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Exploring the Multiple Roles of Lund University in Strengthening Scania's Regional Innovation System: Towards Institutional Learning?

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Abstract *Universities are increasingly seen as potential contributors to regional innovative capacity by serving as local knowledge conduits, bringing global state-of-the-art science and technology into the region. In practice, however, more active university engagement with their regional innovation systems is not as straightforward as it may seem. The article uses examples from a successful case by which less successful regions could be inspired. Our analysis considers how various forms of technological learning intersecting within Lund University around three distinct sectoral engagement efforts have been built up and how this created new structural regional innovation capacity.*

Introduction

Increased recognition of the importance of the knowledge economy has, among other things, raised the interest of policy-makers in regional innovation systems' (RISs) approaches value for regional development policy. Actively reducing interaction deficits in RISs, aiming at stimulating innovation and constructing regional advantage in the globalizing economy, has replaced earlier job creation or market-failure rationales for policy intervention (Asheim *et al.*, 2006; Cooke, 2007). In this context, universities are increasingly seen as potential contributors to regional innovative capacity by serving as local knowledge conduits, bringing global state-of-the-art science and technology into

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the region. "Translating" this knowledge into commercial application can embed and capture value regionally, raising the lagging innovative capacity of incumbent industrial firms and improving their global competitiveness. Increasing regional demands for universities to realize their potential and capitalize on their academic knowledge base come at a time when universities themselves are becoming more open to the idea of a "third mission" of socio-economic contribution.

As a result of this conjunction, promoting university–industry research-based partnerships and stimulating knowledge-intensive entrepreneurship have become core elements of regional development policies targeting systemic territorial innovation. In practice, however, more active university engagement with RISs is not as straightforward as it may seem, and early optimism and euphoria has given way to considerable scepticism and frustration in less successful regions. We argue that this disappointment can partly be traced back to a series of misunderstandings around the practicalities or realities of converting university-based knowledge into commercially applicable knowledge. Firstly, universities have been regarded purely as sources of academic knowledge rather than as regional system builders. Secondly, the contributions made by the variety and complementarity of universities' learning experiences in dealing with many different regional demands have not been considered. To rectify these shortcomings, we analyse the way that one university collaborated innovatively with a range of industrial sectors and used this technological learning to drive wider institutional learning processes.

Empirically, this article presents a case study of the role and involvement of Lund University (LU) in the RIS of the southern Swedish region, Scania. LU is the largest university of the Nordic countries and one of the oldest, covering a comprehensive range of well-established faculties by which most teaching and research activities are organized. Even though LU has often been considered as a traditional teaching and research institution that seeks to safeguard academic independence and bolster disciplinary boundaries, its focus is currently shifting to increased interaction with industrial stakeholders. LU aims to become one of Europe's leading entrepreneurial universities with an emphasis upon increased regional engagement (Lund University, 2006). This region suffered heavily from crisis and decline in heavy engineering during the 1970s and 1980s. Yet, today Scania can be considered as a high-technology success story, driven by Lund, self-styled "city of ideas", a dynamic, high-technology innovative milieu specialized in life science and information and communication technology (ICT).

This transformation was partly driven by research laboratories from a few globally oriented firms such as Ericsson, Gambro and Astra. It is also typified by the IDEON science park, Sweden's first and largest science park, now home to 300 high-technology small and medium enterprises (SMEs). LU is a shareholder in IDEON and works closely with the science park in identifying new business opportunities. Following the IDEON experience, LU has developed a range of specific institutional responses to this economic restructuring process.

In this article, we analyse how LU has contributed to Scania's RIS, primarily focusing on how the university has learned as an organization to improve its own contribution. We in particular consider these institutional learning processes in the context of three large-scale "third task" projects, reflecting different sectoral demands, namely supporting the ICT industry through IDEON, its involvement in the life science cluster Medicon Valley and policy-led support for the more traditional yet important food sector through the VINNVÄXT programme "Food Innovation at Interfaces". LU's engagement in the

RIS defies a "one-size-fits-all" strategy (Tödtling & Trippl, 2005), but instead reflects the particular characteristics and demands of the region's industries, with sectors with differing industrial knowledge bases requiring different modes of innovation support from the university (Asheim & Coenen, 2005; Asheim & Gertler, 2005; Mowery & Sampat, 2005; Pavitt, 2005). The university became a site in which the dissimilarities between sectoral engagement norms were addressed, while offering scale and scope advantages by co-orchestrating activity within one organization. Our key research question is how those variegated sectoral demands for regional engagement resolve in ways that influence and possibly benefit the wider RIS. To explore LU's multiple roles, the analysis considers whether and how processes of institutional learning of different organizations and institutions related to university–industry interaction emerge and are sustained over time.

Conceptual Framework

Constructed Advantage Through RISs

In the burgeoning innovation systems literature emergent from the late 1980s, it is the RIS approach which is most directly concerned with uneven geographies of innovation (Asheim & Gertler, 2005; Asheim & Isaksen, 2002; Brazyck *et al.*, 1998; Cooke *et al.*, 2004; Doloreux, 2002). In comparison with the national innovation systems approach, the RIS approach is more specific in analysing the spatial organization of innovation processes between firms, policy institutions, research organizations and intermediary institutions. Two decades of RIS research have provided compelling evidence that, against the background of globalization processes, regional innovation is indeed enhanced by various kinds of agglomeration economies between co-located firms in similar or related sectors alongside innovation support by regional knowledge producers, such as universities.

The RIS approach studies the social interaction of economic actors in a region within localized innovation networks and considers how institutional evolution can produce "constructed advantage": creating regional capacity for improved innovation and economic performance (Cooke, 1998). In this conceptualization, it is common to distinguish two subsystems, the regional knowledge exploitation subsystem and the regional knowledge exploration subsystem. The exploitation subsystem consists of co-located/proximate firms, within similar or related industrial sectors with localized network relations and regional interdependencies, sometimes with scale and scope justifying their description as industrial clusters. These firms and sectors/clusters share specific territorial "assets" that facilitate innovation processes (e.g. unique local knowledge pools, shared production facilities, access to broad labour markets, socio-cultural embeddedness and trust). One RIS can, in principle, contain and support several clusters representing different sectors (Bathelt, 2001). The second RIS component is the knowledge exploration subsystem, a variety of organizations whose primary purpose is to produce, maintain, distribute, manage and protect knowledge for the society and economy in which it is embedded (Smith, 1997). This includes research and higher education institutes, private R&D laboratories, technology-transfer agencies, chambers of commerce, business associations, vocational training organizations, relevant government agencies and appropriate government departments in the region.

