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New Path Development in the Periphery

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Keywords: Peripheral regions, new path creation, knowledge bases

New Path Development in the Periphery

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Abstract

This paper seeks to enhance our understanding of critical preconditions and factors that facilitate the rise and development of new industrial paths in peripheral regional economies. Current conceptualizations of regional path creation are largely based on experiences from core regions and fail to provide satisfactory theoretical explanations of new path development in peripheral regions. Applying a knowledge base approach, we advance the argument that path creation in the periphery can follow either an analytic or a synthetic route. We highlight that new path development is linked to an increase of knowledge variety through the combination of knowledge from outside and inside the region. The paper contains an analysis of the emergence and evolution of new industries in two peripheral regions in Norway and Austria: the electronics and software industry in Arendal-Grimstad in the South-Eastern part of Norway, and the software industry in Mühlviertel in Upper Austria. The two industries have developed differently; through the 'synthetic route' based on the emergence and restructuring of manufacturing firms in Arendal-Grimstad, and through the 'analytical route' building on the establishment of research facilities in Mühlviertel. However, similar factors, such as exogenous development impulses through the inflow of new analytical and synthetic knowledge, the presence of key actors of change, and building of supportive institutional structures are found to be vital in sparking the formation of new industrial paths in both regions. The two cases, however, differed in their further evolution, as they showed varying capacities to successfully combine the newly emerging knowledge base with the existing one. The findings clearly challenge uniform, narrowly conceptualized models of endogenous industrial evolution and highlight the advantages of applying a theoretical framework that takes not only endogenous but also exogenous sources of path creation and its relation to combinations of knowledge bases into account.

1 Introduction

The notion of path dependent regional industrial development has recently received increasing attention in economic geography, innovation studies and related fields (Martin and Sunley 2006; Martin 2010; Neffke et al. 2011). This approach emphasizes that pre-exisiting industrial and institutional structures constitute the regional environment in which current activities occur and new ones arise. Regional industrial development is based on endogenous factors as past economic development in a region 'sets the possibilities, while the present controls what possibilities to be explored' (Martin and Sunley 2006, p. 403). A basic idea is that new industries in a region grow out of existing ones through branching processes (Boschma and Frenken 2011) and through new firm formation by scientists and engineers working in the region (Feldman 2007). The birth and development of new industries is then largely seen as outcome of dense regional structures and endogenous development processes such as a large number of innovative firms in related industries, scientific excellence, the combination of different knowledge bases, a strong endowment with supporting organisations and institutions, as well as dynamic branching processes resulting from continuous diversification activities, a vibrant entrepreneurial culture and regional knowledge circulation.

This paper departs from the fact that such conditions are clearly lacking in peripheral regions. These areas often have low levels of R&D and innovation, are dominated by SMEs operating in traditional industries, lack combinatorial knowledge bases, and have thin and less specialized structures of knowledge and support organizations (Tödtling and Trippl 2005; Virkkala 2007; Isaksen 2014). Key assets for the development of new industrial paths thus appear to be absent (Isaksen and Trippl 2014. Peripheral regions are locked into paths dominated by traditional and often resource-based industries. However, there is evidence that peripheral areas can open up trajectories by breeding new industries (see, for instance,

Ferrucci and Porcheddu 2006; Virkkala 2007; Christensen and Stoerring 2012). Current models of path dependent regional industrial development, however, fall short of providing a sound theoretical framework for analyzing the emergence of new paths in the periphery. The explanations offered by these models are largely based on experiences from metropolitan regions and university campus cities. Peripheral regions are outside major theoretical debates and empirical generalizations of regional path development activities (Petrov 2011; Jauhiainen and Moilanen 2012; Mayer 2013).

This paper seeks to advance our conceptual and empirical knowledge about the development of new industries in peripheral regions by addressing the following research questions: Under which conditions can new industries emerge in peripheral regional economies? What are the critical factors that contribute to the growth and sustainment of new industrial paths in the periphery and who are the key agents of change? The remainder of the paper is organized as follows. Section 2 of the paper reviews and combines the literature on path dependent regional industrial development, knowledge bases and peripheral regional economies. We identify two main routes of new path creation, i.e., the analytical and synthetic one. The empirical part of the paper (Section 3) contains an analysis of the rise and development of new industrial paths in two regions in Norway and Austria: the electronics and software industry in Arendal and Grimstad, two small cities located in close geographic proximity in the rather peripheral South-Eastern part of Norway, and the software and ICT industry in Mühlviertel, a fairly peripheral area situated in the traditional industrial region of Upper Austria. Finally, Section 4 discusses the theoretical implications of our findings. We challenge uniform, narrowly conceptualized models of endogenous regional industrial evolution and highlight the advantages of a theoretical framework that considers not only endogenous but also exogenous sources of regional path creation and its relation to combinations of knowledge bases.

2 New Path Development in Peripheral Regions: Conceptual Considerations and Literature Review

2.1 Endogenous path dependent development

Current theoretical approaches seek to explain the emergence of new industries by drawing on insights from evolutionary economic geography, focusing in particular on the notion of path development. Core arguments are that new regional growth paths 'do not start from scratch but are strongly rooted in the historical economic structure of a region' (Neffke et al. 2011, 261), and that 'a geographical location (…) can be thought of as having a memory that direct the path of subsequent development' (Maskell and Malmberg 2007, 603). This perspective on regional path dependent development leads to an emphasis on endogenous factors to explain regional industrial evolution. Martin (2010, 20), for example, maintains that 'innovation is indeed often a highly localized phenomenon, dependent on place-specific factors and conditions'.

The existing industrial structure of a region influences the emergence of new economic activities through different types of spin-offs. Firm diversification processes can also play a powerful role in this regard (see, for instance, Tanner 2014). Boschma and Frenken (2011) argue that the extent to which firms and industries in a region are technologically related affects the nature and scope of knowledge spillovers among regional firms. It also has an effect on which new activities branch out from existing ones. Regional branching describes how regional industries diversify into new but closely related activities. A key argument is that new economic activity builds on the existing composition of industries in a region. A certain degree of firm and sector heterogeneity are favorable settings for regional industries to branch out into new but related fields, building on existing competence (Boschma and Frenken 2011). Then, 'the local inherited knowledge and skill base of an industry can form

the basis of the rise of related new local paths' (Martin 2010: 19). Such processes of path branching are mainly industry driven when regional industry mutates and widens in terms of industrial specialization and competence.

Emergence of new industries in a region may also be research driven through commercialization of research results, e.g. through academic spin-offs (Ndonzuau et al. 2002). Path creation based on the rise of completely new industries for a region may still build on existing regional skills and competence as 'new paths may be latent in old ones or spin out from existing ones' (Martin 2010: 19). Orsenigo (2006, 215) claims that 'local sources of knowledge appear to be fundamental in the early stages of the development of a cluster and for new, highly specialized firms'.

