finally, we can distinguish diversification as **saltation** (or leap), that is, a non-gradual change caused by a true breakthrough which is not only new-to-the-region but also new-to-the-world. An example is the discovery of DNA in Cambridge and rDNA in San Francisco (Feldman et al. 2015), or Edison’s light bulb and the rise of the New Jersey lamp industry (Smil 2006).

Going back to the agency perspective advocated by organization scholars and their theories of bricolage (Garud and Karnøe 2003) and institutional entrepreneurship (Battilana et al. 2009), we can further specify the role of actors as entrepreneurs and policy makers in the four development trajectories. Clearly, in the case of replication, actors operate in a context where they can build on (related) existing regional strengths and global regimes. These patterns are readily explained by the key notions of place and path dependence, respectively. In particular, one expects incumbents

to be most active in this process, since related diversification into established regimes fits most firms' own strategy to grow and expand (see Neffke et al. 2014). Another reason why one expects large incumbent firms to be the typical actor in this process is that regime entry requires many resources and a long-term vision given the entry barriers in established regimes.

In the case of transplantation, institutional work has to be done at the regional level to adapt institutions such that globally accepted technologies, standards and regulations are accepted and implemented. One can expect that transplantation activities are carried out by actors who have both the capabilities and interests to make the regime diffuse, for example, global consultancies, multinational corporations, and transnational government agencies. Given that vested interests in a region may well be threatened by the transplantation of regime technology by globally operating regime actors, conflicts may well arise. The introduction of a regime technology that is new to the region often leads to competition for scarce public and private resources. In this context, one can thus regard the regime actor as the institutional actor 'breaking in' regional institutions, and trying to mold them into global regime standards. Thus, transplantation is certainly actor-led, and a key question holds in what contexts what actor(s) take up this role, how outcomes vary according to the actor(s) taking up this role, and what roles regional governments can play to resolve such conflicts.

Regarding exaptation, this is a more local process even if, as explained before, niche creation may well involve concurrent and networked processes across multiple regions. Here, the actors are expected to come from established local industries, as exaptation is a process of related diversification. Think here especially about spinoffs and diversifying firms (Klepper 2007) who tend to pioneer the formation of new industries that build on established ones. The institutional work to be carried out is to get the new niche technology accepted through new regulations and social norms (i.e. fit and conform). Regime actors tend to de-legitimize such efforts; hence, one expects that such institutional work to be most successful in regions where the regime is not well established as well as where powerful niche actors reside with global reach acting as institutional entrepreneurs (cf. Battilana et al. 2009). Regional governments can play this role as well, by lobbying for the creation of supporting institutions at national and global levels.

Finally, a new path created by saltation will be mostly driven by individual agents. Given that such leaps imply that the new path is both unrelated to a region's capabilities and challenging an existing global regime, agents have to change institutions at two levels. They not only break with established knowledge base and institutions and interests at the regional level, but also have to establish a niche in a global regime. While in transplantation and exaptation, either the regime or the region provide a supporting institutional structure, saltation requires a fundamental change of institutions in both dimensions, that is, both globally at the sectoral level and locally at the regional level (i.e. stretch and transform). Here, one expects the new to emerge in a distributed manner, with many heterogeneous agents involved and often located in different regions. As there are only few supporting structures at the regional or global level to build on, these actors have to engage in a collective alignment process emphasized by the notion of bricolage.

Similarly, the work needed to change institutions at regional and global levels will most often be a process of collective institutional entrepreneurship, for example, as driven by a social movement (Sine and Lee, 2009).

In this respect, one can expect saltation which is unrelated to a region's past and unrelated to a global regime, to occur only rarely. Having said this, it prompts the question – referring back to the Windows of Locational Opportunity (WLO) concept – what generic regional conditions may favor the emergence of such radical breakthroughs (Boschma, 1997). Here, one may think of access to patient capital, the presence of a research university, and a liberal cultural climate. Similarly, one can ask the question whether certain types of actors are more likely to develop radical breakthroughs and to get these globally accepted. For example, university scientists have the legitimate role of exactly doing frontier research and generating breakthroughs, and thus may be better equipped institutionally to carry out such radical innovations.

5. Concluding remarks

This paper proposes a new typology of regional diversification that combines complementary logics from two different literatures that evolved in parallel, that is, the EEG literature on regional diversification and the transition literature. In doing so, we tackle a number of weaknesses in both literatures as far as their view on diversification processes is concerned.

