EUROPEAN URBAN AND REGIONAL STUDIES

European Urban and Regional Studies
20(2) 161–169

DOI: 10.1177/0969776412457173
eur.sagepub.com
SAGE

Knowledge sourcing, innovation and constructing advantage in regions of Europe[1]

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There is broad agreement nowadays among economic geographers, regional scientists and policy makers as well as evidence that the performance of regional economies in a globalizing knowledge economy depends to a high degree on innovation and knowledge-transforming capabilities (Archibugi and Lundvall, 2001; Cooke et al., 2008; Malecki, 2010). Innovations are to a large extent the result of firm activities that respond to challenges of global competition and new societal demands. This applies both to high- and low-technology industries (see, for example, Hansen and Winter, 2011).

However, firms do not act in isolation or in a space-less world but they are part of and embedded in particular locations and socio-economic contexts that are shaped also by policy actors and institutional conditions. Such conditions have been pointed out in the innovation systems literature for countries (Edquist, 1997; Lundvall, 1992, 2007) and regions (Asheim and Gertler, 2005; Cooke et al., 2004). The argument is in line with the global production networks literature (e.g. Coe et al., 2008), which stresses the regional embeddedness of firm-level action, its globally networked nature and the significance of institutional contexts.

We also find broad acceptance of the view that the innovation process is to a large extent an open (Chesbrough, 2003) and interactive process based on the exchange and transformation of both tacit and codified knowledge (Lorenz and Lundvall, 2006; Nonaka and Takeuchi, 1995). It has been pointed out that firms from both high- and low-technology sectors nowadays draw relevant knowledge for innovation from a broad variety of knowledge sources, which may be distributed across many locations from local to global levels (Smith, 2002; Tödtling et al., 2006). The search, sourcing, integration and application of external knowledge, however, require well-developed absorptive capacities and internal competencies of companies and firms (Zahra and George, 2002).

Having said that, there is still little understanding of the precise nature of these knowledge interactions, and how that affects innovation performance.

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In this introduction we argue that there is a need for a better understanding of the types of knowledge bases involved, the kinds of externally sourced knowledge, and the role of the socio-economic context in which knowledge interactions and innovation occur. In addition to the well-known categories of tacit and codified knowledge, the distinction between market knowledge and technological knowledge is also important (Giuliani and Bell, 2005). Such a broader view on knowledge has been asked for in the more recent approaches to the knowledge economy (Cooke et al., 2008; Lorenz and Lundvall, 2006). Furthermore, the variety of sources of knowledge, as well as an understanding of the structure of networks and the geography of innovation relations, is of critical importance (Ter Wal and Boschma, 2009). Although the importance of innovation relations in general has already been emphasized in the literature some time ago, more recent work has argued that the more detailed nature and pattern of innovation sources (e.g. customers, suppliers, competitors or science) as well as their geographical location (e.g. within the same region or country or in global knowledge hubs) matter for innovation.

Cluster-based views often argue that relevant knowledge for innovation is industry-specific and specialized, coming from partners along the value chain (Porter, 2003, 2008), i.e. customers, suppliers or sector-specific knowledge providers. Customers and suppliers have indeed been identified as frequent knowledge sources for innovation; however, there are indications that they are more relevant for incremental innovation than for more radical change (Tödtling et al., 2009). Asheim et al. (2011a), Boschma and Frenken (2011) and Cooke (2011) have argued in this context that such a sector or cluster perspective may be too narrow, because key knowledge sources for innovation, in particular the more radical kinds, often come from other, technologically distant sectors and technology fields. Variety, thus, seems to matter, but this might be even more true for related variety. As Frenken et al. (2007) have pointed out, a wide range of local industries that are technologically related to each other may provide opportunities for knowledge spillovers and regional development. Related variety as well as inter-industry platforms, thus, might have more positive impacts on an effective transfer of knowledge and for innovation.

Types of knowledge bases

The concept of knowledge bases provides some further insights into the way in which companies compete and innovate, and how they source knowledge (Asheim, 2007; Asheim et al., 2011b; Asheim and Gertler, 2005). Knowledge processes have become increasingly complex in the globalizing knowledge economy. The binary argument of whether knowledge is codified or tacit becomes too simplistic to accommodate this increased complexity and to provide an adequate understanding of knowledge creation, learning and innovation (Johnson et al., 2002). Thus, there is a need to go beyond this simple dichotomy. One way of doing this is to distinguish between 'analytical', 'synthetic', and 'symbolic' types of knowledge bases, which partly transcends the traditional tacit-codified dichotomy. The knowledge base concept argues that tacit and codified forms of knowledge always co-exist but in different combinations. The concept also states that all types of economic activity can be innovative but that the modes of innovation differ, thus, transcending the high tech–low tech dichotomy. The concept also argues that all types of economic activity can be innovative but that the modes of innovation differ, thus transcending the high-tech–low-tech dichotomy. As this threefold distinction refers to ontological, generic categories, most activities are in practice composed of more than one knowledge base. However, one knowledge base will represent the critical knowledge input that the knowledge creation and innovation processes cannot do without.

