Universities, innovation and competitiveness in regional economies

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Abstract: The paper examines how university strategies and regional development paths co-evolve. The aim is to contribute to the discussion on how regions in a path dependent way transform over time, and how local universities may take on differentiated roles in those processes. Although regional development is path dependent, I discuss how regions may overcome such interties, by illustrating how universities contribute to create new, transform established, or extend existing economic regional development paths through collaboration with the regional industry. The study confirms that universities take differentiated roles depending on what kind of industrial transformation is taking place in the respective regional economies. Four different regional development paths emerge: new path creation, paths new to the region through transplantation from elsewhere, path renewal through diversification into related industries, and path extension through upgrading of existing industries. The findings draw on studies of universities and regional firms in three regions in Norway.

Keywords: innovation; industry-university collaboration; path creation; path transplantation; path diversification; path extension; university strategies; regional innovation system; RIS; regional development; smart specialisation.


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1 Introduction

Evolutionary economic geography is concerned with the geography of economic novelty (innovations, new firms, new industries), and how the spatial structures of the economy emerge from the micro-behaviours of economic agents (Boschma and Martin, 2010).
From this perspective, innovation is traditionally seen as the consequence of interaction between firms in the same or nearby locations. Firms are considered to be the outcome of their history, and their future trajectory is shaped in a path dependent manner (Martin and Sunley, 2006). In this context, regions can be conceptualised as selection environments within which evolutionary processes evolve. Various agents operate in these selection environments: firms, financial institutions, government agencies and universities, to name some. This paper concentrates on two classes of agents: firms and universities, and the relationships between them. The capability of firms to innovate is strongly influenced by the educational and research environment in which the firm conducts its activity. At the same time, the strategies of the universities are influenced by the development stage of industries in the respective regions. The emergent properties of these agents and the regions in which they are localised co-evolve, and lead to different trajectories of economic development over time and space.

The key focus of evolutionary economics is on the processes and mechanisms by which the economy self-transforms itself from within (Witt, 2003). Evolutionary theories are dynamical with attention to change and novelty. Novelty is the ultimate source of self-transformation, based on innovation, knowledge and learning. Cognitive, social, geographical and institutional processes mediate the evolution of the economic landscape. Imperfect understanding and imperfect path-dependent learning entail persistent heterogeneity among agents (Dosi, 2013). A major point of departure in the development of evolutionary economic geography has been the concept of path dependency (Martin and Sunley, 2006). Generally, path dependence examines how a population of heterogeneous agents evolve through interaction among themselves and with the environments they help to shape. The concept of path dependence has found its way into a growing body of empirical work in economic geography. It has been deployed in discussions of the persistence of regional disparities, of the ‘lock-in’ of regions to particular paths, and the revival or reinvention of regional clusters.

It has been argued that regions pursuing their own developmental paths have only limited ability to change course (Heidenreich, 2004). This contention is associated with the fact that studies of regional innovation systems (RIS) rarely discuss how these systems transform over time. The dynamic development of the system is less reflected upon (Doloreux and Parto, 2005; Tödtling and Tripl, 2013). I explore how universities through differentiated strategies and collaboration with regional industry may create, transform or extend these regional development paths, and how those strategies are shaped by the developments in the respective regions. Thus, the paper extends that literature by showing how the regional development paths and the strategies of the universities co-evolve. Forces of inertia do of course exist, but regions do evolve over time and the universities play a role in that evolution.

In this paper, I use the concept of path dependence to address a fundamental question confronting all advanced societies: how can local communities prosper in the rapidly changing and increasingly open global economy? Based on the discussion above, I argue that strengthening local capabilities for innovation, by which I mean the ability to conceive, develop and produce new products and services, to deploy new production processes or to improve existing ones; is a viable option. More specifically, the purpose is to indicate how the local universities may contribute to strengthening those capabilities. The European Union has invoked the concepts of ‘smart specialisation’ (European Union, 2011) and ‘constructing regional advantage’ (European Commission, 2006) to address
the same challenge. This paper presents one strategy for regions to become ‘smarter’ and potentially achieve a competitive advantage: more extensive collaboration between the university and regional industry.

Furthermore, the purpose is to provide a dynamic perspective of regional development that extends over periods of years or even decades. Boschma and Martin (2010) express a need for improved understanding of “where new paths come from, and why they emerge where they do” (p.8). I hope to provide a partial response to that call. With perspectives from evolutionary economic geography and triple helix, I offer a study at the micro level of a crucial agent in that context: the university and their strategies as a regionally engaged actor.

I include a discussion of the planned and emergent strategies (Mintzberg and Waters, 1985) of the universities, and argue that they need to acknowledge the development paths of their respective regions. Planned and deliberate strategies may or may not be realised. The outcome of university strategies depend on how they are linked to, and associated with, the respective regional transformation processes. Universities may deliberately take over a proactive role in defining new paths, adapt to changing industrial structures and markets, or take over a more reactive role.

Much of the hard work needed to cope with the challenges of globalisation: building infrastructure, develop relevant labour markets matching the need of the industry, improving educational performance, and strengthening the collaboration between public institutions and firms, is often better undertaken at the local level than by centralised directives (Hatakenaka et al., 2011). Recently OECD (2013) argued that “place matters for innovation, as it is regions and cities that compete to be hubs in the global networks”.

In the context of regional development and prosperity, regional actors have realised the importance of innovation and a workforce with high and relevant education, and turned to the contributions of regional universities. In the knowledge economy, highly educated talents and new ideas are the most valuable assets, and may constitute a basis for regional competitive advantage. The presence of universities may also attract other key economic resources to the region, either by attracting new firms or by securing that existing firms prosper and develop in the region. At the same time, companies are looking more closely to universities as contributors to their research and product and service development. Corporate interest is stimulated by the growing commercial relevance of university research both in emerging and mature industries.