The EEG literature on regional diversification has revealed important insights how regions diversify over time: its main research interest is to understand how regional capabilities enable diversification of regions. Its prime focus has been on related diversification in regions, and less so on unrelated diversification. However, the role of human agency (especially institutional entrepreneurs) has been poorly integrated in this EEG framework on regional diversification. We have argued that EEG lacks a systematic focus on constraining factors (although there are exceptions, see e.g. Hassink 2005), neglects issues like power and conflicts stemming from contradictory interests among stakeholders (MacKinnon et al. 2009; Boschma and Frenken 2009), and draws little attention to the process of institutional work by institutional entrepreneurs that is required to overcome such constraints (Battilana et al. 2009).

We argued that the transition literature provides key insights on unrelated diversification in particular. There is more focus on disruption and constraints that are reflected in contested socio-technical regimes that represent vested interests. There is also more focus on experimentation and the role of all sorts of actors including governments that enable, or not, niche formation and institutional change. In that sense, the transition literature provides complementary insights to EEG. However, transition studies have also been less keen on developing hypotheses about which actors and which contexts are more conducive to regional diversification. There is also little focus on the geographical configurations of niche formation and regimes so far, and its implications for processes of regional diversification.

We argue that EEG and transition studies share an interest in understanding the nature, loci and radicalness of novelty but their perspectives viz. units of analysis are different. In EEG, the notion of novelty is spatially defined (new-to-the-region). Here, the radicality involves the extent to which a new activity in a region can or cannot build on existing related capabilities in the region. The transition perspective looks at the construction of niches that challenge an existing regime that is globally dominant in a particular sector. Here, the radicality lies in the extent to which the niche differs from the globally institutionalized regime (path-challenging) or not (path-reinforcing). Based on these two logics, we derived four types of regional diversification. Related diversification in regions consist of two types: replication (within an existing socio-technical global regime) and exaptation (creating a niche that can grow out into a new global regime), We also distinguished between two types of unrelated diversification: transplantation involves a change in the regional capability base but within the boundaries of the existing socio-technical regime, while saltation stands for the most radical type of regional diversification, requiring not only a transformation of regional capabilities but also a complete regime change.

We believe this proposed framework opens up a lot of challenging avenues for future research.

A first set of questions concerns the geography of diversification. A key question is how the geography of the four types of diversification trajectories would look like. Are there regions that would be good at in all diversification types? To what extent do regions specialize in one of the diversification trajectories, and why, and which regions fail to develop any type of diversification? This also confronts us with a methodological challenge, that is, how to operationalize the two dimensions (related/unrelated and niche/regime) in our proposed framework. For each new industry in a region, one needs to assess whether the new industry is related or unrelated to the region's capability base, and whether the new industry is constituting a new niche in a particular sector, or whether it extends an existing regime in a sector. Surely, the EEG literature on regional diversification has recently made progress in developing various relatedness measures, but it is still debating how to assess the degree of relatedness between new and existing local activities, and how to connect relatedness to specific capabilities (Boschma 2016). The transition literature has primarily conducted single case studies of countries or regions on niche formation within a regime, and therefore has made little effort so far to operationalize the regime-niche framework for systematic quantitative (comparative) analysis of regions².

Another set of questions concerns the process of diversification and the role of various actors, such as firms, NGOs, citizen movements, trade associations and universities. What sorts of agency are typically necessary for conducting successful bricolage and institutional work at

² This is not to say that our proposed framework should be tackled by taking a quantitative approach only. On the contrary, we favor a mixed approach, as many dimensions of our proposed framework can be measured more accurately by taking a qualitative approach, like unraveling the process of institutionalization, the actions of many sorts of agents (including policy actors) involved in the diversification process, and the types of institutional change.

regional and global levels? And how does the amount and nature of such work differ between the four types of regional diversification (replication, transplantation, exaptation and saltation)? To take one example, in the case of replication, it is not entirely clear what the role of actors is. In this diversification logic, a region replicates its capability base by branching out into related activities and it replicates institutions of an existing socio-technical regime. However, it is unlikely to be a conflict-free process either. In this particular case, it is highly probable that a new industry will take away resources from local related industries (such as highly-skilled employees and capital) because these are highly relevant (related) for the new industry. In the other diversification logics, actors will possibly deal with other sorts of tensions, especially when the existing regime is seriously challenged.