Making this distinction allows RISs to be analysed in terms of systemic processes of interactive learning between the knowledge exploitation and exploration subsystems,

corresponding to the cycle of innovation (Nooteboom, 2002). Successful innovation encourages regional actors in the two subsystems to institutionalize repeated interactions, providing new regional innovative capacities and hence strengthening the RIS. From this perspective, poor RIS performance can result from insufficient interaction between the two halves of the system, which might in turn reflect either an absence of connections between knowledge-exploring and knowledge exploiting actors, or systemic barriers which undermine co-operation between these actors. Better interaction can be stimulated arguably by encouraging knowledge-exploring activities (e.g. universities) to work more closely with regional knowledge exploiters (e.g. firms). A common heuristic is to do so by creating new facilitative intermediary institutions (e.g. regional technology centres).

But this over-simplifies regional innovation processes, assuming a linear knowledge exploitation mechanism without acknowledging the importance of "interactive learning" between innovating actors (Kline & Rosenberg, 1986). Knowledge exchange and diffusion is associative and reciprocal, with information and communication exchanged between the actors involved (Cooke, 1998; Lundvall, 1992). New knowledge is often created through novel combinations of existing knowledge. "Proximity matters" by facilitating repeated interactions between actors, permitting experimentation and risk-taking in making new combinations (Boschma, 2005). It is important to acknowledge pronounced sectoral differences in the organization of technological learning processes (Breschi & Malerba, 1997; Pavitt, 1984; Vang-Lauridsen, 2006). In reality, technological learning follows a range of different knowledge generation, appropriation and diffusion trajectories, which corresponds more closely to sectoral innovation conditions, than to a simple linear flow or indeed to any particular ideal-type interactive model (Rothwell, 1994; von Tunzelmann & Acha, 2005).

Linear models also simplify the value of policy interventions in purposively stimulating new collaborations. Although RIS approaches have become increasingly popular in policy-making circles, their success has proven remarkably sensitive to contextual conditions, both external and endogenous.[1] RISs are articulated within broader fields of influence and governance, not least national science and technology frameworks, despite an increasing autonomy claimed by regional governments and partnerships in promoting RISs (Charles *et al.*, 2003). RIS policies in particular regions evolve on the basis of their past experiences and their present knowledge base (Oughton *et al.*, 2002). Nauwelaers and Wintjes (2002) classify RIS policies on the basis of their mode and target of support and their scale of ambition, from individualized instruments supporting inter-firm collaboration through learning networks between firms and institutions to more ambitious attempts to reconfigure and reorient entire RISs. While many types of instruments can potentially improve RISs, individualized (firm-oriented, funding-based) instruments are easiest to implement (both technically and politically) but yield only limited effects in scale and duration and create relatively few new regional innovation capacities. The broader the target scale and the greater the focus on institutional reconfiguration and system building, the more complex becomes the process of implementing these regional innovation policies. In such circumstances, regional RIS knowledge and institutional learning become important determinants of RIS development capacity.

The Role of Universities in RIS

There has recently been a rising interest in universities' roles within their regional contexts, including RISs, as part of the so-called third task or mission (Cooke & Piccaluga,

2004; Goddard & Chatterton, 2003). The third mission (after teaching and research) refers to direct interaction between universities and society, which can be interpreted in a variety of ways. University's third tasks range from creating new high-technology firms, consulting for local industry, delivering advice to politicians and policy-makers, informing general public debates and shaping the national spatial distribution of social opportunities and services. Although universities have historically been socially engaged in a variety of manners (Arbo & Benneworth, 2007), there is a tendency in recent knowledge economy discourses to privilege economic engagement over other potential roles (Molas-Gallart *et al.*, 2002; Etzkowitz & Klofsten, 2005; AWT, 2007). There is much debate over the dynamics of this third task, particularly the extent to which it is a new task as opposed to a set of windfalls exploited from core university activities, namely teaching and research (Lundvall, 2002).

To unpack this debate, we argue that it is important to acknowledge that universities play a number of different roles in the development of RISs (Boucher *et al.*, 2003; Lawton Smith, 2003; Lazzeroni & Piccaluga, 2003). Gunasekara (2006) distinguishes between "generative" and "developmental" roles. Generative roles refer primarily to the provision of limited, discrete knowledge outputs by universities in response to business or institutional demands. Exemplar outputs are scientific and technological information, equipment and instrumentation, skills or human capital, networks of scientific and technological capabilities and prototypes for new products and processes (Mowery & Sampat, 2005). This perspective can be characterized as "knowledge capitalization", exploiting past knowledge investments for wider regional benefit.

Developmental roles by contrast involve the university constructively interacting with broader regional governance structures which seek to purposively shape future territorial economic development trajectories. Universities acting developmentally are doing more than capitalizing their knowledge, but are drawing on their wider networks to shape "the development of regional institutional and social capacities" (Gunasekara, 2006, p. 730). Universities can become involved in creating new systemic connections within RISs, leaving long-lasting regional impacts and engendering complex institutional changes. What remains unclear within this distinction is "how" universities can play this developmental role, systematizing knowledge flows and creating appropriate environments for collaborative innovation.

Our contention is that this lack of clarity arises from a series of over-simplifications in precisely defining universities' contributions to their RISs. A generative versus developmental distinction fails to reflect the more complex institutional reality of universities, implying that universities' knowledge capitalization can be decoupled from their governance contributions. It is clear that universities' developmental engagement affects their generative capacity, raising the possibility that generative activity can act as a foundation for developmental activities. Likewise, we are concerned in artificially separating the third task from core activities, which many universities tend to undertake simultaneously with considerable overlap, reflecting the fact that, as Mowery and Sampat (2005) argue, most universities are internally organized as co-operative, interactive communities rather than rigid corporate hierarchies. Many universities learn from their different activities simultaneously, leading us to suggest a less antagonistic framework focusing on learning communities rather than segmenting universities' different engagement functions. This allows us to consider the opportunities thereby created for creating new linkages between regional actors.

