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Putting Constructed Regional Advantage into Swedish Practice? The case of the VINNVÄXT initiative 'Food Innovation at Interfaces'

Coenen, Lars (lars.coenen@circle.lu.se)
CIRCLE. Lund University

Moodysson, Jerker (jerker.moodysson@circle.lu.se)
CIRCLE. Lund University

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
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This paper presents a study of the pre-history and evolution of a regional innovation system initiative supporting activities at the intersection of traditional food production and modern biotechnology. Drawing on established ideas on the triple helix of industry, university and government and its impact on innovative capacity (as they are formulated in the regional innovation systems approach) and more recently introduced ideas on 'differentiated industrial knowledge bases', the study illustrates how the VINNVÄXT initiative 'Food Innovation at Interfaces' has been formulated and implemented in close dialogue with the actors and activities constituting the system under support. The initiative is thereby a good example of pro-active and fine-tuned regional innovation policy which is referred to as 'constructed regional advantage'. By focusing on a policy initiative targeting the renewal of a mature industry in a declining phase of its life cycle, the paper fills a gap in the literature which so far has dealt mostly with emerging industries at the start of their life cycle. Two detailed cases of food innovation 'at interfaces' are used to illustrate the arguments.

Keywords: : Regional Innovation System, biotechnology, knowledge bases, regional innovation policy

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Lars Coenen and Jerker Moodysson

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University, Sweden

lars.coenen@circle.lu.se, jerker.moodysson@circle.lu.se

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Abstract

This paper presents a study of the pre-history and evolution of a regional innovation system initiative supporting activities at the intersection of traditional food production and modern biotechnology. Drawing on established ideas on the triple helix of industry, university and government and its impact on innovative capacity (as they are formulated in the regional innovation systems approach) and more recently introduced ideas on 'differentiated industrial knowledge bases', the study illustrates how the VINNVÄXT initiative 'Food Innovation at Interfaces' has been formulated and implemented in close dialogue with the actors and activities constituting the system under support. The initiative is thereby a good example of pro-active and fine-tuned regional innovation policy which is referred to as 'constructed regional advantage'. By focusing on a policy initiative targeting the renewal of a mature industry in a declining phase of its life cycle, the paper fills a gap in the literature which so far has dealt mostly with emerging industries at the start of their life cycle. Two detailed cases of food innovation 'at interfaces' are used to illustrate the arguments.

Introduction

The regional innovation systems approach has found considerable resonance among policy-makers, particularly as a tool to promote innovativeness among small and medium-sized enterprises by connecting them with the regional innovation support infrastructure (Asheim et al., 2003). The approach explicitly employs a systemic perspective on innovation (Edquist, 1997). As such it seeks to enhance stronger collaboration and association between innovating partners (Cooke and Morgan, 1998) recognizing that innovation is fundamentally a localized (though not exclusively local) and interactive process between industry, government and university. Given these characteristics, it is important to acknowledge and analyze how regional innovation systems are shaped differently because of industry-specific characteristics and territory-specific institutions. Such pro-active and fine-tuned regional innovation policy is often referred to as *constructed regional advantage* (Asheim, Boschma and Cooke, 2007).

Especially now that regional innovation systems policy has become more common and widespread, it has become increasingly important to address specific industrial and territorial differences in order to make such policy more effective (and avoid general best practice models). Taking an actor- and activity-based vantage point, this paper addresses the question how regional innovation systems that are sensitive to their industrial and territorial preconditions can be constructed. In doing so it dismisses a static perspective on regional innovation systems but acknowledges Etzkowitz and Leydesdorff's (2000) argument that within an innovation system "the subdynamics and the levels are […] reflexively reconstructed through discussions and negotiation in the Triple Helix" (p. 113). Thus, a dynamic triple helix model refers not only to changing relationships between university, industry and government but also to internal transformations *within* each of the spheres.

Most findings on triple helix collaboration originate in studies of high-tech sectors and emergent industries at the start of their life cycle. In contrast to these studies, this paper focuses on preconditions for prolonging and extending the life cycles of mature industries. Such preconditions have been marginally explored in existing literature, and findings from this case can therefore contribute to a better understanding of triple helix dynamics in regions dominated by traditional industries. The analysis draws on the case of food production in Skåne (the southernmost province of Sweden), a prime example of a traditionally strong but declining industry which recently have entered a phase of renewal based on new combinations with technologies drawing on modern biotechnology. An important factor underpinning this renewal is the regional policy initiative 'Food Innovation at Interfaces', funded by VINNOVA (the Swedish Agency for Innovation Systems) as part of their so called 'VINNVÄXT' program. Our analysis illustrates how this policy initiative have been shaped in a dialogue with the actors of the system it is targeting, paying close attention to the nature of their activities.