This brings us to the specific role of public policy. The four different diversification logics will have implications for the design and implementation of public policy. So what could be the role of the state in all diversification types (Morgan, 2013; Mazzucato 2013)? How can we operationalize smart specialization policy in terms of these diversification strategies? And do countries/regions go through different types of diversification strategies, like developing countries may shift from a strategy based on catching-up in existing technological pathways (transplantation) to developing new pathways (like exaptation)? Do diversification strategies based on 'normal' innovations differ from those that are connected to 'grand challenges'? How can regions/countries moderate the strength of socio-technical regimes in order to enable niche experiments to emerge and to scale up? What about the mix of niche promotion and regime weakening policies for embarking on radical diversification? And which diversification strategies will bring the highest economic payoffs to a region: for instance, is a successful replication strategy necessarily inferior in terms of potential benefits?

A final set of questions addresses the exploration of factors that condition the different types of diversification trajectories that might therefore prevail in certain regions. Even when a new industry requires capabilities new to the region (unrelated), it might still be the case that the region might have a local environment that favors experimentation. Can we identify institutional conditions that enable such a culture of experimentation? How do national and regional institutions condition the different types of regional diversification processes (Boschma and Capone 2015; Cortinovis et al. 2016)? Are certain regions better at running experiments, while others are better at scaling up? And how important are region-external linkages (Asheim and Isaksen 2002; Trippel et al. 2015)? Is unrelated diversification more dependent on international linkages and external actors (Neffke et al. 2014)? And how can we relate strategies in global value chains with diversification strategies of countries and regions?

References

Aldrich, H.E. and C.M. Fiol (1994) Fools rush in? The institutional context of industry creation. *Academy of Management Review* 19, 645-670.

- Andriani, P. and J. Cohen (2013) From exaptation to radical niche construction in biological and technological complex systems, *Complexity* 18 (5), 7-14.
- Asheim, B.T. and A. Isaksen (2002) Regional innovation systems. The integration of local ‘sticky’ and global ‘ubiquitous’ knowledge, *Journal of Technology Transfer* 27, 77-86.
- Bahar, D., R. Hausmann and C.A. Hidalgo (2014) Neighbors and the evolution of the comparative advantage of nations: Evidence of international knowledge diffusion? *Journal of International Economics* 92 (1), 111–123.
- Baker, T., A.S. Miner, B. Dale and T. Eesley (2003) Improvising firms: bricolage, account giving and improvisational competencies in the founding process. *Research Policy* 32, 255–276.
- Baker, T., and R.E. Nelson (2005) Creating something from nothing: Resource construction through entrepreneurial bricolage. *Administrative Science Quarterly* 50, 329–366.
- Battilana, J. (2006) Agency and institutions: The enabling role of individuals’ social position. *Organization* 13(5), 653-676.
- Battilana, J., B. Leca and E. Boxenbaum (2009) How actors change institutions: Towards a theory of institutional entrepreneurship, *The Academy of Management Annals* 3, 65– 107.
- Berge, M. van den, and A. Weterings (2014) Relatedness in eco-technological development in European regions, The Hague: Planbureau voor Leefomgeving.
- Bergek, A., Hekkert, M., Jacobsson, S., Markard, J., Sandén, B. and Truffer, B. (2015) Technological innovation systems in contexts: Conceptualizing contextual structures and interaction dynamics. *Environmental Innovation and Societal Transitions* 16, 51-64.
- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S. and Rickne, A. (2008) Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy* 37, 407-429.
- Binz, C., Harris-Lovett, S., Kiparsky, M., Sedlak, D.L. and Truffer, B. (2016a) The thorny road to technology legitimation. Institutional work for potable water reuse in California. *Technological Forecasting and Social Change* 103, 249-263.
- Binz, C., Truffer, B. and Coenen, L. (2014) Why space matters in technological innovation systems - Mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy* 43, 138-155.
- Binz, C., Truffer, B. and Coenen, L. (2016b) Path creation as a process of resource alignment and anchoring – Industry formation for on-site water recycling in Beijing. *Economic Geography* 92 (2), 172-200.
- Boschma, R.A. (1997), New industries and windows of locational opportunity. A long-term analysis of Belgium, *Erdkunde* 51, 12-22.
- Boschma, R. (2016) Relatedness as driver behind regional diversification: a research agenda, *Regional Studies*, forthcoming.
- Boschma, R., G. Heimeriks and P.A. Balland (2014) Scientific knowledge dynamics and relatedness in biotech cities, *Research Policy* 43 (1), 107-114.