2.2 Emergence of new industries

Entirely new industries often derive from research activity. The focus of this paper is on the ICT and software industry. These sectors are examples of economic activities that depend much on an analytical knowledge base (Asheim and Gertler 2005). While most activities comprise several knowledge bases, 'one knowledge base will represent the critical knowledge input, which the knowledge creation and innovation processes cannot do without' (Asheim et al. 2011, 1135). Scientific knowledge is highly important in the analytical knowledge base. Knowledge creation includes systematic R&D activity and may lead to scientific discoveries and technological inventions, and thus often to radical innovations. Innovation processes often involve cooperation between firms and universities or R&D institutes. As innovation activity is science-driven, the workforce needs some research experience or higher education. Besides innovations in exisiting firms, an important route of exploitation of analytical knowledge is new firm formation and spin-off companies (Asheim and Gertler 2005).

Recent studies have demonstrated that firms innovate mainly through the integration and combination of varying knowledge bases (Manniche 2012). An important factor behind the combination of knowledge bases is the need by firms 'for not only generating new knowledge but also for "pushing" and processing this knowledge towards commercial utilization' (Manniche 2012: 1834-35). Karlsen et al. (2011) came to the same conclusion in a study of the marine biotechnology in Tromsø in Northern Norway. Tromsø has a fairly well-developed analytical knowledge infrastructure with a university and research institutions that have specific research competence in marine biotechnology, and knowledge links exist between the university and the biotechnology companies. Regardless of several policy tools, few biotechnology firms in Tromsø have products on the market (by the time of the study by Karlsen et al. 2011), partly due to little synthetic (experience based) knowledge (e.g. in process technology) of how to industrialize and commercialize research results in Tromsø. The synthetic knowledge base requires concrete know-how, craft and practical skills in the knowledge production process (Asheim and Gertler 2005). New knowledge emerges through novel combinations of existing knowledge and through experience at the workplace, often stemming from the need to solve specific problems at customers.

If we combine the path development approach with its focus on endogenous development processes and the knowledge base approach, new path development activities are deemed to emerge in particular in locations where relevant analytical knowledge exists, and where this knowledge can be processed towards commercial utilization by combining it with other types of knowledge. Feldman and Lendel (2011) examine the geography of the optics industry in the US. Based on this study they argue that 'emerging high-tech industries are born at the places with the highest patent activity of companies within a common knowledge domain' (p. 141). While patent activity is not of similar importance in all industries, the core of the

argument is that new industries emerge from existing strong science bases in some specific locations. Geographically bounded knowledge spillovers are seen as a central explanation of why emerging industries locate close to vital knowledge sources. This is amongst other reasons because only those who are involved in the development of new knowledge, 'or have direct access to the research team who did it, will possess the know-how necessary to replicate the knowledge, at least until the discovery diffuses sufficiently' (Fontes 2006, 138).

2.3 Two routes to new path development

Employing a knowledge base approach enables us to differentiate between two main routes of new path creation, i.e. the analytical and synthetic one. The above studies point to the fact that new industries clearly tend to emerge in core regions with much analytical knowledge at universities and research institutes, other science based industries, a highly trained workforce, etc. Thus, most theoretical approaches point out that new industries emerge through spin-off processes from knowledge organizations and science-based, analytical industries present in core regions (analytical route, box A in Figure 1). New path creation might also be based on branching processes of traditional industries (synthetic route, box B in Figure 1). This, however, often requires an increase of systematic R&D activities, i.e. the infusion of analytical knowledge into the prevailing synthetic knowledge base. The need to combine different knowledge bases is not confined to the synthetic route of new path creation. It is also relevant to the analytical route, which can benefit from an integration of synthetic knowledge in the commercialization phase of science-based innovations (see also Section 2.2). There are thus strong reasons to argue that new path creation rests on a combination of different knowledge bases. Large urban areas normally constitute the best conditions for combining different knowledge bases due to the location of several different R&D organisations and industries.

Nonetheless, we find examples of new industrial paths that have emerged in 'unexpected' places, that is, in peripheral areas. These regions differ in many respects from core areas and as a consequence in peripheral regional economies the analytical and synthetic routes tend to unfold in other ways than in well-performing advanced regions.

Figure 1: Main ways for emergence of new industrial paths

	Core regions	Peripheral regions
Development based mainly on the *analytical* knowledge base	Spin-offs from knowledge organizations and science-based, analytical industries in the region **A**	Ripple effects from the location of knowledge organizations and/or analytical firms by external actors, supported by institution building **C**
Development based mainly on the *synthetic* knowledge base	Renewal of traditional industries in the region through more R&D effort; i.e. regional branching resulting in new industries **B**	Renewal of and institution building for traditional regional industries **D**

Several studies on the rise of new industrial paths in less-favored places point to the role of exogenous development impulses such as the arrival of innovative firms from outside and other forms of inflow of external knowledge (O'Malley and O'Gorman 2001; Leibovitz 2004; Rees 2005; Mayer 2013; Varis et al. 2014). This is in line with Martin and Sunley (2006) who consider '… the importation and diffusion of new organizational forms, radical new technologies, industries, firms or institutional arrangements from outside' as a key source of new path creation. 'Local knowledge sources appear to be relatively less important for firms located in lower-order regions. For these firms, local universities are viewed as suppliers of skilled workforce, rather than loci of innovations or sources of product ideas or spillover

effects. In order to sustain high rates of innovation they must develop linkages with actors located in higher-order regions' (Orsenigo 2006, 198).

The main type of new path development in peripheral regions is, according to Sánchez (1992), efforts by regional or national governments to attract external investments. Current conceptualizations of regional path development have given little attention so far to the role of the state and deliberative social action (MacKinnon et al. 2009; Martin 2012; Simmie 2012) and can thus hardly provide insights into the scope for policy-supported path creation (Morgan 2013). An analysis of new path development in peripheral regions, in particular, should take into account the role of policy actors and inverventions on multiple scales (Dawley 2014). Attempts to 'implant' new industrial activities in peripheral regions (box C) have often resulted in research institutions and science parks that 'remain as cathedrals in the desert because they lack linkages with the regional milieu' (Hansen 1992, 103). Then, a strong academic research base does not match the needs for analytical knowledge among regional firms, and/or regional firms and industries have limited absorptive capacity to collaborate with research organisations and to apply advanced research (Dawley 2014, 102).

Absorptive capacity and new industrial paths can be created over time through the activity of implanted knowledge organizations and firms. Important then is the fact that entrepreneurs are often 'home-grown'; they start new firms where they live and work and use their existing skills and networks. Ferrucci and Porcheddu (2006, 217) state, for example, that the emergence of the ICT industry in Sardinia 'originates from the region's capacity to produce, attract and retain (…) qualified human resources'. The 'production of human resources' took place in several steps. It started by the establishment of an R&D-institute, heavily supported by public money, in 1990. The institute was not linked to the mainly traditional Sardinian economy. The R&D institute, however, created advanced scientific competence, acquired by

a number of junior researchers, in computing engineering science, computer science and physics. The scientific competence was used by a local pioneer company in web publication that recruited junior researchers. Another large internet communication company soon arose, partly started by entrepreneurs from the pioneer firm, which spurred the establishment of further ICT firms in Sardinia. The two large firms 'brought about a nebula of spin-offs' (Ferucci and Porcheddu 2006, 218), which were often started by experienced innovators.