The paper proceeds as follows. The next section presents relevant theoretical perspectives and concepts. Evolutionary theory on path dependency is the point of departure. The concepts include RIS, the triple-helix model and different perspectives on the role of universities. Section 3 explains the research methods and data sources, and Section 4 presents the results highlighting four different regional development paths and the respective roles of universities. These results are further discussed in Section 5, while Section 6 presents some conclusions and learning potential for other European universities, and ends with some recommendations for further research.

2 Theoretical perspectives

The impact of universities on regional development can be studied from various perspectives. In economic geography, RIS have attracted much attention from policy makers as well as academics in recent years with several strands of literature. The
concept has been defined broadly as the set of firms, organisations and institutions which influence the innovative behaviour and the regional economic development (Cooke et al., 2004; Cumbers and McKinnon, 2004; Iammarino, 2005). From an industrial viewpoint, Michael Porter introduced the notion of ‘clusters’ as localised industrial agglomeration as key to industrial competitiveness, further emphasising the importance of firm interactions with supply chains and with public science (Porter, 1990, 1998). The concept of ‘clusters’ caught the imagination of policy makers as well as managers and helped popularise the idea that ‘regions’ matter for competitiveness. A closer examination of successful industrial districts such as Silicon Valley, Emilia-Romagna and Baden-Württemberg led to the idea that local interactions played a special role in such regions (Piore and Sabel, 1984; Saxenian, 1994) and ‘regions’ was soon proposed as an alternative to the national level of analysis (Acs and Varga, 2002; Cooke, 1992). Economists joined the debate with their renewed interest on economic geography and the role of geographic specialisation (Krugman, 1991), and ‘knowledge spill over’ was proposed as key mechanisms for agglomeration dynamics (Audretsch and Feldman, 1996; Jaffe, 1989).

There has been a growing understanding that the diverse nature of regions may preclude one-size-fits-all solutions or generic ‘best practices’ for RIS, and the need for policy recommendations to be differentiated is increasingly recognised (Cooke and Schienstock, 2000; Isaksen and Karlsen, 2010; Tödtling and Trippl, 2005).

This view is also applicable for studies of industry-university relations, where a comprehensive literature has evolved during the latest three decades (Gunasekara, 2006; Lester, 2005; Mowery and Sampat, 2005; Westnes et al., 2009). Governments both in the industrialised and emerging economies have launched initiatives to link universities to industrial innovation (Westnes and Gjelsvik, 2010). This has spurred many stories on how universities should adapt to this ‘third mission’ (Bok, 2003; Geiger, 2004; Svensson et al., 2012). This third mission has been conceptualised in several ways. The concept of the entrepreneurial university argues that universities increasingly complement their traditional missions of research and education by a third one, commercialisation. Universities are expected to contribute to regional growth by commercialising their own knowledge through spinoffs, patents and licensing (Grimaldi et al., 2011). This expectation is underlined by the fact that universities are explicitly measured and rewarded by national policies according to this concept.

The RIS approach mentioned above conceptualises the role of the university differently. Here universities are key actors in a region’s knowledge infrastructure in which they also take on vital bridging roles between providers and users of knowledge. The set of knowledge transfer mechanisms are much broader than commercialisation. Thirdly, the ‘engaged university’ is a concept invoked to describe the university’s intent to focus on regional needs (Uyarra, 2010). The engaged university demonstrates a localised developmental role and is actively seeking to shape regional identity (Breznitz and Feldman, 2012). In the context of this paper, the university will endeavour to shape and identify paths.

One strand of research focuses on the emergence of university-industry-government interactions (Etzkowitz and Leydesdorff, 1997). In this so-called triple helix perspective, universities play a role as a source of firm-formation and regional development in addition to its traditional role as a provider of trained persons and research-based knowledge. According to Etzkowitz and Klofsten (2005), the triple helix model comprises three elements. First, the university takes a more prominent role for
innovation. Second, collaborative relations among the three institutions are increasingly the outcome of interaction rather than a prescription from government. Third, the boundaries between the institutions become blurred as each institution takes the role of the other. Universities commercialise products and services, and firms carry out high quality research. Empirical studies of the triple helix indicate that the synergy between university and industrial R&D enhances the sustainability if firms, and suggest that university R&D plays a vital role as a mediator among the three spheres in the triple helix system (Kim et al., 2012). Campbell et al. (2004) have documented that consulting relationships, research grants or contracts, and researcher training represents major points of intersection between university and industry. The government and industry relations typically relates to public financing and equity positions. In this case, government has created mechanisms to ensure their ownership roles.

This paper adds to the RIS and triple helix literature an evolutionary perspective attempting to understand several economic phenomena, from microeconomic behaviour – in this case in firms and universities – to features of industrial structures and dynamics. Thus, I introduce a dynamic view of regional economies with attention to individual economic agents like firms and universities. These dynamics are shaped by interactions among heterogeneous agents using their capabilities to learn, adapt and innovate with respect to their understanding of the region and institution in which they operate, the technologies and knowledge they master, and their behavioural repertoires (Dosi, 2013). Learning among the agents involved, entail persistent heterogeneity due to different preferences and resources, the models of the world they hold, and the differentiated development paths of their regions. These paths emerge as a collective and often unintentional outcome of micro-interactions and heterogeneous learning. Hence, institutions like universities and the collaboration patterns with the industry are partly the result of purposeful strategies and priorities, partly the unintentional outcome of collective interactions and the interplay of agents’ experiences and learning.

Inspired by Sydow et al. (2012) a path is defined as the course of interrelated events in which a technological, institutional and/or organisational option gains momentum in time-space. A path includes firms, a dominant technology platform and an institutional arrangement (regulation/legislation, policies and supporting organisations like universities and research institutions). In line with evolutionary theory, the development of a path underlines the twin processes of continuation and change (Jakobsen et al., 2012). In evolutionary economics, history matters. The issue is how much history actually matters, how dependent is the path dependency of the history. David (2001) suggests the following categorisation: weak history, moderate history, and strong history. Partly in correspondence with this gradation, I will use four categories which have emerged in economic geography in the past decade: new path creation, path transplantation, path diversification and path extension (Isaksen and Tripl, 2014; Lester, 2005).