Sector Characteristics and Universities' Institutional Learning

Even though universities differ in scope, scale and organizational structure, one can safely argue, at least at a general level, that a university's institutional learning is highly influenced by its interactions with regional partners, not the least the regional industry and labour market. What is difficult to resolve within the university is intra-institutional learning because different industrial sectors place very different demands on universities, leading to differing institutional responses. At the regional scale, universities' learning processes are shaped by dominant regional modes of knowledge exploration and exploitation, what Asheim and Gertler (2005) refer to as the regional "knowledge base". This may direct or inhibit institutional learning within the university, as the organizational responses necessary for universities to engage with particular sectors may not be transferable to the other sectors with which the institution seeks improved interaction (Lorenzen, 2001).[2]

This issue becomes clear if university engagement is distinguished on the basis of the sectoral knowledge base. In engineering-based (synthetic) industries, innovation support involves promoting and upgrading existing industries (e.g. automotives) and revitalizing older sectors (e.g. food) through research collaboration. The innovation process is often oriented towards the efficiency and reliability of new solutions, or the practical utility and user-friendliness of products from the perspective of the customers. Overall, this leads to incremental approaches to innovation, dominated by modifying existing products and processes. Relevant university–industry links involve concrete knowledge applications and applied research. There is know-how, craft and practical skill required in the knowledge production and circulation process, often provided by professional colleges, or by on-the-job training. Universities may create consultancy organizations, centres or departments, may develop their curricula to require student placements and may hire advisers to identify particular applications which can be developed from the knowledge within the professoriat.

Innovation in science-based (analytical) industries involves building new industries and firms from science (illustrated by the pharmaceuticals industry). Knowledge processes tend to be more formally organized (e.g. in R&D departments) with outcomes documented in reports, electronic files or patent descriptions. Companies usually have their own R&D departments as much to digest and implement external research results as to produce new proprietary knowledge, activities which require specific academic qualifications and capabilities. Consequently, the core of the workforce needs research experience or university training and is often involved in scientific discoveries. University–industry links often focus on collaborative research programmes and networks; university institutional responses may involve creating specific, centralized offices to identify patentable knowledge, license that knowledge to end users and establish spin-off companies, often formed on the basis of radically new inventions or products.

We stress that these categories should be understood as ideal types to be used for analytical purposes. Indeed, our argument is premised on the fact that these can represent two countervailing tensions within one institution through which institutional learning processes is filtered. Knowledge bases do not simply correspond to industries or even to particular university/industry interactions, with most drawing on a mix of analytical and synthetic knowledge. Despite this reservation, it is usually possible to identify the most "crucial" knowledge base in real-world cases, not necessarily quantitatively but certainly qualitatively. In the life science industry, for instance, the most crucial—enabling—knowledge is the knowledge of how and why cells behave in a natural

manner. "Cell behaviour" underpins understanding the mechanisms behind diseases and their potential remedy. To put this potential remedy into practice (i.e. to produce a biotechnology-based drug/treatment), these mechanisms need to be controlled and (de)activated. This effectuation requires additional skills to the pure analytical knowledge about cell behaviour. Nevertheless, it is the knowledge about the natural mechanisms that constitutes the industrial knowledge base. Conversely, in the ICT industry, the dominant knowledge base is more appropriately classified as synthetic. The backbone of the industry is the creation of man-made functional systems (e.g. various forms of computational applications). Yet, analytical skills (e.g. advanced mathematics) are simultaneously necessary for systematic evaluation and as a basis for adjustments of performance. Analytical knowledge is, however, not a basic precondition for realizing the application (the knowledge base), merely an add-on for improvement.

Historically, universities have often allowed different departments and faculties to organize their own regional engagement activities, matching target groups' engagement needs and norms at the departmental or faculty level (Arbo & Benneworth, 2007). Increasing pressure and riskiness of universities' knowledge capitalization have led many universities to develop single, centralized professional structures for regional engagement to minimize risk while maximizing exploitation. These professional structures have become new knowledge arenas within the university, in which different actors with diverse sectoral experiences come together to develop corporate support activities (Benneworth, 2007). These new institutions are sites for collective learning activities across knowledge bases, creating tangible linkages between RIS actors. Learning between actors involved in knowledge exploitation in different sectors may help therefore to support new knowledge bridges within the university, but also support learning between sectors within the region, thereby strengthening the RIS. In this article, we restrict ourselves to the former element, whether universities seeking to engage simultaneously with multiple sectoral knowledge bases undergo institutional learning that creates new structural regional innovation capacity, asking three questions:

(1) How does the university mediate the differing structural innovation demands of different economic sectors, and between needs of individual collaborators and the overall RIS?
(2) How does the university learn as an organization, resolving these tensions in a constructive way which augments the university's capacity to contribute regionally?
(3) How does that institutional learning within the university become institutionalized and ultimately embedded within the RIS?

In this article, we consider how the technological and institutional learning processes associated with three distinct sectoral engagement efforts built up, and how the university responded institutionally to facilitate possibilities for inter-sectoral learning within the university, which corresponded to improved inter-sectoral connections within the RIS. We chose the three sectors to illustrate the engagement case as broadly as possible by reflecting diverse knowledge base characteristics, regional governance arrangements and existing regional structures as possible (cf. Table 1). The case studies were developed as stylized representations of detailed narratives developed through three sets of semi-structured interviews (ca 15 in each case) with key personnel at LU, regional partners and other key stakeholders in these areas to understand the dynamics of institutional learning

Table 1. The contrasting features of the three chosen regional engagement projects in Lund by knowledge base, governance structure and technology status

Sector	Knowledge base/ technology status	University innovation support	Governance structure of regional industrial base
ICT	Synthetic/analytical, mature high technology	Spin-off companies Responding to firm-based knowledge demands Collective research in platform technologies	Well developed with wide range of supportive/dedicated business support organizations
Life	science Aspirational, attempting to learn from existing structures	Analytical, disruptive high technology Infrastructure sharing	Spin-off companies Patenting/licensing deals Research networks and collaboration along the pipeline
Food	Synthetic, mature technology	Participating in intermediary organizations and networks Consultancy support and advice in associated technological areas	"Old boys network", traditional, potentially locked in

Source: Authors' own design.

at a regional level in rapidly restructuring RISs. Secondary data from annual reports, strategy documents and websites have been used to complement the interviews.