- Boschma, R., P.A. Balland and D.F. Kogler (2015), Relatedness and technological change in cities: The rise and fall of technological knowledge in U.S. metropolitan areas from 1981 to 2010, *Industrial and Corporate Change*, 24 (1), 223-250.
- Boschma, R. and G. Capone (2015) Institutions and diversification: Related versus unrelated diversification in a varieties of capitalism framework, *Research Policy* 44, 1902-1914.
- Boschma, R.A. and Frenken K. (2006) Why is economic geography not an evolutionary science? Towards an evolutionary economic geography *Journal of Economic Geography* 6 (3): 273–302.
- Boschma, R.A. Frenken, K. (2009) Some notes on institutions in evolutionary economic geography. *Economic Geography* 85 (2): 151-158.
- Boschma, R. and K. Frenken (2011) Technological relatedness and regional branching, in: H. Bathelt, M.P. Feldman and D.F. Kogler (eds.), *Beyond Territory. Dynamic Geographies of Knowledge Creation, Diffusion and Innovation*, Routledge, London and New York, pp. 64-81.
- Boschma, R., A. Minondo and M. Navarro (2013), The emergence of new industries at the regional level in Spain: a proximity approach based on product-relatedness, *Economic Geography*, 89(1), 29–51.
- Buenstorf G. and Klepper S. (2009) Heritage and agglomeration: the Akron tyre cluster revisited. *The Economic Journal* 119: 705–733.
- Bulkeley, H. and V. Castán Broto (2013) Government by experiment? Global cities and the governing of climate change. *Transactions of the Institute of British Geographers* 38(3), 361-375.
- Callon, M. (1998) An essay on framing and overflowing: economic externalities revisited by sociology, in: Callon, M. (Ed.), *The laws of the markets*, Blackwell Publishers / The Sociological Review, Oxford, pp. 244 - 269.
- Castaldi, C., K. Frenken and B. Los (2015) Related variety, unrelated variety and technological breakthroughs. An analysis of US state-level patenting, *Regional Studies* 49 (5), 767–781.
- Coenen, L., Raven, R. and Verbong, G. (2010) Local niche experimentation in energy transitions: A theoretical and empirical exploration of proximity advantages and disadvantages. *Technology in Society* 32 (4), 295-302.
- Coenen, L. and Truffer, B. (2012) Places and Spaces of Sustainability Transitions: Geographical Contributions to an Emerging Research and Policy Field. *European Planning Studies* 20, 367-374.
- Coenen, L., Hansen, T., and Rekers, J. V. (2015) Innovation Policy for Grand Challenges. An Economic Geography Perspective. *Geography Compass*, 9(9), 483-496
- Colombelli, A., J. Krafft and F. Quatraro (2014) The emergence of new technology-based sectors in European regions: a proximity-based analysis of nanotechnology, *Research Policy* 43, 1681-1696.
- Cortinovis, N., J. Xiao, R. Boschma and F. Van Oort (2016) Quality of government and social capital as drivers of regional diversification in Europe, working paper.