An analytical knowledge base refers to economic activities in which scientific knowledge based on formal models is very important, for example in biotechnology and nanotechnology. University–industry links and respective networks are important and more frequent than in the other types of knowledge bases. Knowledge inputs and outputs are more often codified in this type of knowledge base than in the other types. Knowledge creation in the form of scientific discoveries and (generic)

technological inventions is more important than in the other knowledge types, and, consequently, innovations are science driven.

A synthetic knowledge base refers to economic activities in which innovation takes place mainly through the application or novel combination of existing knowledge. Often this occurs in response to the need to solve specific problems occurring in the interaction with customers and suppliers, and, thus, innovations are user and market driven. Industry examples include plant engineering and specialized advanced industrial machinery. University–industry links are relevant, but they are clearly more so in the field of applied research and development than in basic research. Tacit knowledge is more important than in the analytical type, in particular because knowledge often results from experience gained at the workplace, and through learning by doing, using and interacting.

Symbolic knowledge is related to the creation of meaning and desire as well as aesthetic attributes of products, such as designs, images and symbols, and to its economic use. The increasing significance of this type of knowledge is indicated by the dynamic development of cultural production such as media (film making, publishing and music), advertising, design, brands and fashion. In cultural production the input is aesthetic rather than cognitive in quality. This type of knowledge is often narrowly tied to a deep understanding of the habits and norms and 'everyday culture' of specific social groupings. Given the cultural embeddedness of interpretations, this type of knowledge base is characterized by a distinctive tacit component and is usually highly context specific.

The knowledge base concept also has implications with regard to innovation policies, as pointed out by Asheim et al. (2011a). Today there is a strong agreement that innovation is the key factor in promoting competitiveness in a globalizing knowledge economy. Competition based on innovation implies choosing the high road strategy, which is the only sustainable alternative for developed, high-cost regional and national economies as well as for the future of developing economies. For a long time such a strategy was thought of as being identical with promoting high-tech, research and development (R&D)-intensive industries in accordance with the linear view of innovation. More and more the recognition has evolved that a broader and more comprehensive view on innovation has to be applied to retain and develop competitiveness in the heterogeneity of European regions. This implies that regional advantage has to be constructed more on the basis of the uniqueness of the capabilities of firms and regions than solely on the basis of R&D efforts (Asheim et al., 2007)[2]. This requires a differentiated knowledge base perspective as presented above to be fully accommodated. Such a broad-based innovation strategy is in line with the innovation system perspective of defining innovation as interactive learning combining an STI (science, technology, innovation) and a DUI (doing, using, interacting) mode of innovation (Lorenz and Lundvall, 2006).

The innovation system approach (see the respective section below) represents both a selection environment and a milieu for variety creation. The dynamics of the system is secured through long-term and systemic relationships between industry and university, with a strategic role played by policy. The Constructing Regional Advantage (CRA) approach builds on this and emphasizes an even stronger pro-active role for government and public policies in initiating public/private collaboration in the promotion of innovation and competitiveness (Asheim et al., 2011b).

Multi-scalar innovation networks

As we have argued, there is much agreement on the interactive nature of innovation and the important role of external knowledge. This has been studied in the literature on innovative milieux (Camagni, 1991), innovation networks (Giuliani, 2011) and innovation systems (Asheim and Gertler, 2005; Cooke et al., 2000). In earlier innovation studies a strongly localized perspective has often dominated, as studies on innovative milieux and on high-tech regions demonstrate (Keeble and Wilkinson 2000; Saxenian, 1994). On the other side of the coin we find studies emphasizing the role of global innovation relations such as R&D partnerships (Hagedoorn

2002) and virtual communities (Amin and Cohendet, 2005). In recent years a more differentiated multilevel or multiscalar perspective has emerged, going beyond these earlier views. Such a multiscalar perspective also goes beyond the 'local buzz and global pipeline argument' proposed by Bathelt et al. (2004) that suggests that unintended and informal knowledge spillovers are local, whereas intended and formal relations are global.