The Scania Region, LU and the IDEON Learning Community

Scania is the southernmost county of the Kingdom of Sweden, ceded by Denmark at the Treaty of Roskilde in 1658 along with Blekinge and Halland provinces. The region's main city is the port of Malmö, home to 250,000 of the county's 1.2 million population and connected to the Danish capital, Copenhagen, by the Øresund bridge. Lund is Scania's third city, after Malmö and Helsingborg. Since 1997, Scania has enjoyed a trial form of devolution, with an elected county assembly, "Region Skåne", assuming powers from the central governmental office, the "Länsstyrelse". Scania is one of Sweden's three main industrial centres, alongside Gothenburg and Stockholm, historically possessing a large marine and maritime sector around Malmö. This industry underwent significant economic decline in the 1970s and 1980s. In response to this, the regional administration, at the time appointed by the national government, in partnership with the municipality of Lund, focused upon restructuring Scania's economy towards high-value-added sectors. LU became a key part of this restructuring effort.

LU's origins lie in the Treaty of Roskilde: it was created 8 years later (1666) within Crown efforts to develop indigenous Swedish culture within these formerly Danish territories. By the early twenty-first century, LU had grown into Scandinavia's largest university with more than 40,000 students in a city of 75,000 registered inhabitants. The Swedish higher education system traditionally grants professors considerable autonomy and academic freedom, articulated in 1945 as the "lärarundantaget" ("professors'

exception"); this law granted patent ownership filed by employees during their normal work to employers; professors were made the exception to this arrangement. More recently, countervailing pressures for greater central management of academics have sought to increase their contribution to innovation. Universities may now establish investment companies ("Aktiebolag") to help academics in commercializing research: a national discussion is currently underway concerning abolishing the professors' exception.

LU lies at a confluence of divergent pressures, from national and regional partners, to commercialize research, maintain academic standards and promote social development. LU has responded by creating a series of internal structures, associated companies, partnership bodies and external connections to engage with and support Scania's industrial base. Indeed, Melander (2006) argues that LU has transformed in recent years from the classical Swedish "Humboldtian" university norm towards a more "entrepreneurial" university. This transformation has partly involved building a central commercialization community as an arena within which a set of technological and institutional learning processes have unfolded. Simultaneously, Scania's RIS has evolved towards a high-technology metropolitan innovation environment where the new entrepreneurially focused LU has become increasing engaged with a range of regional governance networks. We now turn to look at how LU has engaged with three distinct sectors, and how intra-institutional learning has shaped LU's contribution to Scania's RIS.

ICT: Learning the Lessons from IDEON

ICT is an archetypal sector characterized by incremental innovation with a need for synthetic, engineering knowledge, creating new value by combining existing knowledge together creatively. While certain ICT markets—notably in infrastructure provision—remain dominated by large vertically integrated corporations, ICT offers enabling opportunities, creating very low barriers to market entry for firms exploiting synthetic technologies. R&D-intensive firms' research investments may create regional growth ecosystems which outlive particular firms and laboratories (Garnsey & Heffernan, 2005).

IDEON science park's establishment can be seen as triggering LUs involvement with regional industry in general and the ICT industry in particular (Melander, 2006). IDEON evolved from a science park into a campus housing a regional innovation community. IDEON's early learning relationships set the terms under which the university—and regional partners—worked together to develop new activities to strengthen the RIS. This "community" evolved through three phases: small group of enthusiasts emerged, a mini-innovation system developed around IDEON, then following a crisis in this mini-RIS, collective stakeholder action which saved the IDEON concept. The first phase began in the early 1980s, when an enthusiastic academic persuaded LU's board of the potential value of a science park. The success of pioneers like Stanford (where the world's first science park was established in 1948) and Cambridge, UK (1973) were then attracting global recognition. An article in the *Financial Times* prompted an LU professor to suggest creating something similar in Lund. LU's vice chancellor and the university board agreed to explore European best practice examples, advised by the founding director of Heriot-Watt Research Park in Edinburgh (established in 1971).

LU took these good examples to the original foundation created to promote the idea of a science park in Lund, the "Samverkan Universitet Näringsliv" (SUN), established by the then county governor Niels Hörjel, along with the municipality "Lunds kommun" and

LU. IDEON required all tenants to be research active—many firms formed with natural linkages to LU, but neither university nor municipality actively managed IDEON in this phase. Indeed, many faculties actively resisted IDEON and its influence: the medical faculty initially feared a brain drain from its research capacity in terms of entrepreneurial opportunities on the science park (Melander, 2006).

One company in particular was crucial in establishing and developing IDEON. In the early 1980s, Ericsson wanted to establish its new experimental R&D activities in mobile telephony far away from its headquarters in Stockholm. The company funded 20 staff to develop mobile telephony within a small "skunkworks" laboratory within science park premises. Its location in Lund was influenced by lobbying from both Governor Hörjel alongside key IDEON staff. Despite Ericsson's primary commercial interest in telecoms infrastructure and protecting its proprietary paging and cordless systems (Visscher & De Weerd-Nederhof, 2006), its mobile telephony group understandably grew considerably into a significant employer in Lund. The university oriented itself towards Ericsson both as a potential graduate employer and research partner, with a chair in radio technology established at LU (Löwegren, 2003). Ericsson and IDEON together anchored an emerging ICT cluster in the region.