- Crespo, J., Suire R. and Vicente J. (2014) Lock-in or lock-out? How structural properties of knowledge networks affect regional resilience. *Journal of Economic Geography* 14(1), 199-219
- Dawley, S. (2014) Creating new paths? Offshore wind, policy activism, and peripheral region development. *Economic Geography* 90 (1), 91-112.
- Dawley, S., D. MacKinnon, A. Cumbers and A. Pike (2015) Policy activism and regional path creation: the promotion of offshore wind in North East England and Scotland, *Cambridge Journal of Regions, Economy and Society*, 8, 257-272.
- Dew, N., Sarasvathy, S.D. and S. Venkataraman (2004) The economic implications of exaptation, *Journal of Evolutionary Economics* 14 (1), 69–84
- Dewald, U. and Truffer, B. (2012) The Local Sources of Market Formation: Explaining Regional Growth Differentials in German Photovoltaic Markets. *European Planning Studies* 20, 397-420.
- Duymedjian, R. and Rüling, C.-C. (2010) Towards a Foundation of Bricolage in Organization and Management Theory. *Organization Studies* 31, 133-151.
- Essleztbichler, J. (2015) Relatedness, industrial branching and technological cohesion in US metropolitan areas, *Regional Studies* 49 (5), 752–766.
- Feldman, M.P., D.F. Kogler and D.L. Rigby (2015), rKnowledge: The Spatial Diffusion and Adoption of rDNA Methods, *Regional Studies* 49(5), 798-817.
- Foray, D., David, P. A., and Hall, B. H. (2011) Smart specialisation From academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation. EPFL Working Paper 170252
- Frantzeskaki, N., Castan-Broto, V., Coenen, L. and Loorbach, D. (eds.) (2016) *Urban Sustainability Transitions*. Routledge.
- Frenken K. and R. A. Boschma (2007) A theoretical framework for economic geography: industrial dynamics and urban growth as a branching process, *Journal of Economic Geography*, 7(5), 635–649.
- Frenken, K., van Oort, F.G. & Verburg, T. (2007) Related variety, unrelated variety and regional economic growth. *Regional Studies*, 41 (5), 685-697.
- Fuenfschilling, L. and Truffer, B. (2014) The structuration of socio-technical regimes—Conceptual foundations from institutional theory. *Research Policy* 43, 772-791.
- Fuenfschilling, L. and Truffer, B. (2016) The interplay of institutions, actors and technologies in socio-technical systems - An analysis of transformations in the Australian urban water sector. *Technological Forecasting and Social Change* 103, 298-312.
- Garud, R. and Karnøe, P. (2003) Bricolage versus breakthrough: distributed and embedded agency in technology entrepreneurship. *Research policy* 32(2), 277-300.
- Garud, R., Hardy, C. and Maguire, S. (2007) Institutional entrepreneurship as embedded agency: An introduction to the special issue. *Organization studies – Berlin – European group for organizational studies* 28(7), 957.

- Garud, R., Kumaraswamy, A. and Karnøe, P. (2010) Path dependence or path creation. *Journal of Management Studies* 47, 760–774.
- Geels, F. W. (2002) Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research policy* 31(8), 1257-1274.
- Geels, F.W., Hekkert, M.P. and Jacobsson, S. (2008) The dynamics of sustainable innovation journeys. *Technology Analysis and Strategic Management* 20, 521-536.
- Geels, F., Kemp, R., Dudley, G. and Lyons, G. (eds.) (2012) *Automobility in transition?: A socio-technical analysis of sustainable transport*. Routledge.
- Geels, F.W. and Raven, R. (2006) Non-linearity and expectations in niche-development trajectories: Ups and downs in Dutch biogas development (1973-2003). *Technology Analysis & Strategic Management* 18.
- Giddens, A.T. (1984) *The Constitution of Society. Outline of the Theory of Structuration*. Polity Press., Cambridge.
- Grabher G. (1993). The weakness of strong ties - The lock-in of regional development in the Ruhr area. In G. Grabher (ed.) *The Embedded Firm*, (London: Routledge), pp. 255-277.
- Grin, J., Rotmans and J., Schot (2011) On patterns and agency in transition dynamics: Some key insights from the KSI programme. *Environmental Innovation and Societal Transitions* 1, 76-81.
- Hansen, T. and Coenen, L. (2015) The geography of sustainability transitions: Review, synthesis and reflections on an emergent research field. *Environmental Innovation and Societal Transitions* 17, 92-109.
- Hassink R. (2005) How to unlock regional economies from path dependency? From learning region to learning cluster. *European Planning Studies* 13 (4): 521–535.
- Heimeriks, G. and Balland, P.A. (2015) How smart is specialisation? An analysis of specialisation patterns in knowledge production, *Science and Public Policy*, advance access.
- Heimeriks, G. and R. Boschma (2014) The path- and place-dependent nature of scientific knowledge production in biotech 1986-2008, *Journal of Economic Geography* 14, 339-364.
- Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S. and Smits, R.E.H.M. (2007) Functions of innovation systems: A new approach for analysing technological change. *Technological Forecasting and Social Change* 74, 413-432.
- Henderson, D. (2000) EU Regional Innovation Strategies Regional Experimentalism In Practice?. *European Urban and Regional Studies* 7(4), 347-358.
- Hidalgo, C.A., Klinger, B., Barabasi, A.L. and Hausmann, R. (2007) The product space and its consequences for economic growth, *Science* 317: 482–487.
- Hoogma, R., Kemp, R., Schot, J. and Truffer, B. (2002) *Experimenting for Sustainable Transport. The approach of Strategic Niche Management*. Spon Press, London / New York.
- Hughes, T. P. (1993) *Networks of power: electrification in Western society, 1880-1930*. John Hopkins University Press.