The following section elaborates further on the rationale and form of regional innovation systems policy. This is followed by a closer look at learning in a triple helix context as a specific conceptual tool underlying the construction of regional innovation systems. The last section provides the case-study, analysing the pre-history and emergence of the Food Innovation at Interfaces initiative and two illustrative cases of industrial renewal in the intersection of food and biotechnology, followed by the conclusions.

The added value of regionalizing innovation policy

Before we start addressing how regional innovation systems could be constructed, it would be necessary to discuss the arguably increasing popularity of the regional level for innovation policy. In other words, what is the added value of a regionalization of innovation policy? Even typical proponents of the national innovation systems approach ‘admit’ that “the region is increasingly the level at which innovation is produced through regional networks of innovators, local clusters and the cross-fertilizing effects of research institutions” (Lundvall and Borràs, 1999, p. 39). At the same time, however, various empirical studies across a range of industries and regions observe that both local and distant networks are needed for successful cooperative innovation projects (e.g. Cooke et al., 2000; Gertler and Levitte, 2005; Lagendijk and Oinas, 2005; Coenen, et al, 2004; Moodysson and Jonsson, 2007). To simply assume that collaboration in innovation is best facilitated within the confines of a region due to the virtues of spatial proximity between co-located enterprises would hence not reflect the realities of on-going globalization processes in the learning and knowledge-based economy (Cooke, 2005). Rather, the inherently interlocked character of a regional system in overarching structures and institutions refers to a state of *multi-level interdependence* (Howells, 1999). This does not imply any claims for total regional economic sovereignty yet allows for core economic activities within a value chain to be concentrated in specific regions (Asheim and Coenen, 2006). As such, regional innovation systems are conceived as open, socially constructed and linked to global, national and other regional systems of innovation within a multilevel governance perspective (Cooke et al., 2000).

It is important not to interpret a regional system as a national system writ small. Even though the definition of a regional innovation system certainly resembles that of a national innovation system, i.e. the specific national interplay between the prevailing economic structure and the institutional set-up (Lundvall and Maskell, 2000, p. 362), an important distinction lies in the notion of embeddedness. This refers to the importance of personal relations and networks for economic action and outcomes ingrained in a social and cultural context through social integration (Granovetter, 1985). Innovation system analyses on the national level often involve a plethora of actors and institutions. This makes it difficult to study how embedded learning processes actually take place across the totality of the national system. The problem is sometimes resolved by focusing on specific, important and innovative sectors in the national economy (see for example Edquist and Lundvall, 1993), which, in turn, are often regionally concentrated. Against this background, Mietinnen (2002) concludes in his review of national innovation systems literature to employ more disaggregated 'reduced-form innovation systems' as the basic unit of analysis. This does not conflict with received wisdom that the national environment remains highly significant for innovating firms (Asheim and Gertler, 2005; Cooke 2004; Gertler 2004) nor does it downplay the importance of extra-local knowledge. It can be argued, however, that regional innovation systems provide a more grounded approach to situate socially and institutionally contextualized empirical analysis of innovation systems acknowledging the role of embeddedness to its full right.

Following insights gained from economic geography and regional studies, regions are more and more seen as starting points for national and supranational (e.g. EU) policy measures pursuing not only traditional redistribution targets (exogenous regional development) but progressively also as active arenas of economic force and growth in their own right (endogenous regional development) (Cooke et al., 2000). From an innovation policy point of view, the latter rationale is of course most relevant. In line with our argument about the sharper analytic focus of the regional innovation systems approach, regionalization holds the potential for improved 'on-the-ground' policy know-how about the specific conditions of the regional action level. Measures can thus be formulated, implemented and monitored in a more targeted way. As Nauwelaers and Wintjes (2002, 205) argue:

> "The non-anonymous relations, the complementarity of activities and the historical setting are stressed in the regional context. […] Further, in order to find out and articulate what a particular region or firm needs, or what is lacking concerning innovation, regional proximity and communicative interaction may be needed to address the tacit and latent aspects of such needs."

However, all this stands or falls with the capacity of the policy apparatus to embrace an approach which aims to bring about a process of collaborative problem-solving between the public and private sectors within the region (Cooke and Morgan, 1998; Henderson, 2000). As such it is crucial not to merely lean back and assume that the regional level is "the basic level at which there is a natural solidarity and where relations are easily forged" (EC, 1994 quoted in Henderson and Morgan, 2001) but to recognize the need for deliberate and conscious efforts on the part of firms, public agencies and research and education institutes.