Studies of innovation networks have investigated the geography of such networks using social network analysis tools (Ter Wal and Boschma, 2009). This instrument helps to analyse the topography of innovation networks, identifying, for example, the density of the network, central nodes, peripheral actors and the spatial reach of networks. In addition, one can investigate the variety of knowledge sources to which each node is linked, and how that affects their innovation performance (Broekel and Boschma, 2012). By examining the structure of the innovation network at the regional level, one can measure the innovation potential of regions as well as start to identify the weaknesses and bottlenecks in the local system.

Innovation systems as socio-economic contexts

Innovation system approaches, finally, help to highlight the socio-economic background and context for innovation in particular countries and regions (Asheim and Gertler, 2005; Cooke et al., 2000, 2004; Doloreux, 2002). They emphasize institutional conditions, interactions between actors and subsystems, the role of policy and of governance, etc. The innovation conditions of countries were studied in the national innovation system (NIS) literature (Edquist, 1997; Lundvall, 1992), as well as in the literature on the variety of capitalism or business systems (Cooke et al., 2007; Whitley 2000). The argument, here, is that we find differences between countries regarding the strength of knowledge generation in science and business, in the ease of knowledge commercialization (entrepreneurship, spin-offs, university–industry links, etc.), and in intermediary organizations. In addition, the quality of education and schools, the flexibility of labour markets and the finance system (venture capital) matter. High-quality schools bring forward the well-trained workforce needed for innovation, flexible labour markets support labour mobility and knowledge transfer among firms, and venture capital provides funding for innovation projects and new firms.

Whereas in the business systems literature differences between liberal market economies (the United States, the United Kingdom) and coordinated market economies (Nordic countries, Germany, Austria) are highlighted, the studies on NIS are more open as regards typologies. A recent publication by the European Commission (EC, 2011) distinguishes among leaders, followers, moderate innovators and modest innovators. From the countries studied in that thematic volume we find Sweden, Finland and Germany in the category of innovation leaders, Austria in the group of followers and the Czech Republic among the moderate innovators. Norway and Turkey were not classified in the Commission report. Looking at its 'Summary Innovation Indices', however, Norway would belong to the group of moderate innovators and Turkey would be part of the 'modest' group. We can conclude from this classification that the best socio-economic conditions for innovation seem to exist for the investigated cases and firms in Sweden, Finland and Germany, whereas those in the Czech Republic and Turkey obviously are facing disadvantages in the national institutional settings. The cases in Austria and Norway seem to be in an intermediate position in this respect.

Innovation conditions, however, also differ between regions within countries, as was pointed out, for example, by Hollanders et al. (2009) for European regions. Tödtling and Trippl (2005) have referred to different types of regional innovation systems in this context. A regional innovation system (RIS) is made up of the subsystems of knowledge generation and of knowledge exploitation, policy organizations and other actors situated in a regional socio-economic territory (Cooke et al., 2004; Doloreux, 2002). It is characterized by both 'hard' (the mix of firms and organizations) as well as 'soft' institutions. Whereas the hard institutions include public and private research laboratories, universities and colleges, intermediaries, education and training organizations, as well as firms and clusters, the soft

institutions include innovation-relevant regulations, routines, habits and values in a particular region, a setting also described as 'innovation culture' (Saxenian, 1994; Trippl and Tödtling, 2011). A well-functioning regional innovation system implies well-developed knowledge organizations, clusters and interrelationships within the region and beyond. However, the extent to which firms interact or cooperate with other firms or knowledge-generating organizations such as universities seems to differ strongly across regions (Tödtling and Trippl, 2005).

Metropolitan regions are generally regarded as centres of innovation that benefit from scale and agglomeration economies (Simmie, 2003). There is a high density and diversity of firms and clusters as well as of knowledge organizations and intermediaries. The broad sectoral diversification (Feldman and Audretsch, 1999; Glaeser, 1999), as well as related variety, i.e. knowledge transfers between different but related sectors (Boschma and Frenken, 2011), seems to support innovation in such regions. However, metropolitan regions may also show features of fragmentation, i.e. a lack of networks and interactive learning constraining their innovation performance. Less urbanized or more peripheral regions, in comparison, are often characterized by a lack of dynamic firms and a 'thin' and less specialized structure of knowledge organizations and educational institutions. Also, networks are rather weakly developed, in particular those including more specialized knowledge suppliers such as universities and research institutes. As a consequence, innovation activities are often at a lower level and of a more incremental nature than those of a more developed or metropolitan RIS. Industrial regions, finally, often have a higher density of firms and knowledge organizations than peripheral regions, but compared with metropolitan regions they show a higher degree of specialization in particular industries or clusters. Knowledge organizations and educational institutions often closely fit the needs of the dominating industries. There can be dense networks, but also a latent danger of 'lock-in'. This implies that there can be well-functioning innovation networks for a while in such regions. However, if they face major economic or technological ruptures, companies might be less able to accommodate such changes.