The first type of process is the emergence of an industry with no technological antecedents; it entails the local creation of an entirely new industry in the region. This is the kind of process often associated with universities, with the development of the personal computer and the internet in Silicon Valley as the prime example. It should be noted, however, and as expected from evolutionary theory, that also in these cases industrial precursors may be identified elsewhere. The emergence of an industry entirely without antecedent is a very rare event. Creation of a new industry inevitably involves a mixture of deliberate agency and accidental and unintended emergence. Entrepreneurs
are aware of potentially emerging paths, and invest in and bet on them. In the initial phase, the entrepreneur has only limited insight in the selection environment, hence the outcome of their actions is not always as intended.

Second, a new industry to the region may be an established industry from elsewhere imported and transplanted in the region. In this case, the primary mechanism is the importation of an industry from elsewhere. The success of the transplantation is more dependent on imitation and knowledge and technology transfer from outside the region, rather than innovation. It requires absorptive capabilities both at the firm and the institutional level. In terms of evolutionary economic geography, this transition is the result of an ‘external shock’. From the perspective of the region, this category may look similar to the first, but the university as well as the firms take on other roles.

The third category refers to transitions in which an existing industry in a region redeploy its core technologies and knowledge in order to lead or assist the emergence of a related new industry. This path may evolve when an existing industry goes into decline because of shrinking markets or outdated technology or business models. Examples are oil and gas companies diversifying into renewables, or traditional fisheries evolving into fish farming.

The fourth category applies to the upgrading and extension of an industry through the infusion of new production technologies and business models or the introduction of product or service enhancements. It entails more incremental innovation than the radical or potentially disruptive innovations in type 1 transitions.

3 Research methods

The paper is based on semi-structured interviews with firms and universities involved in collaborative relations in three Norwegian regions: Stavanger, Tromsø and Bodø. These are all relatively small regions that host a university with explicit ambitions of contributing to industrial development through collaboration with firms. The three universities were established rather recently with the purpose to contribute to regional development, making them most relevant to the study of the roles universities actually take in that respect. However, both the industrial structure of the three regions and the research profiles of the universities differ across the cases in order to ensure that the results are not limited to a single industry or type of university. These differences are documented and discussed in Sections 4.1–4.5. A common thread for the three universities is their ambition to contribute to a regional industry and social development. Furthermore, Norway is characterised by high level of government intervention, thus motivating a triple helix perspective.

The characteristics of the three universities are presented in Table 1.

The three universities have a relatively short history. Norwegian universities are government-owned. Nevertheless, their birth history is different. The University in Tromsø was established by the state in order to initiate activities and employment in the most peripheral and industry poor region. In Stavanger, local industry financed the then college to qualify for university status, and in Nordland the local authorities (the county) shouldered that role. External funding is an indicator of the universities’ third role, which may be split in two to further indicate how this role is carried out. A large share of financing from the Norwegian Research Council (NRC) suggests a stronger focus on
basic research, whereas the industry share of contributions and contract research (CCR) signals a stronger orientation towards applied/contract research for industry. This variety of characteristics is reflected in the different strategies and regional contributions explicated in detail in the result section.

Table 1  Overview of the universities (data from 2011)

<table>
<thead>
<tr>
<th>University of Stavanger (UiS)</th>
<th>University in Nordland (UiN)</th>
<th>University in Tromsø (UiT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>'Founding fathers'</td>
<td>Regional industry</td>
<td>The state</td>
</tr>
<tr>
<td>Faculties</td>
<td>Social science, arts</td>
<td>Health, science and</td>
</tr>
<tr>
<td></td>
<td>and education, science and</td>
<td>technology, social</td>
</tr>
<tr>
<td></td>
<td>technology</td>
<td>science, bioscience and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fisheries</td>
</tr>
<tr>
<td>No students (2013)</td>
<td>10,000</td>
<td>12,500</td>
</tr>
<tr>
<td>No faculty (2013)</td>
<td>1,300</td>
<td>1,300</td>
</tr>
<tr>
<td>Income, total (NOK m)</td>
<td>1,130</td>
<td>2,483</td>
</tr>
<tr>
<td>External financing, total (NOK m)</td>
<td>86</td>
<td>487</td>
</tr>
<tr>
<td>External financing as % of total income</td>
<td>7.6%</td>
<td>19.6%</td>
</tr>
<tr>
<td>External financing from the NRC (NOK m)</td>
<td>24</td>
<td>177</td>
</tr>
<tr>
<td>Industry share of CCR</td>
<td>64.1%</td>
<td>36.8%</td>
</tr>
<tr>
<td>Completed PhDs</td>
<td>28</td>
<td>114</td>
</tr>
</tbody>
</table>


The main methods of data collection in each location was in-depth interviews with university researchers and administrators, business managers, local economic development officials, and TTO managers, using semi-structured questionnaires common for all regions. The members of the project team were mainly recruited from each of the three universities. Their historical and contextual knowledge of key players in the region – both in academia and business - was particularly helpful for the research. At the same time, we made conscious efforts to ensure validity and neutrality of our analysis (Markusen, 1999). Two interviewers conducted all interviews jointly, at least one of which was external to the institution in order to ensure reliability. The project manager (from Stavanger) took part in all interviews, including those in Tromsø and Nordland, to ensure consistency in the interpretations of the results. Likewise, the representative from Tromsø assisted with interviews in Stavanger. In addition, the project team included a member from The University of Lund, Sweden. All interviews were taped and transcribed to secure comparability and sharing of data within the project team. The interviews were then analysed in a joint workshop with the full project team.