In sum, when accepting that the regional level qualifies as an effective starting point to enhance innovation, the regional innovation systems approach is regarded as the most comprehensive intellectual framework to guide policy action (Asheim et al., 2003;

Landabaso, 1997) because it provides an amalgam of earlier ideas and theories on territorial innovation models in a knowledge-based economy (Doloreux, 2002). Drawing on findings from previous research (Asheim et al, 2003), innovation policy tools dedicated to the support of small and medium sized firms can be classified in two dimensions, resulting in a four quadrants table (Figure 1). The table distinguishes between two main aims of the support tools. Some tools aim at giving firms access to resources that they lack to carry out innovation projects, i.e. to increase the innovation capacity of firms by making the necessary resource inputs available, such as financial support for product development, help to contact relevant knowledge organisations or assistance in solving specific technological problems. The other type of instruments have a focus on learning, trying to change behavioural aspects, such as the innovation strategy, management, mentality or the level of awareness in firms (Asheim et al, 2003).

FIGURE 1 HERE

Following a more pro-active and dynamic perspective to innovation policy, the objective of policy instruments is thus not solely to provide scarce resources (such as financial assistance) to innovating firms, but also to promote learning about R&D and innovation and the acquisition of new routines within firms. Lack of demand is often a bottleneck for financial incentives to innovation activity, i.e. that firms initially do not see the need to innovate, or alternatively, that firms do not have the capability to articulate their need for innovation. Some policy instruments should, therefore, also attempt to enhance demand for initial innovation activity of firms, and, thus, must include an explicit behavioural aspect with an ultimate policy target of promoting the endogenisation of innovation activity of enterprises.

The other dimension includes the target group of instruments. Some tools focus on innovation and learning within firms, to lower the innovation barriers of firms, such as lack of capital or technological competence. Other instruments to a larger extent have regional production and innovation systems as their target group, aiming at achieving externalities or synergies from complementarities within the regions. The barriers may for example be lack of user-producer interaction or lack of relevant competence in the regional knowledge organisations to support innovation projects. The need for a more system-oriented as well as a more pro-active innovation based regional policy has been emphasized in previous research (Asheim et al, 2003).

Constructing regional advantage: learning in a triple helix

This shift towards more pro-active policy fits well with a (dynamic) triple-helix perspective, which has been given an increased attention among policy makers as well as researchers within innovation research. However, so far this perspective has been applied in a rather static way, more like a heuristic device than as a basis for actual policy formulations. This is also the weakness of the triple helix approach, as it does not give much guidance concerning how collaboration could be functional, operational and implemented in concrete policy settings in order to contribute to constructing regional advantage. In order to achieve this, theoretical and practical advice must be developed with respect to how interaction *between* industry, university and government should be organized, and with respect to how knowledge creation and innovation oriented work should be organized *internally* among the different actors (Hemlin et al., 2004). Independent of the specific triple-helix context policies have been formulated and implemented promoting firms' contacts with R&D institutes and more frequent use of R&D, while universities at least in Finland and Sweden for some years have been given a so called ‘third mission’, i.e. to cooperate externally with the surrounding society in addition to doing research and teaching. However, so far little or nothing has been done concerning changing behaviour of the third actor of the triple-helix, i.e. the government, as well as with the triple-helix system as a whole. An important part of this is to develop a more innovation oriented public sector in a sustained fashion. This entails a focus on pro-active learning to innovate at both universities and government at different geographical levels (national, regional and local), in addition to doing the same with the private sector.

The surprisingly little work that has been conducted on interactions in terms of knowledge flows between the (triple-helix) actors in a network of an innovation system

(Archibugi et al., 1999) fits uncomfortably with the dynamic perspective implied in the learning economy and calls for a shift from a static position of possession of knowledge to a more dynamic position of practice of knowledge (Amin and Cohendet, 2004; Brown and Duguid, 2002). In policy terms such a shift towards a pro-active, learning-to–innovate based policy is often recognized in the concept of 'regional experimentalism' (Sabel, 1996 in Henderson, 2000: 349) in which the triple helix of industry, government and university

> "work in small-scale repeated interactions in an attempt to (re)define regional development support services and priorities in a collective manner, establish specific targets and responsibilities, and monitor outcomes in a way that facilitates learning on the part of those in a position to respond. This regional development agenda relies less on learning as a means of incremental adaptation to existing routines, than as a form of strategic and experimental goal-setting which, it is argued, can help firms and regional support organizations question the validity of existing support structures and adapt to future challenges".