The synthetic route (box D) may avoid the potential problem of cathedrals in the desert. However, this route can also lead to small regional ripple effects if advanced firms have their core production and innovation networks to extra-regional partners. Institution building, for example, the development of policy tools in order to strengthen regional clusters and regional university-industry linkages, can contribute to new path creation. It is important to note, however, that regions differ in their authority and capacity for developing and implementing innovation and economic development policies. The Federal type of states, like German and Austrian *Länder*, are example of sub-national regions with large capacity and economic power to design own policy tools, in contrast to unitary nations like Norway where regions have far less policy formulation and implementation power (Cooke et al. 1997).

Virkkala (2007) illustrates several aspects of the synthetic route in her analysis of the emergence and growth of the electronics industry in the rural area of Oulu South (100-200 km south of Oulo) in Northern Finland. The external growth impulses derived in particular from outsourcing by Nokia in the mid-1990s. Two electromechanical firms in Oulo South benefitted from the outsourcing to gain key positions as lead firms in the local electronics industry, small machine workshops changed to production of electronics and electro-mechanics, and new companies were established. The regional industry emerged and developed as part of the wider value-chain as the firms are first of all contract manufactures,

subcontractors and component manufacturers. The small and medium-sized subcontractors acquire knowledge needed for innovation from local sources, such as from their customers among local lead firms and from regional education and knowledge institutes. The lead firms acquire knowledge from clients, in particular Nokia, from extra-regional knowledge organizations and national technology programs. The growth in the electronics industry was also supported by study programs at the local technical college directed to the need of firms and the provision of new buildings through local industrial policy.

Although there are examples of endogenous development of new industries in peripheral areas, we put forward the argument that current conceptual approaches emphasizing endogenous dynamics are more relevant for large cities than for peripheral regions. We argue that for studies of peripheral regions we need to complement these approaches by a theoretical framework that takes into consideration exogenous sources of new industrial development as well as proactive actions taken by key agents, including policy actors, across multiple scales to overcome barriers that hamper regional economic development in the periphery. Policy has a stronger role in nurturing new path development in peripheral regions than in core regions in which path creation occurs more spontaneously from a rich regional knowledge and resource base. In the next section we examine how this hypothesis stands up when subjected to empirical investigation of the rise of new industries in a peripheral region in Austria and one in Norway.

3 New Path Creation in the Periphery: Empirical Case Studies

3.1 New path development through the analytical route: The software and ICT industry in Mühlviertel (Austria)

The research reported in this subsection on the rise of an ICT and software industry in the

peripheral region Mühlviertel in Austria is based on 21 personal interviews with key actors, including the managing director of the 'Software Park Hagenberg' (SPH), managers or executive directors of 15 firms and representatives of five research and educational organizations situated at SPH. This research step has been complemented by an analysis of various reports, policy documents and available statistics.

The rise and evolution of the Software Park Hagenberg

The region Mühlviertel is located in the North of Austria at the borders of the Czech Republic and Germany. It is a less-developed rural area with around 200,000 inhabitants and 73,000 jobs in 2013. Mühlviertel has one of the lowest GDP per capita of all Austrian NUTS 3 regions, amounting to only 58 % of the national average. The area is dominated by agriculture and tourism and has suffered from job losses, unemployment and out-commuting in the past. As shown below, over the past 20 years several research institutes, educational bodies and a relatively large number of firms have settled down in this area, co-locating in the 'Software Park Hagenberg' (SPH), one of Austria's largest and most internationally renowned science park. They have formed a new industrial path in the fields of software and ICT in the periphery.

Mühlviertel belongs to the province of Upper Austria. The rise and further development of the software and ICT industry in Mühlviertel can only be fully understood by considering some distinctive characteristics of Upper Austria's RIS. First, Upper Austria is a traditional industrial region. Employment shares in sectors such as manufacture of rubber, basic metals, fabricated metal products, machinery and equipment, motor vehicles, and furniture are clearly above the national average (Statistik Austria 2014), reflecting the dominance of a synthetic

knowledge base. As demonstrated below, the traditional industries play an important role, acting as clients and innovation partners of some of SPH's tenant firms.

Second, Upper Austria hosts several advanced research bodies such as Upper Austrian Research (owned by the 'Bundesland'), a number of competence centres in various scientific fields and other organizations carrying out applied research. The most important player, however, is Johannes Kepler University Linz (JKU), one of Austria's younger and smaller universities. As shown below, JKU acted as key agent of change and main driving force for the formation of a new path in the region Mühlviertel.

Third, given its status of a 'Bundesland' (province) within the Austrian federalist political system, Upper Austria has strong formal competences to formulate and implement its own regional development and innovation policy. There are rather strong formal and informal linkages between the regional government, business and academia, reflecting a networked character of the RIS (Tödtling et al. 2011, 2012).

An analysis of the innovation capacity of Upper Austria's RIS (Maier and Trippl 2008) has pointed to some weaknesses in the generation and commercialization of new knowledge. Compared to the national average, Upper Austria was found to lag behind in terms of R&D expenditures, availability of R&D talent and the size of knowledge-intensive service sectors. Employment in science-based and R&D-intensive analytical industries was also below the Austrian average, reflecting the legacy of traditional manufacturing industries, the dominance of a synthetic knowledge base and a strong path dependent character of the region's industrial and technological evolution. A closer look on the structure of R&D expenditures reveals a rather weakly developed analytical knowledge base. Maier and Trippl (2008) found a low

importance of basic research and a strong focus on applied R&D activities, mirroring again Upper Austria's specialization in traditional manufacturing industries.

SPH is located in Mühlviertel, Upper Austria's least developed and most peripheral NUTS 3 region. SPH hosts about 60 firms, four institutes of the University of Linz, eight other research organizations, and the Hagenberg Technical College (Upper Austria University of Applied Sciences). More than 1,000 people are working at SPH; around 45 per cent of them are employed by the firms located there, another 18 per cent by the research organizations and 33 per cent by the educational institutes. In addition, more than 1,500 students are enrolled in various degree programmes offered there. Over the last 20 years, SPH has developed a critical mass of scientific and industrial competences in the field of ICT. Thus, one can argue that SPH represents the core of an emerging regional path in the software and ICT industry. In a next step, we analyse the development of SPH, focusing in particular on the conditions, events and actors that triggered its emergence and further evolution.