Contributions to this special issue

The seven articles in this special issue deal with distinct aspects of knowledge sourcing, innovation and constructing advantage in different types of industries and regions of Europe. The industries represent the three knowledge bases introduced above: analytical (life sciences and marine biotechnology), synthetic (automotive, intelligent machinery, electronics, lightweight material products, software, food, textiles) and symbolic (moving media and digital content industry). The countries represented cover the highly developed Nordic innovation systems of Sweden, Finland and Norway, the 'coordinated' economies of Germany and Austria, and the central European transformation economy of the Czech Republic, as well as the less developed but emerging economy of Turkey. The regions investigated cover well-developed metropolitan RISs such as Scania (including Malmö and Lund), Tampere, Helsinki and Prague, and industrial RISs such as Horten, South West Saxony, Upper Austria, Moravia–Silesia and Denizli, as well as more peripheral and organizationally 'thin'[3] regional innovation systems, such as Tromsö, Agder, South Ostrobothnia and Adiyaman. The first four of the papers deal with detailed analyses and patterns of knowledge sourcing and innovation in such different industrial and regional settings, whereas the following three focus more on challenges and issues for innovation policies in such contexts.

Martin and Moodysson (2013) investigate knowledge sourcing and knowledge interactions of firms in three clusters in the region of Scania: life sciences representing an analytical knowledge base, food belonging mainly to the synthetic knowledge base and moving media being considered to be symbolically based. The findings reveal that companies use a broad variety of knowledge sources such as monitoring, recruitment of highly skilled labour and collaborative links at regional, national and international levels. Geographic proximity turns out to be most relevant for industries based on synthetic knowledge (food) as well as symbolic knowledge such as moving media. Regarding the latter, more than half of all knowledge links were found to be within the region of Scania, with firms from the same industry and technical colleges being important sources of

knowledge. The firms in the life sciences were the most global in their knowledge interactions, with almost half of relevant partners (often universities and research organizations) being located outside the country.

Focusing on the auto industry in South West Saxony, Plum and Hassink (2013) analyse patterns of innovation and knowledge sourcing using the tool of social network analysis (SNA). Quite different from Scania, this is an old industrial region that was part of the former German Democratic Republic. Given the branch plant status of many firms, innovation activities and R&D are rather weakly developed, putting the industry in this region into a problematic 'sandwich position' between the strong auto regions of western Germany and low-cost locations in eastern Europe. Innovation activities are mainly of an incremental type and are based on the new combination of existing knowledge that is typical of a synthetic knowledge base. Knowledge relationships are predominantly vertical along the value chain, partly within the region but more often within the rest of Germany. The authors find rather weak knowledge relations with universities and science, indicating a lack of analytical knowledge, as well as weak international knowledge links, a pattern that signals the risk of lock-in in the long run.

Tödtling et al. (2013) take a comparative approach to investigating the role of a 'modern' sector (software) in enhancing innovation in the old industrial regions of Upper Austria and Moravia–Silesia. They examine the extent to which the different socio-economic and institutional conditions of the two countries and regions have an impact on the innovation activities and knowledge sourcing of firms in this sector. The findings show that there are indeed considerable differences in this regard, which can be attributed both to the organizational characteristics of firms and to the institutional settings in the two regions. The region as an innovation space as well as the international knowledge sources have a clearly higher importance for the firms in the more developed and better-networked RIS of Upper Austria than for those in Moravia–Silesia. Software companies in the latter region are more dependent on innovation relations with subsidiaries of international firms, often located in the capital city of Prague.

Kustepeli et al. (2013) focus on a key sector for Turkey, the textile industry. They compare the innovativeness and knowledge relations of companies in two different types of regional innovation system: the more developed RIS of Denizli and the organizationally thin and peripheral RIS of Adiyaman. Based on a social network analysis, the findings show that companies in Denizli have clearly denser knowledge networks and are also more innovative than those in Adiyaman. Companies in the latter region are lacking the institutional structure for knowledge generation, dissemination and networking, putting them at a disadvantaged position regarding innovation.