We conducted interviews with firms identified by the universities as collaboration partners, but which had varying degrees of relations to these universities. The interviews were carried out in spring and fall 2013, and each interview lasted 90 minutes on average. The guideline questions included how the university carries out its “third mission”, its regional strategy and its implementation, incentives and mechanisms for regional
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collaboration, if and how regional ambitions have evolved, and priorities of industries (if any). Potential dilemmas related to regional priorities and how the university broadly supports entrepreneurship were discussed. The final question concerned what the region would have been without the university. In each location, we conducted about an equal number (5-7) of business and university representatives, respectively. In principle, we used the same questionnaire for both categories of respondents, as we wanted the opinions and reflections from both sides to the same issues. There was some variation as to reflect the specifics of the university and the companies, respectively. To give an example: By asking the same questions we were able to differentiate between the intended, official strategy of the university and the realised strategy, as perceived of those concerned, the industry. The interviews were augmented by using university statistics, archival materials, and strategy documents in the respective universities.

4 Results

Our data documents three major findings:

a four different regional development paths or transitions are documented, and the contribution of the universities is adapted to those paths

b the regional paths are to a large extent defined by the region’s comparative advantage and endowment of natural resources

c the universities do indeed have a strategy to contribute to a regional business development.

These strategies are partly intentionally planned, partly the result of repeated and distributed interaction between faculty and industry.

The regional ambitions are reflected in the formal strategies of the university. In their action plan for collaboration with the industry, the UiS states that “our ambition is to strengthen UiS as a regional and national actor with international significance within education, research and innovation”. And the management of the University of Nordland states that “The University in Nordland is unique as a university in and for Nordland, and has a particular responsibility for research and education in Nordland to ensure a regional social and industrial development”. Furthermore, the world’s northernmost university, UiT, proclaims that “our vision is to create a national and international powerhouse to advance competence, growth and innovation in the northern areas. With our location it is natural to focus on knowledge about the region’s nature, culture and society”.

By themselves, these strategies are no more than performance goals or statements of desire. A good strategy contains a diagnosis of the challenges at hand, a guiding policy for dealing with the challenges, and a set of coherent actions designed to carry out the policies (Rumelt, 2011). As argued in the introduction, these formal and deliberate strategies may or may not be realised. I argue that the outcome of university strategies depend on how they are linked to and associated with the respective regional transformation processes. Furthermore, realised strategies are not always deliberately planned, they emerge and reflect the development or transitional paths of their respective regions. This is reflected in several ways. I find examples where the university takes a proactive and leading role in developing a new industry in the region. In other instances,
the university aligns its strategy to the paths developed by the regional industry. I do not claim, of course, that universities develop regional paths on their own. They contribute to a varying degree in a triple helix way together with the industries and national or regional government.

Four different regional development paths emerge, as described in Table 2 and in line with Lester (2005) and the recent literature on differentiated path trajectories presented in Section 2.

<table>
<thead>
<tr>
<th>1</th>
<th>Creating new, emerging industries</th>
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<tbody>
<tr>
<td>2</td>
<td>Transplantation of an industry from another nation/region</td>
</tr>
<tr>
<td>3</td>
<td>Diversification of an industry into related industries</td>
</tr>
<tr>
<td>4</td>
<td>Upgrading and extension of existing industries</td>
</tr>
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</table>

The differentiated roles of the university in defining or assisting the four paths will be explained below.

4.1 The creation of new industries – UiT

The University of Tromsø is a prime example of indigenous business development. The challenge is to develop a peripheral region way up north, characterised by a small industrial sector both in absolute and relative terms. With a modest industrial base, the university takes on a more proactive role than in the two other cases, by creating new firms based on world leading research. Hence, the university is bent on delivering basic research in combination with resources typical for this particular region.

The university exploits its unique location (at nearly 70° north, the same latitude as Alaska) in the northernmost region and act as an entrepreneur based on competitive advantages from the natural resources in the arctic region. With financial support from the Norwegian Research Council, the university hosts a so-called Centre for Research-Based Innovation within marine bio prospecting, established to analyse and characterise bioactive compounds from arctic marine organisms. This is a long-term endeavour requiring basic research to understand processes. The centre hosts four firms that aim to commercialise products from the research activities, including the development of antioxidants and anti-inflammatory components to cardiovascular diseases and an entirely new class of cancer drugs. One of the firms in the consortium has introduced a blockbuster pharmaceutical product based on the first omega-3 derived prescription drug approved by the European and US regulatory authorities. Another firm develops new solutions within wound care, cancer therapies and other immune related disease areas based on cold adapted marine enzymes.

Another example is Kongsberg Satellite Services AS (KSAT), a commercial Norwegian enterprise uniquely positioned to provide ground station and earth observation services for polar orbiting satellites. With three interconnected polar ground stations; Tromsø at 69°N, Svalbard (SvalSat) at 78°N and Antarctic TrollSat Station at 72°S, KSAT operates over 60 antennas optimally positioned for access to polar orbits. KSAT supports more than 60 satellites, allowing them to provide earth observation data and services to a wide range of customers. No other university in Norway has prioritised the needs of KSAT. In recent years, UiT has relocated resources towards the demands of the company. The most important contribution from the university is access to people, and its
knowledge and methods to analyse data. The science-based knowledge at UiT can explain why satellites can observe oil spills on the ocean. The firm acts as a link between the demands of the customers and the knowledge at the university: “we understand the needs of our customers, and how they may be connected to professors at the university”. Informal relations are important; many firms collaborating with the university, originated from the university. “That’s how academia works”, says one informant.

Commercialisation of applied basic research sometimes goes beyond the natural resources of the arctic region, typically related to individual professors’ unique expertise. An illustration is based on experimental computer science that evolved into a firm active in wireless data, network security and distributed architecture for intranets and the internet, which later was Fast Search & Transfer, which still later was acquired by Microsoft. Presently, Microsoft is in the process of locating its big data analytics to Tromsø. Another example is a greenfield firm – and a sole supplier – specialising in analysing drugs’ impact on the liver.