Origins and early development: Settlement of university institutes

The origin of the new path dates back to the end of the 1980s. The region Mühlviertel lacked any pre-existing capabilities and assets for the emergence of an ICT and software industry at that time. The creation of the new path in the periphery had exogenous sources. It can be traced back to the settlement of the "Research Institute for Symbolic Computing" (RISC) in Hagenberg, a small town in Mühlviertel. RISC was founded in 1987 at Johannes Keppler University (JKU) in Linz, Upper Austria's capital city. JKU could not offer enough space for the rapidly expanding new institute and appropriate facilities in the agglomeration Linz were rare. The head of RISC, Bruno Buchberger, was thus compelled to look for facilities elsewhere. In 1989 RISC moved to an unoccupied renovated medieval castle in Hagenberg,

Mühlviertel. The former governor of Upper Austria persuaded Buchberger to develop ideas about how RISC's settlement could provide economic impulses for the peripheral region. Buchberger developed the concept of a science park that combines business, research and education in the field of ICT and software 'under one roof'. He also became director of SPH and has performed this function until July 2013.

At the beginning of the 1990s two other JKU institutes, FAW (Institute for Applied Knowledge Processing) and FLL (Fuzzy Logic Laboratorium-Department of Knowledge-Based Mathematical Systems), followed RISC to the periphery and moved to Hagenberg. The settlement of these three university institutes was a key triggering event for the creation of a new path. They have played and still play a leading role in the dynamic evolution of SPH. Not only have they spun off new firms, which have chosen SPH as location; the JKU institutes' research capacity has also allured other R&D and educational bodies (see below) as well as new firms to Hagenberg/Mühlviertel. In 1993 the technical college "Upper Austria University of Applied Science" (UAS) was established at SPH, complementing the activities of the university institutes by providing more applied research and teaching at SPH.

The inflow of analytical knowledge through the settlement of university institutes and 'ripple effects' (e.g. in form of spin-offs) have thus led to the formation of a new industrial path in ICT and software in the peripheral region Mühlviertel. University institutes have indeed acted as driving forces of new path creation. Whilst the university performed as leading agent for the rise of the new industry, other actors have played a more supporting role. A local bank ("Raiffeissenbank Oberösterreich") secured the expansion of SPH over the years by acquiring land and investing in real estate development in Hagenberg. Regional policy actors supported new path creation activities by facilitating the establishment of a technical college and funding SPH's development.

Further evolution: Sustainment of the new path through exogenous and endogenous development

From 1999 onwards, SPH has attracted additional research institutes from outside and has created new ones partly from within. In 1999 SCCH (Software Competence Centre) was founded. SCCH is a particularly interesting case. It is a co-operative R&D institute that is jointly run by research institutes and firms and receives financial support within the context of the national 'competence centre initiative'. This policy program provides funding to the nation's best competence centres only. SPH's successful qualification for public funding from this source shows that it has developed a critical mass of high-quality research and industrial competencies, pointing to a growing importance of combining analytical and synthetic knowledge bases within SPH. In the first half of last decade, several research bodies – such as RIPE (another institute from JKU) and UAR (Upper Austria Research) – were also attracted to SPH. Upper Austria University of Applied Sciences has expanded its degree programs in this period. In 2002, also a secondary school in the field of ICT was established at SPH.

More recent steps in the development of SPH include the international attraction of talented students and researchers and a further strengthening of the research capacity. To promote the inflow of highly skilled people from abroad, an international master programme in informatics has been set up in 2006, and five years later an international PhD programme has been initiated. At the end of the past decade, the 'International Incubator Hagenberg Austria' was established at SPH. The incubator is the outcome of the interplay between SPH, tech2b (a publicly funded institution that promotes academic spin-offs and start-ups in Upper Austria), and Raiffeisen-Landesbank Oberösterreich, supported by the regional government. Its main aim is to support new firm formation by foreign students and researchers who have been lured to SPH. Finally, the last years have witnessed a further strengthening and diversification of research activities conducted at SPH. Since 2008 two "Josef Ressel Centers" (publicly

financed research centres that are jointly run by technical colleges and firms) and a Christian Doppler Laboratory for Client Centric Cloud Computing (Christian Doppler Labs are publicly funded research centres to promote long-term R&D co-operation between universities and companies) have opened their doors at SPH. Policy initiatives, both at the regional and national level, have thus played and still do play a major role for SPH's development. This finding is in line with the claim made in the conceptual part (section 2) that new path creation in the periphery is often a policy-supported process.

Since the beginning of the 1990s, when the new path emerged, the number of firms situated at SPH has been growing constantly. In the year 2008, SPH hosted around 40 firms and currently (2014) there are about 60 software and IT firms located in Hagenberg/Mühlviertel. In 2008, one of the authors of this paper has conducted interviews with 15 firms and five research and educational bodies located in the park. Many of the interviewed firms were of small size, employing fewer than 20 workers. Only two firms were larger, employing 82 and 105 workers respectively. The interviewed firms seem to rely strongly on an analytical knowledge base. On average, almost 60 per cent of their employees are working in research and development and the large majority of the firms are highly innovative. More than 60 per cent reported generating radical innovations (development of new software concepts and new product lines) and another 20 per cent were generating mainly incremental innovations (customization of existing software to the particular needs of their clients). The investigated firms were operating in various fields, ranging from the development of high-end hardware technology and related software applications, to software engineering, customization of existing software and IT oriented consulting.

Interviews with research organisations located in SPH included three larger players (employing between 40 and 70 researchers) with varying foci on basic versus applied

research. One of them (a university institute) was almost exclusively oriented on carrying out basic research (95 per cent), while the two others (a competence centre and the research centre of the technical college) were characterised by large shares of applied research (between 80 and 90 per cent). We also conducted interviews with two smaller university institutes (employing around 15 researchers), which had a rather strong orientation on more applied research activities (80 and 50 per cent respectively).

These face-to-face interviews with both research bodies and firms residing in SPH have pointed to well-developed knowledge linkages between these actors. Knowledge exchange between the research organizations and their spin-offs and other tenant firms takes various forms, including formal R&D collaborations and informal networking. There are also knowledge flows through the mobility (recruitment) of highly skilled people within SPH. The interviewed tenant firms reported recruiting highly qualified workers among the graduates of the educational facilities and the researchers of the university institutes present in SPH. Furthermore, the firms located in SPH are connected to each other through supplier-client links and various forms of formal and informal knowledge relations. There is thus evidence for an intense exchange of products and knowledge between the firms located in SPH. Both inter-firm relations and linkages between research organizations and firms seem to be at a rather high level, suggesting that networking is a key feature of the new path.

New path creation and the local and regional context

The impact of the rise and development of SPH on the peripheral region Mühlviertel is ambiguous. On the one hand, SPH has become a major employer in the rural region and has counteracted the depopulation trend by attracting researchers, students, IT workers and entrepreneurs to the area. On the other hand, SPH is an ‘innovation enclave’ in the midst of

the periphery. Our interviews did not point to any knowledge links or economic relations between SPH and other actors located in Mühlviertel.