- Isaksen, A. and M. Trippel (2014) Regional industrial path development in different regional innovation systems: A conceptual analysis, Papers in Innovation Studies 2014/17, Lund University, CIRCLE.
- Karnøe, P. and Garud, R. (2012) Path creation: Co-creation of heterogeneous resources in the emergence of the Danish wind turbine cluster. *European Planning Studies* 20, 733-752.
- Kemp, R., Schot, J. and Hoogma, R. (1998) Regime Shifts to Sustainability Through Processes of Niche Formation: The Approach of Strategic Niche Management. *Technology Analysis & Strategic Management* 10, 175-195.
- Klepper, S. (2007) Disagreements, spinoffs, and the evolution of Detroit as the capital of the U.S. automobile industry, *Management Science*, 53(4), 616–631.
- Kogler, D.F., D.L. Rigby and I. Tucker (2013) Mapping Knowledge Space and Technological Relatedness in US Cities, *European Planning Studies* 21(9), 1374-1391.
- Lévi-Strauss, C. (1967) *The savage mind*. Chicago: University of Chicago Press.
- MacKinnon, D., Cumbers, A., Pike, A., Birch, K., McMaster, R. (2009) Evolution in economic geography: Institutions, political economy, and adaptation, *Economic Geography* 85(2), 129-150
- Markard, J., Raven, R. and Truffer, B. (2012) Sustainability transitions: An emerging field of research and its prospects. *Research Policy* 41, 955-967.
- Martin, R. (2010) Roepke lecture in Economic Geography – Rethinking regional path dependence: Beyond lock-in to evolution. *Economic Geography* 86 (1): 1-27.
- Martin R. and Sunley P. (2006) Path dependence and regional economic evolution, *Journal of Economic Geography* 6(4), 395–437.
- Mazzucato, M. (2013) *The entrepreneurial state, ebunking public vs. private sector myths*, London/New York: Anther Press.
- Morgan K. (2013) Path dependence and the state: the politics of novelty in old industrial regions. In: Cooke P (ed) *Reframing regional development: evolution, innovation, transition*. London: Routledge, 318-340.
- Morgan, K. and Henderson, D. (2002) Regions as laboratories: the rise of regional experimentalism in Europe. In Gertler, M. and Wolfe, D. (Eds) *Innovation and Social Learning: Institutional Adaptation in an Era of Technological Change*, Palgrave Macmillan UK, pp. 204-226.
- Murphy, J.T. (2015) Human geography and socio-technical transition studies: Promising intersections. *Environmental Innovation and Societal Transitions* 17, 73-91.
- Neffke, F., Hartog, M., Boschma, R. and Henning, M. (2014) Agents of structural change. The role of firms and entrepreneurs in regional diversification, Papers in Evolutionary Economic Geography 14.10, Utrecht University.
- Neffke F., Henning M. and Boschma, R. (2011) How do regions diversify over time? Industry relatedness and the development of new growth paths in regions, *Economic Geography* 87(3), 237–265.