The second phase (1990s) involved a number of organizations being created to support spin-offs, led by the Technology Bridge Foundation (TBF). TBF created a business advice firm (Teknopol), a seed capital firm (Teknoseed) as well as a technology-transfer unit (Forskarpatent i Syd AB). LU also increased its own institutional capacity through the creation of LUAB, a small-scale spin-off firm holding company, initially supporting only a few firms. This small community remained directly concerned with creating and incubating high-technology firms. LU and Lunds kommun remained relatively peripheral to this suite of activities, as IDEON became the centre of an evolving "RIS-in-miniature". Lunds kommun became institutionally involved in IDEON when they invested in the late 1990s in the "IDEON Innovation" project. Further grassroots development took place as important personal networks were forged between key individuals at LU and support organizations. As an example, Peter Honeth, LU's Director, became an IDEON board member and the chair of Teknopol.

In the late 1990s, IDEON faced crisis as its developer face bankruptcy; the regional savings' bank rescue was made contingent on LU becoming more explicitly involved with promoting and running IDEON. LU's concerns over academic freedoms had constrained their involvement in IDEON's development: this deal forced LU to engage more actively. Although the university was institutionally willing to engage more closely with IDEON, managers found delivering those changes very difficult. LU's weakly developed links with other regional actors were a constraint; even by the early 2000s, LU felt in competition with TBF over who should exploit university IP.

After the global high-technology market collapse in 2001, Ericsson merged its handset operations with Sony, marking a more general sectoral restructuring away from developing and manufacturing of hardware towards software and content provision for new generations of mobile handsets. This was not necessarily an area in which emerging ICT firms in Lund had significant competences. The sector therefore faced the challenge of avoiding "lock-in" to the former industrial configuration, ensuring that Ericsson's crisis did not translate into a regional ICT crisis. Inter-firm relationships in the regional ICT sector were comparatively loose, limiting the crisis's outward spread. Jonsson (2002) noted that the university–firm linkages were primarily bilateral, between professors and firms rather than between firms and the university corporately. IDEON itself was not

dependent upon Ericsson for its primary activities, and its deepening relationships with LU provided a continuing stream of companies to act as science park customers. In attempting to deal with this potential lock-in situation, IDEON proved to be an important point of stability around which new activities could emerge and allow Ericsson time to reinvent itself without undermining the RIS's integrity.

LU has contributed significantly to the diversification of the ICT sector in recent years, drawing heavily on lessons from the 1990s in seeking to increase its regional impact. But IDEON was also used by LU to make itself better at exploiting its existing knowledge. As noted earlier, LU was originally very resistant to participation in regional engagement activities, but this learning driven through the commercialization activity helped LU to drive forward an institutional opening-up process, increasing its effective contribution to regional development. The successes of past spin-offs were used by LU to promote commercialization to its staff. The university created a new organization within its institutional boundaries, Lund University Innovation (LUI), to encourage its staff to commercially exploit their knowledge. LUI generated a series of commercial deals between academics and the (IDEON-centred) business support infrastructure, partly facilitated through personal linkages built up in the previous years. This deal-making activity opened up communications pathways by which the university came into contact with a range of regional innovation partners, with whom interaction had previously been hindered by poor connections with these stakeholders. One consequence of this increased interaction was that a number of key regional partners (LU, Region Skåne, IDEON and TBF) agreed in 2004 to create the Innovation Forum (IF) to ensure that particular elements of the RIS worked more effectively together. IF is chaired by LUs vice chancellor and consists of top-level representatives from LU, IDEON, TBF, Region Skåne and Lunds kommun. Even though IF does not have any formal decision power, it served as a critical platform to resolve various conflicts that had erupted between various support organizations and LU. The IF stimulated the university to consider its engagement more generally across a range of sectors simultaneously and to develop a corporate perspective, in turn facilitating more effectively functioning micro-scale relationships.

It is perhaps unsurprising that the university learned lessons from IDEON to apply to ICT commercialization because IDEON was developed to support novel ICT businesses. What is perhaps more interesting is the nature of the institutional learning which took place. IDEON's success, primarily built around creating new businesses and exploiting knowledge, was used to change the internal organization of the university and to support the creation of LUI. LUI stimulated a certain level of interaction with regional organizations, highlighting the systemic shortcomings in the RIS (duplication and rivalry)—which worked against the university's and the regional interest—to university senior managers. This motivated LU to actively support the establishment of IF, which helped to improve and systematize the Lund RIS. Organizational learning within LU enabled a generative project to lead to a developmental improvement, thereby "inverting" the expected relationship between university engagement roles.

Life Science: Learning to be Global/Local

Life science, or, more precisely, healthcare-related applications of biotechnology, is a prime example of a sector predominantly drawing on analytical knowledge (Asheim & Gertler, 2005). The sector's development is characterized by "punctuated evolution"

with incremental upgrades and step-wise development periodically "punctuated" by radical shifts and disruptive technologies (Tushman & Anderson, 1986; Mayr, 1992; McKelvey *et al.*, 2004). The life science sector has expanded steeply in recent years with thousands of new start-up firms across the world. A large majority of these start-ups have been established in close connection with world-class universities, accentuating the development of globally dominant "nodes of excellence" or "megacentres" (Cooke, 2005).

Lund's life science sector has long traditions through the presence of two large pharmaceutical companies Astra (subsequently merged with Zeneca to become AstraZeneca) and Pharmacia (subsequently merged with Upjohn to become Pharmacia & Upjohn, and eventually acquired by Pfizer). Both companies had located important research units in Lund; AstraZeneca is still present with a major research unit employing 1200 staff. After the Pharmacia merger in 1997, cancer and immunology research teams were spun out to form the Lund-based Active Biotech AB, while the rest of the company's activities disappeared from the region. Active Biotech AB is today, with 90 employees, the second largest and second oldest dedicated biotech firm (DBF) in the region, after Bioinvent International AB, which today employs around 100 staff. Bioinvent was founded in the 1980s but reshaped in its current form in 1995 by researchers at LU who wanted to commercialize their findings. In addition to these two medium-sized firms, the region hosts about 35 other DBFs of varying size and age. Most of the companies are university spin-offs (e.g. Camurus, Cellavision, Genovis and Wieslab) while some are local sub-units of global biotech companies. The vast majority of Scania's DBFs are located in the immediate vicinity of IDEON. LU and the regional hospitals remain key influences on the biotech cluster, while local inter-firm linkages, despite spatially dense patterns of location, are relatively rare (Moodysson & Jonsson, 2007; Moodysson *et al.*, 2008). LU's challenge was therefore to replace the dynamism of the two lead companies and consolidate regional activity into a "pharmaceutical megacentre".