Whilst there is no evidence for economic and knowledge flows at the local level, such connections do exist with actors at the regional level. Our interviews have shown that SPH has manifold ties to actors and organizations located in other regions in Upper Austria. The newly emerging path based on software and ICT is to some extent related to and complements the old, still dominating one that is based on more traditional manufacturing activities, indicating a combination of analytical and synthetic knowledge bases at the regional level. First, there are various forms of supplier-client relations. Some of the tenant firms have Upper Austria as their main market[1] and in particular the larger IT consultants situated in SPH have linkages to big firms operating in older industries such as steel and automotive. There is thus some evidence of flows of products and services from SPH in Mühlviertel to large traditional firms located in other parts of Upper Austria. Actors belonging to the new path thus contribute to the diffusion of new technologies within the wider region and to the modernization of traditional industries. The penetration of new technologies (electronic control technologies, automation, automatic data collection, etc.) into old industries creates a demand for SPH's tenant firms in form of needs for consulting, new software solutions and implementation of new ICT systems. The challenges associated with bridging ICT and other industries (and their production processes) have resulted in various research, education and policy initiatives in fields such as mechatronics and digital media. Research organizations located in SPH have taken up some of these new areas early and have commercialized their research results through spin-offs. Second, there are manifold university-industry linkages

[1] Interviews have shown that around 30 per cent of the firms serve a global market and another 50 per cent stated that their main geographical market is Austria. For around 20 per cent of the firms Upper Austria is the main market area. These differences reflect the type of products produced by the firms. Consulting and customization are oriented to the regional market, while specialized software is sold at higher spatial scales.

between SPH actors and organizations of the wider RIS. The research organizations located in SPH reported having many R&D co-operations with firms operating in traditional sectors. Indeed, big players active in the steel industry, the automotive sector, the machinery tools industry, the textile industry, etc. are amongst their main industry partners in collaborative research projects. This points to the existence of various opportunities for cross-sectoral knowledge flows and a certain degree of interrelationship between the old path and the new one. Third, SPH appears to have a positive impact on the province's labour market. The educational bodies, research organizations and firms present in SPH attract students and researchers from abroad to Upper Austria whilst at the same time providing employment opportunities for highly qualified talent from the region. In addition, the university institutes and the technical college provide skilled graduates to the regional labour market.

3.2 New path development through the synthetic route: The electronics and software industry in Arendal-Grimstad (Norway)

The analysis of the electronics and software industry in Arendal-Grimstad builds on information from several studies of these sectors by one of the authors of this paper. A first study was conducted at the end of the 1980s consisting of firm interviews and reported in Isaksen (1989). The study did analyze the development of the electronics industry until the late 1980s and characteristics of the production process and the value chain of the firms at that time. The last study was conducted late 2012 and early 2013 and focused on software and ICT firms that are members of a cluster organization in the larger region where Arendal-Grimstad is located. This study focused in particular on innovation activities in firms, and is based on nine firm interviews and a survey with answers from 35 firms (out of a sample of 54 firms). In between, and also later, lies recurrent visits and interviews in the 4-5 largest electronics and

software firms. This type of information is supplemented with statistics, reports and newspaper articles.

The rise and evolution of the electronics and software industry in Arendal-Grimstad

The study area includes the two neighbouring municipalities of Arendal and Grimstad in the most southern part of Norway, about 270 kilometres from Oslo. The two municipalities constitute a common labour market with about 65,000 inhabitants and 30,000 jobs. The electronics and software industry have a bit more than 1,000 jobs in this region (according to official figures from Statistics Norway); about 730 in the electronics industry[2] and 320 jobs in the software industry[3]. The electronics industry has comparatively many jobs in Arendal-Grimstad with a location quotient of 7.7. The industry includes, however, only four firms of some size; Kitron which is the second largest contract producer of electronics products in the Nordic countries, one other large firm (with more than 100 employees) and two medium sized firms (with between 20 and 100 employees). The software industry is much less concentrated in Arendal-Grimstad. This industry is first of all concentrated in the Oslo region in Norway that have about 56 per cent of the jobs in the industry compared with 27 per cent of all jobs. Excluding the Oslo region, Arendal-Grimstad is a bit overrepresented with jobs in the software industry with a location quotient of 1.2. The software industry includes more than 30 firms in this region, of which 28 have fewer than 20 employees and four firms have between 20 and 100 employees (Source: Statistics Norway).

The roots the electronics industry and parts of the software industry are found in two pioneer firms established during the 1960s. As in the case of Mühlviertel, Arendal-Grimstad lacked any capabilities and assets for the development of new industrial paths in the electronics

[2] Defined as sector C26 Manufacturing of computer, electronic and optical products in SIC 2007.
[3] Defined as sector J62 Computer programming, consultancy and related service activity in SIC 2007.

industry in the 1960s. Arendal-Grimstad was a rather stagnant and peripheral region at that time. It had experienced population decline or stagnation for decades. The population increased by less than 1,000 persons, or 2 per cent, between 1890 and 1960, compared with 80 per cent in total in Norway. About 35 per cent of the jobs in the region were found in manufacturing industries in 1960 compared to nearly 37% in Norway (Population census 1960, Statistics Norway). The manufacturing industry in Arendal-Grimstad was however quite traditional. For example, Aust-Agder county (where Arendal-Grimstad had just over half of the population in 1960) had only a bit more than 100 jobs in the electrotechnical manufacturing industry in 1961 (according to Manufacturing statistics from Statistics Norway). This industry constituted an important base for the growth of the electronics industry (as revealed in the Aragon example by Sánchez (1992) and in the Oulo south case by Virkkala (2007)). In comparison, Oslo had 9,000 jobs in this industry in 1961 and the rest of Norway had 5,000 jobs. Although Arendal-Grimstad has a much more 'modern industrial structure' today than in the 1960s, its industry has a lower R&D-intensity than the national average and much lower than in the most R&D-intensive regions in Norway, such as those including the capital region, the national technological university in Trondheim, and in some advanced industrial cluster in other parts of Norway (Research Council of Norway 2014).

Origins and early development: Two pioneer firms

In contrast to the case of Mühlviertel new path creation activities in Arendal-Grimstad have been mostly driven by industry and not by research. Thus, a bulk of the existing jobs in the electronics and software industry in Arendal-Grimstad derives from two firm establishments in the 1960s, and some key events in the further development of the two firms. Since the 1960s the emphasis has changed from fairly simple, standardised and labour intensive production to engineering, development, and administration of complex production. It has also meant an extension of the key knowledge in these industries in the region, from practical

knowledge of how to organise effective production processes in the 1960s and 1970s to gradually more focus on product and software development, business development, logistics and marketing. The dominant knowledge base has been, and still is, the synthetic one, however, it includes currently a much wider set of synthetic knowledge, and also analytical knowledge in some firms.