On the other hand, the University in Tromsø has taken a minor role in research to support the evolution and growth of existing businesses. The lack of research effort is probably linked to the fact that the region has a smaller share of private firms than other city regions. Public jobs outnumber private jobs; the university has responded by educating people to the public sector. Consequently, in the private sector the mission of UiT seems to be the creation of new business based on university research. Consistent with this, managers of established firms perceive the university as non-cooperative. Paradoxically, the openness and commercial orientation of the university complicates the collaboration with existing firms. One informant exclaims: “it has become too complicated with contracts and overhead; and they insist on ownership to all commercial rights. They want to patent their discoveries and establish a company with the entrepreneur as manager”. This situation is unintended from the perspective of the university. It may rather be argued that it is a collective, but uncoordinated consequence of the university’s preference for, and insistence on, basic research. In other words, this is an example of an emergent strategy (Mintzberg and Waters, 1985).

The university contributes to this path through cutting edge basic research. In the words of rector: “we are strongly committed to our role of basic research. Experience tells us that the best basic researchers come up with the most path-breaking ideas”. The university helps to create an industry identity through organising international conferences and workshops, and by conferring legitimacy to nascent companies.

4.2 Transplantation from elsewhere – UiS

From the perspective of the region, this type of process is similar to the one above as it entails a development new to the region, but the role of the university is different. The best example from our cases is the Stavanger region. The region hosts an extensive oil and gas cluster, which has grown extensively since its local conception in the late 1960s. At the time of the oil discoveries in the sea outside Stavanger, the region had no knowledge of oil operations. Based on our interviews and historical sources (Hatakenaka et al., 2006) the UiS (then a regional college) consistently attempted to fill a critical gap in the supply of personnel to the growing industry. These efforts cannot be appreciated without the link to national policies. The government systematically evaluated and rewarded foreign oil companies who were contributing to domestic capacity building. As
part of these policies the foreign oil companies had to recruit locals and transfer knowledge to them. The national and regional authorities made concerted efforts to develop local capabilities in the oil and gas industry and to concentrate industry-related institutions in Stavanger. What was to become the University in Stavanger (UiS) was created coincident with the founding of the oil industry in the region.

Established in 1969 as a regional college, UiS always saw its role as serving the educational needs of local industry, and developed key capabilities in relevant fields such as petroleum engineering. Over time, the institution first became a university college and then a university by virtue of its track record with and support from the petroleum industry. An interesting aspect of the situation in Stavanger was the close alignment between UiS, the regional authorities, and industry, which exerted considerable pressure on the national government over a long period to realise the regional goal of establishing a true university in Stavanger. Petroleum-related research and education was a decisive factor in those efforts, which succeeded in 2005 when UiS became the fifth university in Norway. In effect, the oil and gas industry spearheaded the establishment of the university. Its contribution has shifted upwards, first to master level education and later to the education of PhDs, all in application oriented fields of critical relevance to the industry.

Supplying a rapidly growing industry with competent employees was the first challenge. Strategically, the Stavanger College had no intention of copying universities or other technical colleges. It sought to differentiate itself from other players by combining basic scientific disciplines such as mathematics, geology and chemistry with more applied technological disciplines like drilling and well completion. So the college managed to build an education program that had a scientific and theoretical knowledge base with practical applications superimposed. The industry took actively part in building the programs, often taking part in teaching activities. Both the university and industry testify that the UiS positioned itself between the traditional universities and the engineering colleges. UiS added an applied perspective to the basic disciplines, and is regarded even today as having a greater application orientation than its peers.

Many resource rich countries stay poor because of so-called grabber friendly institutions like corruption, weak rule of law and malfunctioning bureaucracy (Mehlum et al., 2006). Norway offers a production and efficiency friendly set of institutions that facilitated the development of a continuously more competitive local supply industry, thus avoiding the resource trap. In order to succeed with that, a region needs to offer a highly educated workforce with relevant skills. The other essential challenge was to build an absorptive capacity in firms quickly in order to transplant the new industry firmly in the region, and further down the road supply the industry with relevant, applied research to overcome challenges related to geology foreign to the established, mainly US oil companies. The combination of Norwegian policies and the efforts of UiS to build local capabilities were decisive in the further path development of the industry, including a world leading supplier industry.

In summary, the main contribution of a university in this path development is very different from the first path. In this case, the university (then a college) educated a relevant regional/national labour market. The curriculum was adapted to the industry, with the active support from the same industry, and the research is applied to the specifics of the Norwegian shelf.

Interestingly, the UiT may take on a similar role as the oil and gas industry presently is in the process of establishing itself firmly in the northern parts of Norway. UiT recently
became host to a government-funded centre for petroleum research in the Arctic, in which eighth oil companies participate. A new path may evolve in the northern regions, and actors there may be able to learn from Stavanger. A transplantation of the oil and gas industry from Stavanger (and the rest of Southern Norway) is the most likely scenario.

4.3 Diversification into related industries – UiN

This third category refers to transitions in which an existing industry in a region redeploy its core technologies and knowledge in order to lead or assist the emergence of a related new industry. The university in Nordland and its close interactions with the emergent fish farming industry serves as a good example. Over the past decades, the university has supported the transition from traditional fisheries to fish farming, and the industry was instrumental in the efforts of the then college to climb the academic ladder to become a university.

In order to qualify as a university, the college in Nordland needed to develop four education programs at the doctoral level, two of which should be of great regional impact. Aquaculture and bioscience was a natural choice, both of historical reasons and access to natural resources. The county of Nordland offers the longest coastline in Norway with strong roots in the traditional fishing industry. Over the past four decades, these traditions have diversified into fish farming. About 1/4 of the salmon farming in Norway takes place in Nordland. In principle, fish farming has historical antecedents to China 4,500 years back in time. From an industrial perspective, however, fish farming of salmon was initiated in Norway in the early 1970s, and the knowledge base had to be built nationally. That situation was contrary to the oil industry, which was a global industry when it entered Norway. Consequently, knowledge could be imported in order to manage the transition of that industry to Stavanger.