In this, regional experimentalism bears close resemblance to the notion of regional development coalitions (Asheim, 2001; 2002) and system-oriented, learning-based policy tools (Nauwelaers and Wintjes, 2002). Examples of such regional innovation policy can be found in the European Commission's article 10 programs: RTP (Regional Technology Plan), RIS (Regional Innovation Strategies) RITTS (Regional Innovation and Technology Transfer Strategies) and the most recent Innovative Actions. Also the Norwegian REGINN program as well as in the Swedish VINNVÄXT program have incorporated a more comprehensive innovation policy approach building on broad participation and engagement and with emphasis on collective learning.

Regarding the nature and characteristics of learning processes between the actors in the regional innovation system it is important to realize that these are heavily shaped by dominant regional modes of knowledge exploration and exploitation, what Asheim and Gertler (2005), refer to as the industrial 'knowledge base'. Different industry-specific needs in terms of innovation support put different demands on policy. Despite the generic trend towards increased diversity and interdependence in the knowledge process, the innovation process of firms and industries differ substantially between various sectors, whose activities require specific knowledge bases. In this paper we distinguish between two knowledge bases (and related activities): 'analytical' and 'synthetic'. These contain different mixes of tacit and codified knowledge, codification possibilities and limits, qualifications and skills required by organisations and institutions involved, as well as specific innovation challenges and pressures. The typology encompasses and acknowledges the diversity of professional and occupational groups and competences involved in the production of various types of knowledge.

As an ideal type, a synthetic knowledge base refers to the knowledge required for activities involved in the design of something that works as a solution to a practical problem. Innovation takes place mainly through the application or new combination of existing knowledge. Most R&D are applied, often in the form of product or process development. University-industry links are sometimes relevant, but mainly in the field of concrete knowledge application. New knowledge is created less in a deductive process or through abstraction, but in an inductive process of testing, experimentation, computer-based simulation or through practical work. The 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 a rather incremental way of innovation, dominated by the modification of existing products and processes.

Activities drawing on an analytical knowledge base are geared to understanding and explaining features of the natural world. Scientific knowledge is highly important, and knowledge creation is based on cognitive and rational processes (e.g. formal models). Companies usually have their own R&D departments but they also rely on research results of universities and other research organisations in their innovation process. University-industry links and respective networks, thus, are important and relatively more frequent than in activities drawing on a synthetic knowledge base. The core of the work-force, as a consequence, needs research experience or university training and is often involved in scientific discoveries. Table 1 summarizes the main differences between an analytical and a synthetic knowledge base:

TABLE 1 HERE

Previous research has shown that there are distinct rationales for innovation support depending on the knowledge base of the industry. In synthetic industries, innovation support involves promoting and upgrading existing industries and revitalising older sectors through research collaboration, whilst supporting analytical industries involves building new industries and firms from science (Asheim and Coenen, 2005). However, most industries, whether characterized as analytical or synthetic, involve elements of both analytical and synthetic knowledge. In some cases synthetic industries are 'upgraded' by the introduction of analytical technologies, while in other cases the synthetic activities serve as carriers for the analytical findings, i.e. justifying the mere existence of these. Whether such industries, representing the interface of analytical and synthetic knowledge, are results of science-push or demand pull, they provide new challenges and opportunities for innovation support. The remainder of this paper reveals the emergence of a regional policy initiative targeting the intersection of the two knowledge bases, i.e. exploiting the potential of combining them rather than treating them as distinct fields with different needs. The analysis illustrates how processes of path dependency, both in terms of social networks and technological choices, play a crucial role in conditioning the strategy adopted.

'Food Innovation at Interfaces' - basic structure and strategy

The policy initiative analysed, Food Innovation at Interfaces, belongs to the first generation of VINNVÄXT winners, funded by VINNOVA (the Swedish Agency for Innovation Systems). The strategic idea is to stimulate industrial renewal in the food sector in Southern Sweden. The way to pursue this strategy is not by taking a strict sectorally bounded approach but by exploring innovation at interfaces with other sectors and knowledge domains. It is hence the fruitful combination of the two knowledge bases that represents the opportunities for expoitation. Our analysis focuses on the 'pre-history' of the initiative, understanding the origins of the strategy and how the program has been shaped by previous success-stories of innovation at interfaces.