The first establishment was Elektrisk Bureau (EB) in Arendal in 1962. EB was then an Oslo based company producing telephones and electrical equipment. The company experienced scarcity of labour and space for expansion in Oslo. Many manufacturing firms in the Oslo region restructured their production and expanded outside Oslo during the 1960s and 1970s (Isaksen 1992). The establishment in Arendal was assisted by state politics in two ways; firstly, the building of a new factory in Arendal was supported by means from at that time the Development Fund for Rural Areas (DU), secondly, the main customer for the factory was the state own telephone company (Televerket). The establishment of a factory in a rather peripheral area gave EB goodwill for continued production of telephone sets for the Norwegian marked for the monopolist Televerket. The establishment in just Arendal was somewhat random, but an important pull factor was an untapped reserve of female labour. The female occupational participation (per cent of women aged 15 and over with a profession) in Arendal-Grimstad was 21.5 per cent in 1960 compared to 37.1 in Oslo[4]. For comparison, the male occupational participation was 77.8 per cent in Arendal Grimstad and 81.5 in Oslo. The old industrial development path in Arendal-Grimstad led to mostly male jobs in the area's smelters, pulp, ship and boat building companies, and the area also had a large number of sailors (according to Statistics Norway). Thus, the old path resulted in a female labour reserve which made up one prerequisite for the new development path of electronics production.

[4] Population census 1960, Volume II, Statistics Norway.

The EB factory in Arendal was a typical Fordist organized branch plant (Phelps, 1993). It focused upon production of a few phone models to one large customer. In 1975 the factory had about 900 employees, of which 70-80 were office workers (Isaksen 1989). A main task the first years was training of workers and to create a 'manufacturing culture' among many newcomers to the labour market.

The second pioneer firm, Stratonic, was a quite different type of establishment (in 1966). The founder was a local ship owner, and the firm aimed to develop and produce electronics equipment to ships. As the area lacked competence in electronics development, engineers were recruited from other parts of Norway. The new firm, however, soon experienced economic trouble caused by the fact that development of new products was expensive, and more expensive than intended. Stratonic made a strategic decision in 1971 to focus on contract production. Thirteen persons in the development department started three firms based on the technology and customers from Stratonic. Two of the spin-offs still exist as medium sized firms, however, one of these have been through a number of takeovers and is now part of a larger Norwegian company. The history of the two pioneer firms demonstrates that the emergence of the new path in Arendal-Grimstad had exogenous sources as also seen in the case of Mühlviertel.

Further evolution: Restructuring of the pioneer firms and new path development

From the 1970s onwards much restructuring of the two pioneer firms took place, often spurred by external events. In 1976 EB established a new factory for production of phone sets in Risør, which is a small and remote town about 50 kilometres from the Arendal factory. This establishment was again (as the original establishment of the Arendal factory) seen as part of a social contract by EB. Risør had urgent need for new jobs after several shutdowns,

and the State contributed with much development funds. The Arendal factory kept the more advanced production of phone switchboards. However, the factory lost the tender for switchboards to Televerket in 1983 (which they won again after a few years). The loss was a chock for EB, but it resulted in the upgrading of the Arendal plant to a more complete firm with more developers, engineers and planners in order for the firm to be able to produce other types of products for other customers. The Swedish LM Ericsson was main shareholder in EB and took over the Arendal factory towards the end of the 1980s. Some years later the factory were divided into two units; a development department owned by Ericsson and an electronic contract supplier.

The last firm merged at the beginning of 2000 with the production firm that succeeded Stratonic and with the former telephone factory in Risør to one firm (Kitron) located in the previous EB premises in Arendal. Kitron has become the leading Norwegian electronics manufacturing service provider and the second largest in the Nordic countries (Awaleh, 2008). Kitron has a majority of foreign shareholders. Besides the factory in Arendal, Kitron has two factories in Sweden and one in each of Lithuania, Germany, China and USA. The total number of employees is about 1,100, of which about half is found at the Arendal factory. Kitron delivers service for the entire value chain; it develops, industrialises and manufactures products for professional customers mainly within high complexity and low volume manufacturing. Kitron has thus extended it competence from efficient electronics production into a range of activities, such as development and design, industrialisation, sourcing and logistics, redesign and upgrading of products, and it has changed from contract production to one state owned customer to have numerous global customers and to organise a global value chain.

The development department of Ericsson has caused considerable changes in the software industry in Arendal-Grimstad. In the mid 1990s Ericsson had two development departments in Norway; one near Oslo with 500 employees and one in Arendal with 400 employees. Ericsson decided in 1997 to co-locate the two departments close to the new head office of Telenor (former Televerket) near Oslo; which was the main customer of the two departments. The decision caused large local protest at Arendal, and Ericsson decided to stay in the region much because very few engineers would have moved to Oslo. This demonstrates that the development department had been locally embedded through the employees' experience, in contrast to the earlier standardised production of phone sets which was moved to and from Arendal.

The struggle to keep Ericsson's development department became a wake-up call for the local industry and political system. Local opponents argued that Ericsson's department was important as a locomotive for the regional industry, while leaders of the department asserted that if so, the locomotive is without wagons as the department (in the mid-1990s) have very few local links. The result was that Ericsson moved about 20 kilometres (in the Arendal-Grimstad region) to newly built premises next door to the University of Agder. The department became a key actor in starting bachelor, master and PhD programmes in ICT engineering with a focus on mobile systems. This resulted in the development of more analytical knowledge of mobile communication that supplemented long standing experiences in developing mobile phone technology in the Ericsson department in Grimstad and it has led to more academia-industry links. More local co-operation was initiated, resulting in a cluster organisation for ICT firms (which includes a wider region than Arendal-Grimstad). The Ericsson department has gradually downsized in line with Ericsson's loss of competitiveness on the mobile phone market. The downsizing has, however, led to establishment of several IT consulting companies by groups of former Ericsson employees.

The local and regional context

The establishment and transformation of the two pioneer firms, EB and Stratonic, has contributed in reshaping the economic structure and labour market in Arendal-Grimstad. The core of the production has changed from simple contract production to administration of complex value chains, automated production lines and advanced software production and consulting, which include change from many unskilled production workers to technicians, engineers, planners, and economists. Institution building has occurred at the same time, including new study programmes at the University of Agder tailored to the local software industry, the building of a technology park at the campus area, an incubator located in the technology park, and a cluster organization focusing on regional software firms.

Nevertheless, the local impact of the transformation and institution building is rather limited because many firms link up to partners outside the region. Three of the four electronics firms have national and international owners, all have a national and international market, and have few local suppliers and knowledge links. Many software firms are part of a cluster organization, named Digin, focusing on the regional ICT industry, which has achieved status as an 'official cluster' by the Arena programme in Innovation Norway. The organization consists of about 65 firms and organizations in the larger Agder region. About 50 of the members in the cluster organizations are private ICT-firms, mostly small software firms, and 11 of these are located in Arendal-Grimstad.

The firms in Digin are innovative. The innovation activity first of all builds on the experience of employees and through reusing competence acquired in former projects. A majority of the companies also carry out systematic research and development, i.e. they base their innovation

activity on both synthetic and analytical knowledge. The combination reflects a high education level; just over 80% of the employees have higher education, almost 50% have at least a master degree.

Customers and users are the main external information and knowledge sources in firms' innovation projects. The customers are first of all from Agder and the rest of Norway. The firms, however, find much other knowledge for their innovation activity internationally; central participants in discussion forums on internet and suppliers that contribute with knowledge to innovation processes are mainly found outside of Norway. Use of internal experience and global knowledge to satisfy demand from local customers is a simplified formulation of the innovation pattern in the ICT firms in Digin.