The transition from traditional fisheries to fish farming represents a formidable challenge. As explained by the dean: “fish farming is very different from the oil industry. No other country has experience with fish farming, so we had to develop the competences ourselves. There was no international knowledge to import”. The knowledge base in fisheries is mostly experience-based and is associated with an ad hoc culture of finding solutions as you go. Fish farming, on the other hand, requires science-based knowledge to solve several crucial issues related to fish health, nutrition, breeding, product quality and farming technology. In this transition phase, the policy of the university has been to take a crucial role to convince the industry of the need for new knowledge and technologies. Initially, the industry was sceptical to the need for science-based, systematic knowledge, accustomed as they were to experience-based competences. Interestingly, the university also experiences a transition, as explained by the dean: “I urge my colleagues early in the projects to consider which ideas are patentable for us. It has not been popular to protect and commercialise our knowledge, contrary to the firms”.

Endogenous as well as exogenous factors have motivated this radical diversification. The profit potential is huge, including a vast export market, and farming technology evolves rapidly. On the other hand, environmental issues have captured centre stage. No fish farmer can develop solutions to these problems individually. They look for industrial collaboration and cooperation with the university.
The university took the initiative to establish NCE\textsuperscript{1} Aquaculture, a partnership of 20 firms and research institutions. The participating firms include competing fish farmers, feed and equipment suppliers and several research institutions, with the university as project manager. It is expected that the curriculum at the university is adjusted to the need of the industry and that the university scouts for future trends. The establishment of a common arena was very important to overcome the rural locations of the plants with quite some distances in-between. In this process, the university acted as a mediator to facilitate access to additional public funding.

The strategy of the university in regard to the development of this path is to offer extensive contributions to education as well as relevant research. Education relates to young talents as well as further training and education of adults employed in the industry. The university helps to define and introduce new quality standards in the industry. The university collaborates with a number of regional firms that are integrated in Norwegian owned, internationally leading corporations. Consequently, the university also competes on the international scene. The firms collaborate with the university through joint projects with elements of both basic and applied research.

4.4 Upgrading and extending existing industries

This type of transition applies to the upgrading and extension of an industry in a region through the infusion of new production technologies or the introduction of product or service enhancements. It entails more incremental innovation than the radical or potentially disruptive innovations in type 1 transitions.

The prime example from our cases is the contributions of the University in Stavanger in the growth of the petroleum cluster in the region. The region is highly dependent on the oil and gas industry, and crucial challenges include increasing oil recovery, capture export markets for technology and mitigate environmental concerns. Note that the university has evolved with the industry from its first phase (when it was transplanted from abroad) to this current phase. Its contributions have changed considerably as a result of extensive collaboration and close links between academics and the industry, as well as the fact that the former college has been upgraded to a university.

For the university the guiding policy over the years has been to establish close links with the oil and gas industry, both at the individual and institutional level. For the university, the strategic choice is straightforward. The oil and gas industry is by far the dominant industry in the region, and as commented by a representative from faculty: “we prefer working with the oil companies, that’s where the money is.”

The relations are often long term and based on trust. A number of mechanisms for collaboration are at work. So-called joint industry projects include several competing oil companies and a research institution. These projects are popular because risks and costs are shared between the participants, thus reducing risks and costs for the individual firm. The petroleum companies are willing to share the technology developed, as they usually have no interest in ownership. All participating oil and gas companies have a great upside through the use of the new solutions, not ownership\textsuperscript{2}. Consequently, few problems related to IP rights with the university arise. Furthermore, they have great incentives to do research in Norway; a 77% tax\textsuperscript{3} on profits and associated depreciation rules implies that the Norwegian state takes most of the bill.
The establishment of joint centres is another mechanism. These are meant to be long term and include professor positions, education of master or doctoral students as well as applied research; and again risks and rewards may be shared between the funding companies. Some centres are funded by the oil companies alone; others with government funding. A centre for increased oil recovery was recently awarded by the Norwegian Research Council.

Framework agreements between the university and oil companies/service providers are a third mechanism for long-term collaboration. The motivation is reduced transaction costs as issues related to IP rights and rules for publication are agreed upon, making it easier to initiate contract research later. Industry reduces their search costs.

These forms of collaboration normally involve interaction between the firms and academia. Ideas originate from both sides, and long-term relations imply that researchers are well acquainted with the needs of the industry and the focal company, and may even come up with ideas beyond the imagination of the firms that may be steeped in daily operations. Personal relations are vital: “the firms know with whom they want to collaborate. They approach individual professors with the best reputation”.

Regardless of mechanism, it is usually straightforward to combine resources in complementary ways since IP is no key issue. Links with the oil related service and supply industry is more troublesome. These firms build competitive advantage through their unique technology, and demand at least exclusive rights to use new products. Consequently, their primary interest in collaboration with the university is rather access to talented people, especially various categories of engineers. Although companies may receive public funding in order to undertake research with a university, contract research is not always straightforward. Two cultures may collide: “we want to develop products fast; the university has a slower pace. We expect results; they present concept sketches. They present feasibility studies that they think we can develop and commercialise. The hours are running with no results”. In other words, the dominant logics of the firm and the university need to be attuned to each other in order to utilise the potential complementarities.

Industry is invited to discuss the curriculum. This collaboration is institutionalised as industry representatives are members on the board of institutes, which sanction study programs, their content and the number of students to accept. Furthermore, relevant industrial partners are invited to think strategically: what should this group be doing ten years ahead? Industry is also invited to have their say in the development of experience-based master programs. Recently a master in offshore technology was introduced to upgrade or retrain employees and managers in the oil and gas industry. The university has established a self-financed and commercially-oriented dedicated department to serve these needs.

In summary, the main contributions of the university is problem solving through applied research and consultancy. Both standard and specialised education is offered, to students as well as executives in the industry. Several representatives from the oil and gas industry want a stronger university engagement in convening conferences in order to make the industry, the region and the university more visible both nationally and internationally. Such arrangements may have reputational effects and attract more business and students to the region.