The strategic vision, developed by Skåne Food Innovation Network, addresses the 'increased value-added' challenge by targeting innovations that draw on existing knowledge and competence in the regional innovation system yet recombining these in new growth areas. This strategy is informed by a previously conducted analysis of the food industry in Skåne that argues for strong cluster advantages for the food industry in the region. Basically the complete food value chain, from raw material to consumer products, is present in Skåne. In addition to these vertical cluster advantages, there is an advanced support industry in relation to packaging, logistics, ICT, and biotechnology. There is also a strong concentration of food related R&D capabilities in the region. In a global benchmarking study commissioned to the Centre for Food & Health Studies in London, the region is mentioned as *the* most innovative milieu for functional foods (Lagnevik et al, 2003)

This description raises an interesting and somewhat paradoxical question. If there is an apparently well-developed food cluster that includes nearly all necessary components of the value chain, why is the industry losing its competitive edge with increased outsourcing and relocation of production? Partly the answer can be found in the nature of the industry. The sectoral innovation system for agro-food is generally characterized by low degrees of opportunity, appropriability and firm-level cumulativeness, caused by the maturity of the industry (Malerba, 2005). Opportunities for innovation are typically aimed at lowering production costs by introducing new (raw) materials or process machinery and at improving quality control schemes (Lagnevik et al, 2003). Assets and production inputs based on such price competition are easy prey for processes of ubiquification. Over time they become everywhere available at more or less the same cost, gradually eroding the competitive advantage of the innovator. Moreover, the ability to innovate depends strongly on the adoption of knowledge developed elsewhere (Wilkinson, 2002). This hampers the endogenous development of food firms' technological competencies and their absorptive capacity. As it is locked into a very mature technological trajectory, agro-food sectoral innovation system consists in general of few innovative firms. In the light of this, it is doubtful whether innovative impulses will originate from within the sector, narrowly defined. Strengthened ties with related and complementary knowledge bases, competence and research activities in other sectors and organizations, such as universities and research institutes, is therefore a potentially more conducive strategy to increase added value for this sector. Instead of focusing on incremental improvement in the production processes, this can create conditions for truly novel product groups by recombining existing knowledge bases in new ways.

In a response to these challenges, Food Innovation at Interfaces builds on the strategic vision to increase the added value of the food industry's products and services by targeting new market opportunities in areas such as functional foods, convenience foods, high-quality niche products and ecological products. Functional foods, convenience foods as well as ecological products all require an infusion and re-combination of different, new knowledge and skills in relation to the existing competence base found in the food industry. Functional foods build on an integration of food technology with life sciences, convenience foods require additional insights from logistics and process technology while ecological products draw to a large extent on traditional organic farming methods and principles. Even though the initiative mentions the four above growth areas, it needs to be noted that ecological products have disappeared from the final action plan. Instead nearly all attention has been focused on functional foods, convenience foods and food marketing. This implies that the strategic direction of Food Innovation at Interfaces during the application process took a pronounced science and technology oriented direction much in line with the industrial profile of the food industry and the knowledge base of the knowledge infrastructure in the region, at the loss of a 'green' organic food products and production systems (Cooke, 2008).

To upgrade the innovative capacity of the food industry the program has emphasized strengthening ties between research activities at the universities in the region. Particularly Lund University plays an important role in this new strategy. This is clearly reflected in the way the program is coordinated and managed. The process management group consists of Magnus Lagnevik, professor at Lund University School of Economics and Management, and Kjell Olsson, previously the director of 'Djupfrysningsbyrån', the industry association for frozen foods. In 2006, Lotta Törner took over Kjell Olsson's position. She was previously Director of Information for Skånemejerier, one of most important and innovative firms in Skåne's food cluster. The task of process leader for Food Innovation at Interfaces coincides with that of executive secretary for Skåne Food Innovation Network. The process management for the respective sub-programs is mainly carried out by staff from Lund University. In addition the program has a steering group with triple helix representatives from university, business and regional government. This steering group more or less overlaps with that of Skåne Food Innovation Network. The strong personal networks that have existed between representatives of Lund University and industry dating back to the genesis of Skåne Food Innovation Network have proven important to generate and embed a consensus on the need for a new development strategy. Again, this means that Food Innovation at Interfaces builds upon renewal within existing networks rather than on novel combinations of actors and interests.

Lund University offers a broad range of competences and knowledge in new and emerging domains that can serve as platform technologies for innovations in the food industry. This includes both scientific and engineering domains such as food engineering and technology, applied nutrition, food chemistry, biomedical nutrition, microbiology in foods and packaging logistics found at the university. In comparison, the agricultural university in Alnarp plays a more modest role. This university is specialized in the fields of horticulture, landscape, and agriculture. These knowledge domains are considered of less relevance for upgrading the regional food industry. However, it was an important player in the traditional network around Skåne Food Innovation Network, and its presence in the program has also contributed to its legitimacy.