The ICT industry in Agder (and Arendal-Grimstad) is undeveloped as a regional cluster. This reflects little cooperation among the regional ICT firms and with the University of Agder. Digin firms state (in a survey) that other regional ICT firms and regional knowledge organizations are fairly unimportant knowledge sources in innovation projects, and common, local input factors are not developed, according to the firms. Thus, Agder does not seem to have very favorable location factors for the ICT-industry or to have great attraction on the ICT firms in other places. The firms are generally located in Agder to be close to regional customers, which is the case with departments of national ICT-companies that cover the Agder market, or are in Agder because entrepreneurs worked and lived there before they founded their own firm.

4 Conclusions

This paper sought to examine the conditions under which new industries can emerge and grow in peripheral areas. We advanced the argument that recent conceptualizations of regional path creation are not well suited to address this question as they rest too strongly upon experiences of core regions only. They focus on the notion of path development and emphasize that new industries grow out of existing ones through branching processes or through new firm formation by scientists and engineers residing and working in the region. The emergence and evolution of new industrial paths is conceptualized as an endogenous, self-reinforcing process, resulting from the presence of research organizations and scientists, innovative firms operating in related industries, combinatorial knowledge dynamics, an excellent endowment with supporting institutions, continuous branching activities, a vibrant entrepreneurial culture and regional knowledge spillovers.

Such assets for path development may prevail in metropolitan regions and university campus cities. Peripheral regions lack such preconditions. These areas are often specialized in traditional primary and secondary economic activities, have low levels of R&D, knowledge variety and innovation, and thin structures of knowledge and support institutions. This raises fundamental questions about the applicability of models of endogenous path creation to peripheral regions. These models fall short of offering a convincing theoretical framework for analyzing how new paths are created in non-core areas. Peripheral regions are outside current theoretical debates and empirical generalizations of new path creation.

The two empirical case studies discussed in this paper as well as other work on new industry formation in peripheral regional economies have shown that the exogenous development impulses in form of the inflow of new analytical and synthetic knowledge through the inward

transplantation of firms and research institutes from outside can initiate new industrial paths. We also found that policy-makers and other key actors have played a pivotal role in creating and sustaining new industrial activities in the periphery. Finally, building supportive institutional structures from weak basis turned out to be a critical factor. These phenomena tend to be neglected in current models of endogenous, self-sustaining path creation processes.

Both the Austrian and the Norwegian case studies point to a vital role of exogenous sources in new path creation. In Mühlviertel, new path development in ICT and software activities originated from the settlement of research facilities from elsewhere. In Arendal-Grimstad the arrival of a pioneer firm from outside the region and the inflow of skilled engineers from other Norwegian regions essentially triggered the emergence of the ICT industry. The research institutes and the pioneer firms acted as key agents of change in the two cases. They played a role as magnets for the attraction of other actors from outside the region and set in motion endogenous development processes by generating spin-off firms. Our findings thus clearly challenge the strong focus on endogenous sources in current models on new path creation. They are in line with a growing body of work that suggests that new development paths may also have exogenous sources (see, for instance, Martin and Sunley 2006). This account is often overlooked in current debates but it is highly relevant for understanding the rise of new industrial paths in the periphery.

Another common theme linking our two cases is the role of policy in the emergence and growth of new industries. Current accounts of regional path development tend to neglect the role of policy interventions in new path creation (MacKinnon et al. 2009; Martin 2012; Simmie 2012, Morgan 2013, Dawley 2014). Our case studies have revealed that policy actions were pivotal in nurturing new industries in the periphery. Both in Mühlviertel and in Arendal-Grimstad the settlement of ICT and software organizations were seen as instruments

to promote local economic development and generate new economic activity in structurally weak, less favored regions. Supportive public policies have shaped new path development in multiple ways. In Arendal-Grimstad, the national state level provided subsidies to attract firms from outside, acted as main customer of the firms' products and, more recently, engaged in stimulating regional networking and establishing specialized support structures such as a technology park. The software complex in Mühlviertel benefited from continuous public investment by both the Upper Austrian province and the national level in research and education, promotion of science-industry partnerships leading to novel combinations of analytical and synthetic knowledge, support for new firm formation, and a long-term commitment by regional policy actors in conjunction with other regional stakeholders into the development of SPH's infrastructure.

Although our two cases share several commonalities as both reveal opportunities for exogenous-led, policy-supported forms of path creation in the periphery, Mühlviertel and Arendal-Grimstad have followed different trajectories. This highlights that new path creation in the periphery does not only differ from that in core areas. Our findings suggest that the rise of new industrial paths in peripheral areas can take various routes. The software and ICT industry in Arendal-Grimstad has developed through a synthetic route, based on the attraction and restructuring of manufacturing firms. In Mühlviertel new path creation followed an analytical route, building on the establishment of research facilities. Forms of regional embeddedness in the course of their evolution also differ. In case of Mühlviertel, regional embeddedness is based on intensive knowledge exchange within SPH and networking with actors of the wider region, pointing to opportunities for combining analytical and synthetic knowledge and resulting linkages between old and new paths in Upper Austria. In Arendal-Grimstad there is less evidence for regional knowledge circulation, although it has be somewhat increased through the establishment of specially adapted study programmes at the

regional university. Regional embeddedness of foreign-owned firms was based on a highly skilled but immobile local workforce. Software and ICT actors in both Mühlviertel and Arendal-Grimstad have strong links to market and knowledge sources outside the region as is typical for analytical industries (Asheim and Gertler 2005) and peripheral regions.

To summarize, our results clearly challenge uniform, narrowly conceptualized models of endogenous path creation that have played a dominating role in recent theoretical debates on regional industrial evolution. Current conceptual approaches of path development need to be extended in various respects to enhance their explanatory power for processes of path creation outside core areas. As argued in this paper, a widening of the focus by taking not only endogenous but also exogenous sources of new path creation into account and conceptualizations of the state's manifold role in regional development would essentially enhance our understanding of new path creation in regional contexts that exhibit other characteristics than well-performing core areas.

References

Asheim, B. T., Moodysson, J., & Todtling, F. (2011). Constructing Regional Advantage: Towards State-of-the Art Regional Innovation System Policies in Europe? *European Planning Studies, 19, 7*: 1133-1139.

Asheim, B., & Gertler, M. S. (2005). The Geography of Innovation: Regional Innovation Systems. I J. Fagerberg, D. C. Mowery, & R. R. Nelson, *The Oxford Handbook of Innovation* (pp. 291-317). Oxford: Oxford University Press.

Awaleh, F. (2008). *Interacting Strategically within Dyadic Business Relationships. Series of Dissertations 6/2008.* Oslo: BI Norwegian Scool of Management.