The main university activities associated with the four respective industrial transformations and regional paths are summarised in Table 3.
Table 3  The role of universities related to different paths

<table>
<thead>
<tr>
<th>1 Creating new industries</th>
<th>2 Transplantation from elsewhere</th>
<th>3 Diversification into related industries</th>
<th>4 Upgrading of existing industries</th>
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</thead>
<tbody>
<tr>
<td>Cutting edge basic research</td>
<td>Education</td>
<td>Convince existing industry of the need for science-based knowledge</td>
<td>Problem-solving through applied research</td>
</tr>
<tr>
<td>Commercialise new solutions</td>
<td>Responsive curricula</td>
<td>Bridging between unconnected actors</td>
<td>Consultancy</td>
</tr>
<tr>
<td>Adopt IP and licensing policies</td>
<td>Technical assistance</td>
<td>Mediate public funding</td>
<td>Executive education, industry relevant master programs</td>
</tr>
<tr>
<td>Establish new firms</td>
<td>Problem-solving through applied research</td>
<td>Education of students, managers and employees</td>
<td>Joint industry projects/centers</td>
</tr>
<tr>
<td>Connect academic researchers and local entrepreneurs and venture capital</td>
<td></td>
<td>Define new quality standards</td>
<td>Framework agreements</td>
</tr>
<tr>
<td>Create an industry identity</td>
<td>Basic and applied research</td>
<td></td>
<td>Convening conferences</td>
</tr>
<tr>
<td>Confer legitimacy to nascent companies</td>
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<td></td>
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</tr>
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</table>

5 Discussion

The most important finding from our cases is that the universities’ role in local innovation processes depends on which transition pathway the region is experiencing. In line with recent prior research (Lester, 2005; Lester and Sotarauta, 2007) four distinct regional development paths were identified. The regions follow different paths, and the strategies of the university are aligned with those trajectories. Consequently, the strategies of the universities are different; there is no standard model into the future. Recent research has concluded in similar ways (Isaksen and Trippl, 2014; Tödtling and Trippl, 2013), identifying three paths: path extension, path renewal and path creation. I add a fourth: a path new to the region, but transplanted from elsewhere. This distinction between a path new to the region (transplanted from elsewhere) and new to the world (path creation) offers more insight into the related strategies and actions from the universities, as described above. To successfully shape a new path, the university provides cutting edge basic research, cultivate relations between academic researchers and local entrepreneurs, and helps to communicate an industry identity. When an industry is transplanted from elsewhere, the main role of the university was to supply relevant education and thus establish an absorptive capacity in the region. This role should not be underestimated, as it may be the crucial mechanism for a resource rich region to avoid the resource trap. Not only have locals been recruited to the oil companies, an advanced and internationally competitive supply industry has evolved.
I admit that the four types of paths or transitions are somewhat idealised. In practice, the distinctions between them are ambiguous. Because even the creation of new industries usually has historical antecedents, this path may be hard to distinguish from the path ‘diversification into related industries’. Furthermore, each region may evolve along more than one trajectory, as it hosts industries with dissimilar development paths.

The alignment between regional transformations and the university’s strategies comes in several forms. First, the university may be in the front seat, carrying out research that defines new industry in the region; or alternatively align their research to an industry already evolving. In other words, the university may be active in different ways. Second, when analysing strategies it may be helpful to differentiate between planned and realised strategies (Mintzberg and Waters, 1985). A strategy may be understood as a deliberate intention with a set of coherent policies and actions, as described in formally adopted documents. On the other hand, the realised strategies of universities (and other organisations) may emerge from entrepreneurial initiatives originated at the faculty, institute or even individual level at the university, unaffected by formal strategies at the institutional level. Burgelman (2002) elaborates on strategy making processes in organisations through an evolutionary framework, in which he differentiates between induced and autonomous strategic actions. Induced strategy is the official and purposeful strategy based on the beliefs that top management has about the basis for its past and future successes. Autonomous strategic action “involves initiatives of individuals or small groups that are outside the scope of the corporate strategy at the time that they come about” [Burgelman, (2002), p 13]. Many of these initiatives will never grow to be important, but some do and may extend or complement or even substitute a company’s or university’s familiar environments. Autonomous initiatives from faculty create more variation than a top-down induced strategy. Priorities unfold as the result of an extensive interaction between faculty and industry, more than as a consequence of administrative decisions by the board of the university.

Our findings question the utility of a one-size-fits-all approach to regional economic development that many universities and governments have been pursuing, with its focus on patenting, licensing and start-ups. This dominating concept of a university’s role in regional development, regardless of the heterogeneous development paths in the regions, is underlined by the fact that universities are evaluated and rewarded on those activities. These strategies are often more aligned with the requirements and expectations from the national government, and less with the differentiated paths experienced in the regions. The results from this study support the strategies advocated in the recent concept of ‘smart specialisation’. These strategies are place-based policies that aim to promote economic diversification of regions (Boschma, 2014; McCann and Ortega-Argiles, 2013). Smart specialisation focuses on each region’s strength and competitive advantage and recommends policies that avoid imitation of successful policies in other regions. In the context of development paths, regions should avoid copying strategies of regions evolving along other paths.

Is the role of the university proactive in the sense that they define the evolution of an industrial path? We identified some cases of new business creation in which faculty members played a crucial role in establishing new firms based on university research; they often even play a supportive role as consultants and reputation transmitters to the greenfields. In one case where the region hosts a small industrial sector, the university plays, relatively speaking, a more dominating role. Interestingly, the roles may be turned
around: in two cases the regional industry and local government agencies have played
decisive roles in the transformation of former regional colleges into universities.
Consequently, they have strongly influenced the paths taken by the university and their
strategies.

In order to take the ‘third role’ seriously, new institutions and routines are needed.
Combining high quality, independent research with needs and requirements of the
business sector, the universities are required to leverage their competence in making
contracts. In two cases, the university has recruited dedicated personnel to safeguard the
integrity of the university in parallel with commercialisation activities. It is also a matter
of traditional faculty attitudes and organisational culture.