The particular emphasis on bringing more scientific and technological competence into the food industry is clearly illustrated by the way that industry-university collaboration is organized in various innovation projects. The program consists of the four project areas (1) Food and Health / Functional Food, (2) Better Food in Big Scale / Convenient foods, (3) Market, Consumers and Evaluation, (4) Inovation in Theory and Practice. Each of these areas represents distinctly different competence and knowledge domains. The project area that receives most funding and which can be seen as the program’s flagship is ‘Food and Health / Functional Food’. It is the most science-driven project area in the program as it primarily aims to strengthen the Functional Food Science Centre. The second project area is more engineering-based as it addresses research for convenience food in spheres such as logistics, risk analysis, food quality, food processing and consumer behaviour. Examples of innovation projects that are carried out in active collaboration between university and business are the development of technical management tools concerning microbiological safety in the food chain and methods for preventing so-called 'Warmed-Over-Flavour' of heated meat products. The third project area is more concerned with non-technological aspects of food innovation as it intends to enhance knowledge, communications and tools for the international marketing of advanced food products. The fourth and final project area supports entrepreneurial activities through Ideon Agro Food, a technology transfer office located at the science park Ideon set up to finance and support the commercialisation of Lund University based research related to food. In this it draws to a large extent on collaboration with existing food firms in Skåne.

(Food) innovation at interfaces - two exemplar cases

The strategy outlined above reveals that Food Innovation at Interfaces made a clear choice vis-à-vis the technological platforms that it considered necessary to upgrade the incumbent food industry (functional foods and convenience foods). This choice needs to be seen in the light of considerable path-dependency preceding the initiative. The two exemplar cases of food innovations at interfaces presented below help us understand the strategic direction that was chosen to position and brand this program, at the same time as they illustrate the different requirements for innovation support that such a program need to take into account.

Functional food: the case of Proviva[1]

A functional food is defined as food with added ingredients that demonstrate scientific evidence of positive health effects. In other words, it is a hybrid form between nutrition and pharmaceuticals. The Proviva product line consists of dairy and fruit drinks to which the bacterial strain Lactobacillus plantarum (299v) has been added which improves the bacterial flora in the human bowel system. Among other effects, reduced flatulence is documented. Proviva is today owned by Sweden's second largest dairy company Skånemejerier but it has been developed through a collaborative effort of researchers at Lund University and the Swedish dedicated biotechnology firm Probi AB.

Even though Probi and Skånemejerier are the main actors that brought Proviva to the market, its history started in the 1980s with academic research conducted at Lund University and Lund University Hospital. A group of researchers with a disciplinary spectrum that involved surgery, food technology and applied microbiology, were involved in a project to develop a fermented nutrient solution that could be administered by tube which reduced the risk of a leaking gut after surgery. The main questions that the researchers needed to deal with referred to how to make the technique 'work': for

[1] In addition to own research based on interviews, data from company websites and annual reports, the case draws on original work by Lagnevik et al (2003) which provides a detailed description of the innovation trajectory.

example, which nutrient profile and bacteria would be best to keep the intestines functioning, how to arrive at a stable mixture and what effects that can be expected in the patients' intestines. Even though this research project was completely carried out in the academic domain, the aim of the research was heavily geared to medical application (typical for a synthetic knowledge base). Moreover, the various dimensions of the problem at hand necessitated the combined competences from various scientific and technological areas. Besides a set of doctoral theses at Lund University, the project resulted in a successful patent application on the bacteria in the product and their manufacturing process.

Building on the successful initial inter-disciplinary collaboration, two key researchers in the medical project decided to also find and develop an application of the bacterial strain in commercial food products. But in order to bring such a probiotic functional food successfully to market the researchers realized they needed a partner from within the food industry. Therefore they approached a well-known serial entrepreneur in order to approach and negotiate with larger food companies. Initially the idea was received with much scepticism by most food companies but eventually a long-standing personal relationship between one of the researchers and the R&D manager at Skånemejerier made sure that a suitable industrial partner could be found. Skånemejerier is a medium sized dairy company with an annual turnover of approximately 270 million euro. It employs about 800 people. Lacking the economies of scale of its major competitors, the company's competitive strategy is specifically aimed at healthy products and well-being. Against this background there was, arguably, sufficient support for the collaboration with the probiotic researchers. The latter established Probi AB in spring 1991 and in 1992 Skånemejerier acquired 25 per cent of its shares. Another important role in matching the two companies was played by the science park Ideon in Lund as it provided the meeting place (literally) for the two companies. The collaboration between the two companies was organized by means of a product development group whose task was to launch a commercially feasible dairy product containing Lactobacillus plantarum 299v.