Boschma, R., & Frenken, K. (2011). Technological relatedness and regional branching. In H. Bathelt, M. P. Feldman, & D. F. Kogler (eds.), *Beyond Territory. Dynamic geographies of knowledge creation, diffusion, and innovation* (pp. 64-81). London and New York: Routledge.

Christensen, J. L., & Stoerring, D. (2012). Facilitating Cluster Evolution in Peripheral Regions: The Role of Clusterpreneurs. In B. T. Asheim & M. D. Parilli, *Interactive Learning for Innovation. A Key Driver within Clusters and Innovation Systems* (pp. 137-160). Basingstoke: Palgrave Macmillan.

Cooke, P., Uranga, M. G. and Etxebarria, G. (1997), Regional innovation systems: institutional and organisational dimensions. 26, 4–5: 475–491

Dawley, S. (2014) Creating New Paths? Offshore Wind, Policy Activism, and Peripheral Region Development. Economic Geography 90, 1: 91-112.

Feldman, M. P. (2007). Perspectives on entrepreneurship and cluster formation: biotechnology in the US Capitol region. In K. P. Polenske (ed.), *The Economic Geography of Innovation* (pp. 241-260). Cambridge: Cambridge University Press.

Feldman, M. P., & Lendel, I. (2011). The emerging industry puzzle. Optics unplugged. In H. Bathelt, M. P. Feldman & D. F. Kogler (eds.), *Beyond Territory. Dynamic Geographies of Knowledge Creation, Diffusion, and Innovation* (pp. 107-148). London and New York: Routledge.

Ferrucci, L., & Porcheddu, D. (2006). An emerging ICT cluster in a marginal region. The Sardinian experience. In P. Cooke,& A. Piccaluga (eds.), *Regional Development in the Knowledge Economy* (pp. 203-226). Londan and New York: Routledge.

Fontes, M. (2006). Knowledge access at distance. Strategies and practices of new biotechnology firms in emerging locations. In P. Cooke, & A. Piccaluga (eds.), *Regional Development in the Knowledge Economy* (pp. 135-159). London and New York: Routledge.

Garud, R., Kumaraswamy, A., and Karnoe, P. (2010). Path Dependence or Path Creation? *Journal of Management Studies*. 47, 4: 760-774.

Isaksen, A. (1989). Elektronikkbedrifter og lokal industriutvikling. *Nordisk Samhällsgeografisk Tidskrift, 9*: 46-55.

Isaksen, A. (1992). The changing geography of manufacturing employment in the post 1970 period: Tentative interpretations of the Norwegian case. *Norsk Geografisk Tidsskrift, 46*, 2. 63-74.

Isaksen, A. (2014) Industrial development in thin regions: trapped in path extension? Journal of Economic Geography, first published online July 9, 2014 doi:10.1093/jeg/lbu026

Isaksen, A. and Trippl, M. (2014) Regional industrial path development in different regional innovation systems: a conceptual analysis. Papers in Innovation Studies, No. 2014/17, CIRCLE, Lund University

Kalsaas, B. T. (2011). Business Interaction and Knowledge Creation Illustrated by a Supply Chain from the Offshore Oil- and Gas Industry. *The IMP Journal, 5, 2*: 107-121.

Karlsen, J., Isaksen, A., & Spilling, O. R. (2011). The challenge of constructing regional advantages in peripheral areas: The case of marine biotechnology in Tromsø, Norway. *Entrepreneurship & Regional Development 23, 3*: 235-257.

Leibovitz, J. (2004). ‘‘Embryonic’’ knowledge-based clusters and cities: the case of biotechnology in Scotland. *Urban Studies*, 41, 5/6: 1133–1155.

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.

Manniche, J. (2012). Combinatorial Knowledge Dynamics: On the Usefulness of the Differentiated Knowledge Base Model. *European Planning Studies, 20, 11*: 1823-1841.

Martin, R. (2010). Roepke Lecture in Economic Geography - Rethinking Regional Path Dependence: Beyound Lock-in to Evolution. *Economic Geography, 86, 1*: 1-27.

Martin, R. (2012). (Re)Placing Path Dependence: A Response to the Debate. *International Journal of Urban and Regional Research*, 36, 1: 179-192.

Martin, R., & Sunley, P. (2006). Path dependence and regional economic evolution. *Journal of Economic Geography, 64, 4*: 395-437.

Maskell, P., & Malmberg, A. (2007). Myopia, knowledge development and cluster evolution. *Journal of Economic Geography, 7*: 603-618.

Mayer, H. (2013). Firm Building and Entrepreneurship in Second-Tier High-Tech Regions. *European Planning Studies*, 21, 9: 1392-1417.

Morgan, K. (2013). Path dependence and the state. In P. Cooke (ed.), *Re-Framing Regional Development* (pp. 318-340). London and New York: Routledge.

Ndonzuau, F. N., Pirnay, F., & Surlemont, B. (2002). A stage model of academic spin-off creation. *Technovation, 22*: 281-289.

Neffke, F., Henning, M., & 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.

Petrov, A. N. (2011). Beyond spillovers. Interrogating innovation and creativity in the peripheries. In H. Bathelt, M. P. Feldman & D. T. Kogler (eds), *Beyound Territory. Dynamic Geographies of Knowledge Creation, Diffusion, and Innovation* (ss. 168-190). London and New york: Routledge.

Phelps, N. A. (1993). Branch Plants and the Evolving Spatial Division of Labour: A Study of Material Linkage Change in the Nothern Region of England. *Regional Studies, 22, 2*. 87-101.

Rees, K. (2005) Collaboration, innovation and regional networks: evidence from the medical biotechnology industry of Greater Vancouver. In A. Lagendijk & P. Onias (eds), Proximity Distance and Diversity. Issues on Economic Interaction and Local Development, pp. 191–215 (Aldershot: Ashgate).

Research Council of Norway. (2014). *Det norske forsknings- og innovasjonssystemet - statistikk og indikatorer.* Oslo.

Sánchez, A. M. (1992). Regional Innovation and Small High Technology Firms in Peripheral Regions. *Small Business Economics, 4*: 153-168.

Simmie, J. (2012). Path Dependence and New Technological Path Creation in the Danish Wind Power Industry. *European Planning Studies*, 20, 5: 753-772.

Tanner, A. (2014) Regional branching reconsidered: emergence of the fuel cell industry in European regions. *Economic Geography*, 90(4): 403-427.

Tödtling, F., & Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy appraoch. *Research Policy, 34*: 1203-1219.

Trippl, M., & Tödtling, F. (2007). Developing biotechnology clusters in non-high technology regions - The case of Austria. *Industry & Innovation*, 14, 1. 27-47.

Varis, M., Tohmo, T. and Littunen, H. (2014). Arriving at the Dawn of the New Economy: Is Knowledge-Based Industrial Renewal Possible in a Peripheral Region? European Planning Studies, 22, 1: 101-125.

Virkkala, S. (2007). Innovation and Networking in Peripheral Areas - a Case Study of Emergence and Change in Rural Manufacturing. *European Planning Studies, 15, 4*: 511-529.