Isaksen and Karlsen (2013) also look at small and partly peripheral regions, but in the highly developed Norway and from a policy-oriented perspective. They analyse four industries: marine biotechnology in Tromsö, electronics in Horten, light-weight material products in Raufoss, and oil and gas equipment in Agder. Whereas the companies in the first case innovate based on analytical knowledge, the other three rely more on a synthetic knowledge base. The authors argue that, to achieve advantages under such conditions of organizational 'thinness', policies should focus less on the regional level and more on the internal competences of firms that put them in a position to use external knowledge from national and international knowledge sources. Related variety matters in the form of combining scientific knowledge with experience-based knowledge.

Sotarauta and Kosonen (2013) address the question of whether Finnish innovation policies are customized to meet the needs of firms in different regions and industries. The cases investigated are the digital content industry (symbolic knowledge base) in the metropolitan region of Helsinki and the intelligent machinery industry (synthetic knowledge base) in the industrial region of Tampere and in the rural region of South Ostrobothnia. The findings demonstrate that innovation processes, knowledge sources and networks, and policy needs do differ quite strongly among these industries as well as the investigated regions. The region turns out to be an important knowledge space for the firms in metropolitan Helsinki, whereas the firms in the

organizationally thin RISs of South Ostrobothnia are highly dependent on links to the national Finnish innovation system.

A different perspective and approach is taken in the last article in this special issue, by Blazek et al. (2013) it investigates emerging regional innovation strategies in the capital city region of Prague, the well-developed region of South Moravia and the old industrial region of Moravia–Silesia referred to above. The article finds that the region with the best preconditions for an innovation strategy (Prague) makes the least effort to design and implement such a strategy, partly because of a lack of interest and leadership in this regard. The other two regions made more extensive efforts to set up innovation policies due to a greater need for such policies, as well as a leading role of key actors in these regions. Whereas the national level was of little help to introduce such policies, there was quite strong financial and conceptual support from the European Union level. This confirms the need for engaging in networks at regional and higher levels including the European one, in order to make regions more innovative and competitive.

Overall, the contributions in this issue demonstrate that innovation and knowledge processes matter in most of the investigated cases in order to improve the competitiveness of companies. Also, companies usually rely on some combination of internal competences and external knowledge. The detailed patterns and routes these processes take, however, differ depending on the underlying knowledge bases of the sectors and their mix, and on the innovation conditions of the respective regions and countries. As regards knowledge bases, the contributions show that, although there is often a dominance of a particular knowledge base in a certain industry, there can be considerable benefits for companies to tap into complementary or related knowledge bases. As regards the pattern and geography of knowledge sourcing, the articles in this special issue show that even in seemingly low-tech sectors such as textiles, food and materials there are often quite complex and multiscalar networks of knowledge sourcing and of innovation involved. The way these are used and shaped again depends on underlying conditions such as firm structures, and the characteristics of national and regional innovation systems.

Funding

This research was supported by European Science Foundation (ESF) and was funded by the National Science Funds from Austria, Finland, Germany, Norway, Sweden, The Czech Republic, The Netherlands and Turkey.

Notes

1. This special issue is based on research within the European Collaborative Research Project 'Constructing Regional Advantage' (CRA, 2007–2011) supported by the European Science Foundation (ESF) and the respective national science funds. The Partners were the Lund University (coordinator, Sweden), the University of Agder (Norway), the University of Tampere (Finland), the University of Kiel (Germany), the Charles University Prague (Czech Republic), the Utrecht University (The Netherlands), the Dokuz Eylul University in Izmir (Turkey) and the Vienna University of Economics and Business (Austria). The papers included in this issue were presented at the 8th European Urban and Regional Studies Conference 'Repositioning Europe in an era of global transformation', 15–17 September 2010, in Vienna.
2. Constructing regional advantage means turning comparative advantage into competitive advantage through an explicit policy push promoting a Chamberlinian monopolistic competition based on product differentiation creating unique products, an assumption that was fundamental also for Porter's cluster approach (Asheim et al., 2011b).
3. The term is related to Amin and Thrift's (1994) concept of 'institutional thickness' as it was applied by Smith (1998) to regional development in Slovakia. It includes both 'hard' (i.e. organizations) and 'soft' institutions such as conventions, rules and habits. The empirical work of the CRA project, however, has focused more on the density of relevant organizations and their relationships (e.g. universities, R&D organizations, intermediaries) than on the 'soft' institutions.

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