Employees from both companies collaborated intensively together at a local production plant in Southern Sweden which, according to the current Quality Assurance (QA) Manager (previously directly involved in research and product development), was a necessary precondition for success. Probi had the research experience and scientific knowledge, which food engineers from Skånemejerier could complement with practical reflections often unacknowledged by the researchers. Despite the different educational and professional backgrounds the communication between the researchers and engineers was relatively frictionless, also when dealing with complex issues. This was, according to the QA manager, largely thanks to good personal relations, while "[…] both parts are open for new ideas and we can talk easily."

The collaboration between Probi and Skånemejerier around Proviva was not a one-off event but resulted in sustained co-operation around functional foods. The basic fundament was however put in place through the success of Proviva and its success in creating synergy between two firms that operate in two quite 'distant' industries that can be characterized as high-tech (Probi) respectively low-tech (Skånemejerier). Moreover it served as a source of inspiration and role-model for future activities for both companies. Probi has continued to offer specialised knowledge and competence in developing and producing bacterial cultures for partners in the food and nutrition supplement industry (e.g. Danone and Institut Rosell) while Skånemejerier has recognised the need to access knowledge alliances with small knowledge intensive firms to facilitate product innovation related to positive health concepts. In sync with the collaboration around Proviva, the firm has changed its business strategy away from being a mass producer of food commodities towards a developer and producer of high-quality foods.

Convenience Foods: the case of Time Temperature Biosensor (TTB)

This case describes the development of a Time Temperature Biosensor (TTB) developed by Bioett, a small dedicated biotechnology firm located in Lund. For this, Bioett was awarded with Skåne Food Innovation Network's annual innovation price in 2004. The firm owns the intellectual property rights on which TTB is based and exploits its commercial application. Currently the sensor, or rather the system, is used by various food companies such as Sardus and Skånemejerier to monitor parts of their product logistics. As shown below the TTB has been developed in interaction with a set of other actors, both within and outside the Skåne region and provides a clear example of interactive innovation. The system is based on the electrochemical properties of an enzyme contained in a small tag that responds differentially to temperature fluctuations over time. This makes it possible to track the accumulated temperature load of products on a continuous basis across longer periods of time based on ratio measurement. From a food quality perspective, this makes TTB superior over conventional methods that are based on ordinal measurement (sensors based on colour differences) and periodical measurement (based on interval testing). Within the tag, the electrochemical properties of the enzyme affect an electric circuit. In turn, the circuit's signals are converted to radio frequencies that can be measured by means of a manual detector, which, through wireless internet, is connected to a database that stores all information. As such, the TTB system consists of various components, namely the actual biosensors (tags), detectors and a database. It offers the basis for an integrated monitoring system that can be used to optimize the food distribution chain.

While TTB is heavily based on a biotechnological application, its development trajectory does not follow suit to the typical analytical, science-based model found in drug development . Even though university was involved in the innovation process at an early stage, the initial, basic idea was conceived through feedback from customers (typical for synthetic knowledge production). At the time, the two 'inventors' behind TTB were working in a different company called AromPak. Having a background in food packaging and automation from Tetra Pak in Lund, they received a request by one of their customers how to optimize and secure a frozen food distribution chain. On the basis of this they developed the basic but still rather unpolished idea that underpins the TTB and patented this in 1999. Exactly which enzyme was used and how the electric circuit was constructed were still unresolved issues at this stage. In fact, these inventors did not have any knowledge or competence in biochemistry and in electronics to start constructing any prototype themselves. While searching for seed capital, the inventors came in contact with Bengt Sahlberg, an entrepreneur who was willing to invest in a company (Bioett) and become its CEO. One of the actors that were contacted was aforementioned Ideon Agro Food. Through Ideon Agro Food's network, The Center for Chemistry and Chemical Engineering at Lund University became involved in the choice and design of a suitable enzyme that would constitute the core of the biosensor. Initial collaboration mainly took place through flexible, short-term arrangements, but while the feasibility of the project became increasingly convincing among all project members, one of the main researchers from The Center for Chemistry and Chemical Engineering joined forces with Bioett. The research and development carried out at this stage mainly comprised experimentation with different prototypes.