- Nelson, R. R. and Winter S. G. (1982). *An Evolutionary Theory of Economic Change*, Cambridge, MA and London: The Belknap Press.
- Quatraro, F. and S. Montresor (2015) Key enabling technologies and smart specialization strategies. Regional evidence from European patent data, DRUID working paper, Rome.
- Quitow, R. (2015) Dynamics of a policy-driven market: The co-evolution of technological innovation systems for solar photovoltaics in China and Germany. *Environmental Innovation and Societal Transitions* 17, 126-148.
- Rigby, D. (2015) Technological relatedness and knowledge space. Entry and exit of US cities from patent classes, *Regional Studies*, 49 (11), 1922-1937.
- Rip, A. and Kemp, R. (1998) Technological Change, in: Rayner, S., Malone, E.L. (Eds.), *Human choice and climate change - Resources and technology*, Columbus, pp. 327-399.
- Sabel, C. F. (1996) A measure of federalism: assessing manufacturing technology centers. *Research Policy* 25 (2), 281-307.
- Saviotti, P.P. and K. Frenken (2008) Trade variety and economic development of countries. *Journal of Evolutionary Economics*, 18 (2), 201-218.
- Schot, J. and Geels, F. W. (2008) Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy. *Technology Analysis & Strategic Management* 20(5), 537-554.
- Scott, A.J. and M. Storper (1987) High technology industry and regional development. A theoretical critique and reconstruction, *International Social Science Journal* 112, 215-232.
- Sengers, F. and Raven, R. (2015) Toward a spatial perspective on niche development: The case of Bus Rapid Transit. *Environmental Innovation and Societal Transitions* 17, 166-182.
- Simmie, J. (2012) Path Dependence and New Path Creation in Renewable Energy Technologies. *European Planning Studies* 20, 729-731.
- Sine, W. D. and Lee, B. H. (2009) Tilting at windmills? The environmental movement and the emergence of the US wind energy sector. *Administrative Science Quarterly* 54(1), 123-155.
- Smil, V. (2006) *Transforming the Twentieth Century: Technical Innovations and Their Consequences*. Oxford: Oxford University Press.
- Smith, A. and Raven, R. (2012) What is protective space? Reconsidering niches in transitions to sustainability. *Research Policy* 41(6), 1025-1036.
- Sotarauta, M. and R. Pulkkinen (2011) Institutional entrepreneurship for knowledge regions: in search of a fresh set of questions for regional innovation studies, *Environment and Planning C*, 29, 96-112.
- Spaargaren, G., Oosterveer, P. and Loeber, A. (eds.) (2012). *Food practices in transition: changing food consumption, retail and production in the age of reflexive modernity*. Routledge.
- Späth, P. and Rohrer, H. (2012) Local demonstrations for global transitions—Dynamics across governance levels fostering socio-technical regime change towards sustainability. *European Planning Studies* 20 (3), 461-479.

- Stinchfield, B.T., Nelson, R.E. and Wood, M.S. (2013) Learning From Levi-Strauss' Legacy: Art, Craft, Engineering, Bricolage, and Brokerage in Entrepreneurship. *Entrepreneurship Theory and Practice* 37, 889-921.
- Storper, M. and R. Walker (1989) *The capitalist imperative: Territory, technology and industrial growth*, New York: Basil Blackwell.
- Sydow, J., Windeler, A., Müller-Seitz, G. and Lange, K. (2012) Path Constitution Analysis: A Methodology for Understanding Path Dependence and Path Creation. BuR - Business Research, German Academic Association for Business Research (VHB) 5, 155-176.
- Tanner, A.N. (2014) Regional branching reconsidered: Emergence of the fuel cell industry in European regions, *Economic Geography*, 90 (4), 403-427.
- Tanner, A.N. (2016) The emergence of new technology-based industries: the case of fuel cells and its technological relatedness to regional knowledge bases, *Journal of Economic Geography*, 16 (3), 611-635.
- Trippl, M., M. Grillitsch and A. Isaksen (2015) External “energy” for regional industrial change: attraction and absorption of non-local knowledge for new path development, Papers in Innovation Studies, no. 2015/47, CIRCLE, Lund University. Lund.
- Truffer, B. and Coenen, L. (2012) Environmental Innovation and Sustainability Transitions in Regional Studies. *Regional Studies* 46, 1-21.
- Truffer, B., Murphy, J.T. and Raven, R (2015) The geography of sustainability transitions: Contours of an emerging theme. *Environmental Innovation and Societal Transitions* 17, 63-72.
- Verbong, G. and Geels, F. (2012) Future electricity systems: Visions, scenarios and transition pathways, *Governing the Energy Transition: Reality, Illusion or Necessity?*, pp. 203-219.
- Wenting, R. and Frenken, K. (2011) Firm entry and institutional lock-in: An organizational ecology analysis of the global fashion design industry. *Industrial and Corporate Change*, 20 (4), 1031-1048.
- Xiao, J., R. Boschma and M. Andersson (2016) Regional diversification: the differentiated role of industry relatedness over sectors and regions, working paper.
- Yeung, H.W. and Coe, N.M. (2015) Toward a dynamic theory of global production networks. *Economic Geography* 91, 29-58.