In particular, the university had to deal with life sciences' global extent and limited automatic opportunities for integrating activities regionally. LU responded by participating in global projects with global critical mass, while ensuring that knowledge capitalization is encouraged in Scania, often actively seeking out regional partners for global projects to attain this goal. Among the first initiatives chronologically dedicated to life science was Medicon Valley Academy (MVA). This started as an EU INTERREG II project initiated by LU and the University of Copenhagen in 1995, to create a cross-border life science region (MVA, 2006), promoting local integration and cross-fertilization between industry and academia. MVA's current membership of 280 (counted in June 2008) includes public actors such as university faculties, hospitals, counties, private companies working with life science, as well as investors, clinical research organizations, science parks, service providers and other organizations in the region. LU is a key actor in MVA, chairing of the board of directors, with all relevant research departments represented as active members. The MVA initiative has contributed substantially to the development of the region, not the least because of attractive power for venture capital, research funds and human capital, often from the biotech "megacentres" of San Diego, Boston, Munich or Cambridge, UK (Moodysson & Jonsson, 2007). In 2007, MVA changed its name to Medicon Valley Alliance to reflect the increasingly heterodox nature of the network, and increasing active participating by "big pharma" and biotech spin-outs.

Another initiative by LU to promote life science in the region was the formation of the Biomedical Centre (BMC) in 2001. The BMC sought to transcend life sciences'

compartmentalization along faculty-based divides by assembling all the university's life science research within a single facility, located adjacent to Lund University Hospital. This primarily attempted to strengthen LU's brand name as biomedical research centre of excellence, strengthening the knowledge exploration subsystem of the RIS, in a more integrated and "exploitable" manner. BMC is today LU's single largest unit for teaching and research with 700 researchers, including 50 affiliated professors (BMC, 2006). Its research "flagship" is the Lund Strategic Research Center for Stem Cell Biology and Cell Therapy (Stem Cell Centre), established in 2003. Noteworthy within BMC was the creation in 2006 of the Bioincubator Unit within the centre. This drew on the "IDEON Innovation" incubation model and builds its support activities on connections between TBF, IDEON Innovation, LU, Lunds kommun and various private investors offering opportunities for creating biomedical SMEs.

A third related LU initiative, with a somewhat wider geographical scope but with a similar rationale as the BMC, is the Postgenomic Research and Technology Programme in southwestern Sweden (Swegene) that started in 1999. Swegene was a joint programme involving LU, the University of Gothenburg and Chalmers University of Technology in Gothenburg. This initiative aimed to create internationally competitive technology platforms in genomic research. After 7 successful years, more general financial pressures on participants clouded the question of its future (Melander, 2006). However, a spin-out initiative did emerge in 2004 with the establishment of the strategic research centre "Swegene Centre for Integrative Biology at Lund University" (SCIBLU, 2005, p. 3), aiming to "break down many of the obstacles caused by compartmentalization of research into distinct subjects creating a unique research environment (. . .) in the heart of the main biology research area in southern Sweden".

These three related life science initiatives highlight three types of learning activity that took place within LU which improved the regional impacts of what were primarily global, placeless research projects—LU has been learning what it means to be global/local. The first is that there has been learning about life science commercialization; the various initiatives were all dependent on attracting external investments, as much dependent upon global visibility and connectivity as local integration. MVA built critical mass at the scale of the Öresund, while the BMC is an interesting example of building critical mass at the institutional scale. This "global" nature of the research projects allowed regional activity to be appended to LU without diluting the knowledge assets' wider appeal. Regional activities complement this global critical mass, drawing on the university as a global pipeline to create regionally exploitable assets. LU has demonstrated its regional engagement to its partners, further increasing their institutional support for the activities.

The second dimension of learning was the importance of external partners in influencing university perceptions; the need to assemble international scientific advisory boards for projects and spin-offs continually reinforced the need for the university to manage its external relations, and not solely to focus on Scania as the target of its engagement efforts. In this sense, regional and international networks and institutions have overlapped—international networks had regional value by helping new local businesses to form and raise investment, while the presence of these globally networked biotech researchers and entrepreneurs in the region also made it more interesting for global firms.

The third, and perhaps most unexpected, learning dimension, was transferring the experience of IDEON to the BMC. LU recognized that IDEON offered a sensible commercialization model for a hybrid organization such as BMC and that commercialization itself

added to the diversity and hence attractiveness of BMC. What began as relatively small generative projects emerged with larger developmental effects at the regional scale. The IF required a number of practical projects as the foundation for future work, and "generative" projects emerging from biosciences helped provide a rationale behind this organization, which then expanded to produce effects which could be considered as more developmental.

Food: Learning to Innovate at Interfaces

The food industry is a prime example of a traditional industry with a synthetic knowledge base drawing on incremental process streamlining. EU accession opened Sweden's formerly protected national agricultural market to increasing intensified global competition. The industry experienced structural transformations including increased foreign ownership and a growth in export markets; adaptation was partly benign, but food industry employment decreased substantially in recent years, notably in Scania. As Scania represents 45% of Sweden's total food production (Lagnevik *et al.*, 2003), the sector's regional fate is of national significance. LU's challenge in this sector has been helping to address structural change in a sector with very low research absorption capacity, shifting from labour-intensive bulk production heavily aimed at price competition and economies of scale towards higher-value-added products.

Achieving this change in the industry's innovation absorption capacity has involved supporting a high volume of small-scale incremental innovations which over time reorient the regional industry towards higher-value-added markets. The knowledge requirements of Scania's food industry were extremely diverse, across a range of disciplinary and knowledge bases. Particular firms could have simultaneous demands for analytical knowledges (biosciences), synthetic knowledges (mechanical engineering, automation) and social science knowledges (marketing, entrepreneurship), albeit in very small measure. Although LU had strengths across these areas, it lacked an expertise in providing relatively small contributions to many firms. A key element of institutional learning has been LU learning to have a sensible impact on the Scania food innovation system, where the institutional and commercial benefits justify the costs incurred.