In all transition types, the firms’ links to universities are partly motivated by access to
public funding. The government stimulates firms to do more research, preferably with
universities. Some firms comply even if it runs contrary to their strategies of doing
intranamal research. The state has a tendency to compensate for lack of private seed
money and too modest interest for research in incumbent firms. In this respect the triple
helix model of university-industry-government relations are at work. The university takes
on a mediating role, guiding the firm through the bureaucracy to access financial support
from government bodies.

The evolutionary perspective highlights that paths evolve over time in the same
region. For example, the initial development of the oil and gas industry in Stavanger was
made possible by the decisions of multinational oil companies to locate there and to bring
the needed competence with them, illustrating a typical type 2 path. Very soon, however,
entrepreneurs in local engineering, construction and shipbuilding firms diversified into
the new industry; substituting or collaborating with foreign firms, thus elucidating path 3.
Furthermore, the regional oil and gas cluster over time has matured and evolved to a
Type 4.

Table 4 The roles of universities in regional path development

<table>
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<tr>
<th></th>
<th>UiS</th>
<th>UiN</th>
<th>UiT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main type of research</td>
<td>Applied</td>
<td>Applied and basic</td>
<td>Basic</td>
</tr>
<tr>
<td>Relations to existing industry</td>
<td>Strong</td>
<td>Moderate</td>
<td>Weak</td>
</tr>
<tr>
<td>Relations to emergent industry</td>
<td>Weak</td>
<td>Moderate</td>
<td>Strong</td>
</tr>
<tr>
<td>Role in defining regional paths</td>
<td>Passive</td>
<td>Moderate</td>
<td>Pro-active</td>
</tr>
<tr>
<td>Contractual competence</td>
<td>Strong</td>
<td>Weak</td>
<td>Weak</td>
</tr>
</tbody>
</table>

A comparison between the indigenous creation (type 1) and upgrading of existing
industries (type 4) may help to highlight the highly different challenges associated with
the respective paths. In cases of new industry formation, prevalent in Tromsø; financing
originated mainly from some combination of the founders themselves, business angels,
professional venture capital firms and government support. In contrast, for the upgrading
of an established industry, new product or process development is financed mainly with
internal company funds, or government-funded demonstration projects. Innovation
processes in well-established industries are more often incremental, responsive to
requirements from demanding customers, and supported by advanced suppliers. In cases
of new industry formation the dominant innovation culture is science-driven and
entrepreneurial, often associated with basic research. University technology transfer is
proactive and oriented towards start-ups and small firms. For upgrading in existing and
larger firms, the collaboration with the university centred on long-time relationships, often based on tacit knowledge and trust. The differences of the universities and their roles are summarised in Table 4.

6 Conclusions

The study identified four distinct regional development paths and how these paths are shaped or extended through interaction between industry and universities. To strengthen their third mission, universities need a strong awareness of the specific trajectories of regional industries and clusters, and appreciate the innovation potential associated with those alternative pathways. The findings also confirm that ‘the one size fits all’ approach to regional economic development is not viable; neither are the ‘arms-length’ strategies of some university leaders. In other words, in order to be effective contributors to regional development, their strategies should reflect the differentiated development paths in their respective regions.

Secondly, the strategies of universities should be sensitive to the ongoing initiatives of faculty members to collaborate with industry. These strategic initiatives are often rather autonomous and based on trustful relations between professors and research oriented companies. As documented above, firms often relate to individual professors or research groups, rather than the institution as such. The board and management of the university should welcome such initiatives and view them as emerging new or adjusted strategies to make an improved fit with the evolving development paths of the region.

The paper is based on three cases and does not pretend to draw general conclusions. However, the two conclusions above as well as the taxonomy developed and illustrated in the paper, should be applicable to other European regions. University administrators and regional policy makers may use these concepts to better develop strategies to stimulate paths in their local economic landscape. It is interesting to note that although the universities are very similar institutions and owned and monitored by the state, their strategies and priorities differ widely. The taxonomy may contribute to materialise the ongoing European discourse on regional and national ‘smart specialisation’.

European innovation policies should take notice that the present focus on technology transfer is too narrow to describe the university’s role in supporting the capabilities to innovate. The university/industry relations are broad, and include collaborative research, contract research, consulting, teaching, and informal networking activities; practiced by a far larger proportion of academics than commercialisation. This echoes the argument of Lester and Sotarauta (2007, pp.2–3): “the focus on patenting, licensing and new business formation, should be replaced with a more comprehensive, more differentiated view of the university role”. This view is further supported by the fact that the corporate managers stress the need for talent and human resources and emphasise the role for universities not only to educate candidates, but to attract talent to the region in the first place. Lastly, some managers argue that the university should serve as a public space for ongoing or potential conversations about the future direction of technologies, markets and the region. When local and national government policies stress the need for universities to contribute to future development paths, the policy implication is that the regional or third mission of universities should be measured and evaluated along these broader contributions.
The exigencies of the knowledge economy linked to pressures of globalisation require a more contextualised research-led model of a RIS (Cooke, 2004). I hope this paper may facilitate such a contextualisation. Future studies should include clever case studies to illustrate how universities may engage more actively in the specific context of their respective regions. In the advent of ‘smart specialisation’ European universities will meet more varied and nuanced demands, which in turn implicates that strategy development and implementation in universities becomes decisive for success both for themselves and their regions. Future research should investigate how university strategies come about, and how they may be improved. These studies should include studies of processes leading to formal as well as emergent strategies as explicated above, realising that strategies are the result of directed and purposeful actions by agents as well as the unintentional outcome of collective interactions between faculty and between them and industry.

References


Notes

1 Norwegian Center of Expertise, financed by the Norwegian Research Council and other public institutions.

2 To give an indication: one percentage point increase in the oil recovery from a field yields 80 m. barrels of oil.

3 The regular tax rate is 27%, but another 50% is added as rent of a finite resource.