This engagement was stimulated by a traditional large-scale strategic innovation project, "Food Innovation at Interfaces", which because of its size was significant to LU. This project was funded under the prestigious VINNVÄXT (the national "Regional growth through dynamic innovation systems" programme). To win funding, bidding partnerships had to demonstrate a broad, supportive coalition of public and private sector actors with a track record of effective collaboration in innovation. Food Innovation at Interfaces sought to upgrade the innovative capacity of the food industry, and complement historically low R&D levels, by strengthening ties with research activities at the universities in the region. Food Innovation at Interfaces represented the culmination of a decade of interactive network-building in Lund around food innovation, creating systemic innovation connections able to mobilize in response to such an opportunity. As a large-scale (10 year, SEK200 m) project, LU was able to prioritize supporting the project and becoming a linking node between appropriate sources of knowledge and expertise within LU and regional partners.

The funding application was coordinated and written by the Scania Food Innovation Network ("Skånes Livsmedelsakademi" or SLA), with a membership encompassing

university faculties, the Region Skåne, dairy firms and leading food production actors. As with MVA, LU is a key actor in SLA, holding several posts in the board of directors and being a leading partner in several research projects managed by the organization. SLA was created in 1994 to enhance the Scania food industry's competitive position via increased co-operation between the business and scientific communities. The project provided funds to realize the potential of a latent innovation network in which LU already played an important role. However, the project also stimulated LU itself because of the different types of knowledge involved in the project and the need for particular relationships to encompass the transfer of many different types of knowledge types, disciplines and bases.

LU's strategic support for mobilization reflects a number of learning processes for LU in seeking to increase its regional engagement. LU had already recognized the importance of building an identified critical mass to attract outside public and private scientific investments (cf. MVA): the Food Innovation at Interfaces project was developed to meet this criterion. One project area, creating foods with specific health-giving properties, supported the Functional Food Science Centre at LU, a new wave university research centre involving 70 senior researchers from 40 departments and 5 faculties at LU. Programme funding established a PhD curriculum within the centre delivered in close collaboration with the food industry and representatives of the commercial and industrial development and the health and medical care system in Scania.

A second example of institutional learning within LU came through the way the IDEON lessons were implemented in the project. Although the university lacked capacity to work with large numbers of partners on tiny technology-transfer projects, IDEON Agro Food was developed to extend the IDEON "mini-RIS" while "translating" it into the technological domain of food. The university actively supported IDEON Agro Food, transferring the IDEON business support model originally for exploiting ICT and biotech companies (using mainly analytical knowledge in high-technology fields), to encourage bigger networks and better relationships between food companies and knowledge producers, using predominantly synthetic knowledge in low-technology fields.

The third element of institutional learning came in using large-scale strategic projects to resolve the potential distraction of involvement in large numbers of small-scale commercial engagements simultaneously. There was no easy recipe to provide technology transfer to lots of small businesses directly, so the university pursued a two-pronged approach to ensure that it retained strategic focus on core scientific activities. First, intermediary organizations (including IDEON) were enrolled in the network to relieve the necessity for LU to work with many small firms simultaneously. Secondly, their success in winning strategic projects focused academic leaders on thinking "how" to best engage with regional communities and businesses, to deliver the core university missions by providing access to core research funding, increasing their world-class status and visibility.

The focus of the Food Innovation at Interfaces programme demonstrates how many of the activities supported to enhance the food industry's innovative capacity had a dual basis, first in university research but also in wider university-centred—but nevertheless boundary-spanning—activities which emerged as LU became regionally engaged. In one way, "Food Innovation at Interfaces" embodies LU's contemporaneous institutional learning in the domain of regional engagement, where LU developed capacity to assemble strategic projects with a critical mass encompassing scientific and valorization activities. These strategic projects delivered multiple outcomes simultaneously using a variety of appropriate knowledge-transfer mechanisms. This partly resolved tensions between

these different knowledge bases. These strategic projects involved a range of regional and external stakeholders and provided a site for a learning community working together to create new linkages and address systemic barriers within Scania's RIS.

Conclusions

LU's role within its RIS has evolved in the last two decades as Scania has developed into a high-value-added economy. The university has evolved a set of structures by which tensions between different sectoral engagement activities have been mediated and have acted as the site for their "engagement learning communities". Initially, the university became involved in a science park, IDEON, around which a number of regional agencies developed a range of support services. The university limited itself to playing "generative" roles in the unfolding RIS, but over time, the university changed its approach. There is evidence that these early, small-scale experiments informed the development of larger-scale activities and that there has been a cross-sectoral learning process, contained within the university community, which has provided the university with a capacity to play a more "developmental" role within the Scania RIS. It is possible to see that a number of university engagement activities that followed from IDEON in the 1980s were dependent on learning that had taken place in the community that had formed around IDEON.

First, LU has been active in learning from different types of engagement activity. The university has responded to regional partners in a variety of manners, and these responses have built up within the university into an enhanced regional engagement capacity. This learning has been boundary spanning, creating linkages between different sectoral knowledge bases (life sciences, ICT and agriculture), between generative projects and developmental outcomes such as IF, and creating regional critical mass to capture the attention of outside investors. These constructive learning trajectories have in turn involved a range of external partners contributing to these activities, so that learning activities undertaken within the university and specific university-centred partnerships have diffused into the wider RIS.

In that sense, the university's institutional learning trajectories have played a role in systematizing the RIS, and helping to "construct advantage" regionally, drawing together a range of world-class assets in creative combinations to improve their overall regional contribution. This raises the question of how to characterize this multi-trajectory learning process: to do this we distinguish between three processes within LU's overall regional contribution. There is first a deepening within the RIS, as LU has helped to create institutions which systematize inter-actor relationships promoting technology transfer. Secondly, there is a widening of the RIS as the university has actively sought out regional partners to enrol in its networks to contribute to developing regional critical mass in knowledge activities. Thirdly, the university has enacted an integrative role, as large projects which it has promoted, sponsored and supported have become a focus allowing a range of regional actors to make more structured contributions to the RIS.

The university's contribution to the various sectors has deepened over time, with the university becoming more actively involved in a range of activities. LU has shifted from being a supplier of (generative) human capital towards actively (developmentally) shaping change within regional support organizations, ensuring that those organizations work together better as a coherent RIS. This could be considered as a "deepening" of

the university's involvement in the RIS, with the university moving from being involved purely with knowledge exploration to concerns with its subsequent exploitation, and maximizing the arising returns.

Alongside this "deepening" of involvement has been what could be called a "widening" of the university's involvement, as the university creatively assembled local assets to have some semblance of critical mass that wins external investment. The university "creatively confronted" its local partners, drawing on its external linkages, to widen the regional network's effective extent. These connections bring concrete investments to Scania: people, infrastructure and ideas which interact with existing innovation activities. This has stimulated interest among regional partners in further global networking; given the challenges to Scania's RIS in avoiding becoming locked-in, providing a wider, externally facing dimension to the RIS may yet prove to be a significant contribution.

The third element of the change introduced by the university, alongside deepening and widening, has been "integrating" the various sectors into a more mutually self-reinforcing RIS. Although IDEON was initially stimulated to support high-technology knowledge-intensive concepts emerging from the university, IDEON has supported high-technology firms in less knowledge-intensive sectors, notably the food industry, over a decade in which LU became more interested in food-based research. IDEON also hosted an institutional experiment, the incubator, whose success helped a number of co-located facilities, the university, the science park and the hospital to develop other co-incubator spaces where they could begin to work together. Both the Bioincubator and IDEON Agro Food relied for their concept, their organization and the people to deliver their services upon IDEON's "RIS-in-miniature". The IDEON approach, developed for knowledge-intensive businesses with synthetic knowledge bases (ICT), expanded over time to cover analytical knowledge bases (life science) and less knowledge-intensive industries (the food sector). These concrete outcomes formed the basis for these partners to develop more strategic relationships from which large-scale collaborative innovation projects were proposed, approved and successfully implemented.

These three dimensions of change help to nuance our understanding of the development trajectory of policy capacity within fragmented RISs. Partnerships have been assembled to develop particular resource-based policies and instruments. The university has played a number of roles in these partnerships, deepening its involvement and also those of other innovating partners in strategic innovation governance networks, widening those networks through the university's global networks and eliminating barriers to co-operation at the regional scale. The constructive tension between these three developments, within a broadly positive approach from regional partners, has driven the RIS' creative evolution, increasing its capacity to deliver innovative solutions, helping to make existing innovative solutions more successful and more developmental. We show these three dimensions and the way that the university acts as a common focus in integrating the three drivers to improve the RIS in Figure 1.

This provides an insight into the question raised by Nauwelaers and Wintjes (2002), namely "how can innovation policies move from individualized firm-based subsidy programmes to a more systemic restructuring process?" The answer appears to be that the university uses these three additional dimensions to take what are relatively small activities and outcomes and joins them up creatively with other partners in the university's networks, other regional innovators and its external partners. Similarly it joins these together with other innovative activities with which the university is involved. In parallel

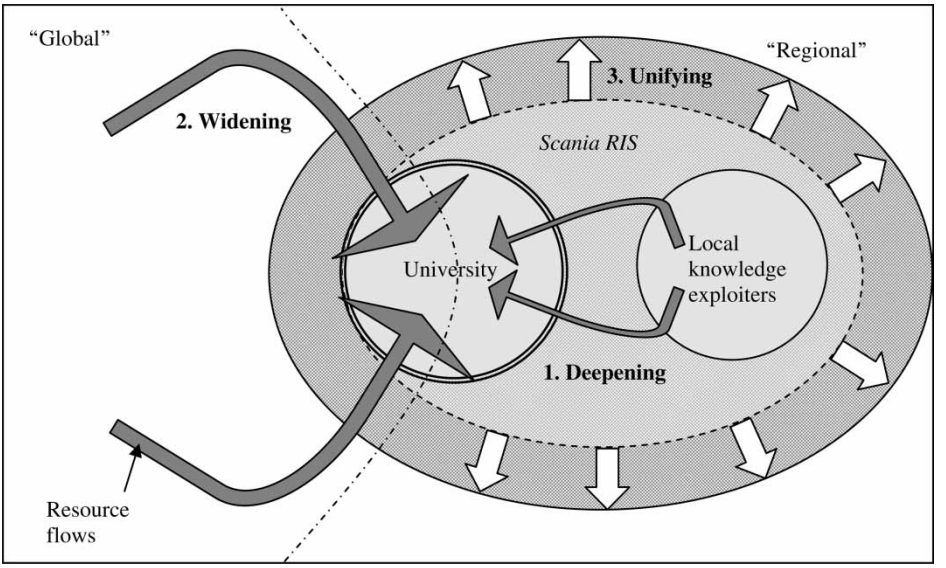

Figure 1. The multiple impacts of university engagement on restructuring and strengthening the Scania's RIS

with this, this "travelling activity" has given regional partners further reasons to work together and, as a result of this collaboration, get to know, or at least know about, and therefore trust each other. This creates the ground conditions for attracting external investment and generally a regional environment more conducive to more constructive interaction. The regional learning journey therefore reflects the university's own learning developments and trajectories, and the experiences generated by the university influence the overall regional trajectory.

Notes

1. This context sensitivity caters for an important added value of the RIS approach compared with Triple Helix (Etzkowitz & Klofsten, 2005). This concept has also made an important impact on policy practice and discourse around universities and regional development through its focus on the entrepreneurial university. It has, however, been criticized for inducing a one-size-fits-all policy framework (Coenen, 2007).
2. However, at the same time as the dominant knowledge base characteristics of the regional industry are affecting the scope for, and form of, university–industry relations, the knowledge base of the regional industry is often in itself shaped by the particular strongholds of the regional university's activities.

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