The necessary competence in electronics was acquired in a similar way. External consultants were hired on a temporary basis for concrete problem-solving in constructing a suitable electric circuit. After some time, Bioett employed one of these consultants within the company to secure access to this competence base on a more permanent basis. With regard to the development and production of suitable tags, to be used as 'carriers' of the biosensor, Bioett contacted a company in Belgium. Even though this relation can be characterized as a supply-based market relationship, it involved user-producer collaboration to develop and design a suitable tag for TTB. Similarly, Bioett outsourced the design and production of the detectors to a company in Motala, East Gothia but was actively involved in the development process to tailor-make a detector that was useful in the context of TTB. These initial activities and innovation processes to develop TTB can probably best be described as engineering-based to adjust and fine-tune the different components of the system (typical for synthetic knowledge production). In this Bioett has been mainly responsible for the development of the biosensor and the final assembly of the different system components. The modularity of the system allowed the development activities for the different components to be carried out separately. The researchers involved emphasized the importance of know-how rather than know-why to reach an initial working prototype. However, this situation reversed when the TTB was taken into production.

While working prototypes of the system were now available, the next challenge was to take the system into production and start application in real industrial contexts. Local food producing firms were first contacted to start using and testing the TTB system in practice. The presence of an existing network, facilitated through organizations such as Ideon Agro Food and Skåne Food Innovation Network, played a crucial role in making this happen. The first tests were carried out in collaboration with the regional dairy firm Skånemejerier for cooled product distribution chains and with the Nordic frozen food company Findus for deep-frozen product distribution chains. The tests with Skånemejerier's distribution chains also involved the collaboration of Frigoscandia who took care of the actual distribution process and the retailer ICA. Taking TTB into real use entailed various challenges. It was important to integrate the system into an existing distribution line which required considerable process engineering to make the system fit both from the side of Bioett and respective food companies. This required a close dialogue and in-house co-operation. Obviously, this collaboration benefited substantially from the close geographical proximity between the partners. Moreover, the collaboration can be seen as a clear case of interactive learning. Based on feedback from the food companies Bioett was forced to increase the quality of the measurements in order to provide better accuracy and to find cheaper tags. In relation to the first requirement, Bioett had to change its strategy. The experimental, muddling-through model used to construct the prototype did not work anymore. To increase accuracy, Bioett had to better understand the way TTB works (typical for analytical knowledge production). The food firms, on the other hand, gained greater insight and knowledge about their food chains which in turn allowed for optimization and improved management of their logistics operations.

Conclusions

Food Innovation at Interfaces is clearly an example of how parts of a regional innovation system are constructed. The initial conditions for this to happen are fairly positive. Not only does Skåne host core economic activities within the food value chain, it also has important knowledge generating organizations. As such, the most important regional innovation system elements (a knowledge exploitation and exploration subsystem) are in place. Moreover there is solid support from regional authorities (Region Skåne) which have prioritized the food industry in its regional development strategy. There is also an array of support innovation organization whose principle aim and mission is to stimulate knowledge transfer, entrepreneurship and networking between industry and university. However, the region is faced with two challenges which explain policy support in the form of Food Innovation at Interfaces. Firstly, a large share of the food industry is locked into an unsustainable low-road strategy based on price competition and economies of scale that meets new ideas and innovations with the 'not-invented-here' syndrome. Secondly, there is suboptimal exploitation of the co-location of knowledge exploitation and exploration organizations in the region. In other words, knowledge interaction between industry and the research infrastructure is limited which gives rise to a fragmented regional innovation system (Tödtling and Trippl, 2005). Food Innovation at Interfaces seeks to repair this fragmentation by initiating and supporting learning collaborations between firms and actors in academia and thus to prolong the life cycle of the industry through industrial renewal.

Two features characterize the 'pre-history' of the Food Innovation at Interfaces initiative shaping the program to a considerable degree. First of all, it is important to note that the program benefits from the increased administrative regionalization in Sweden. The new regional authority 'Region Skåne' play an important role in providing political support and visibility for Food Innovation at Interfaces. This has partly created a regional 'governance milieu' that proves to be conducive to public-private collaboration by creating various fora for dialogue between stakeholders from industry and university (e.g. through the regional growth agreements). In this particular case there has been a positive overlap between what VINNOVA (the Swedish Agency for Innovation Systems) calls a functional region and the existence of a powerful administrative region. Secondly, it needs to be noted that one specific private-public forum has been of crucial importance for Food Innovation at Interfaces, the network organization Skåne Food Innovation Network. In a sense, the network that connects the various triple helix actors in Food Innovation at Interfaces had already been forged through Skåne Food Innovation Network. This is clearly both an advantage and a disadvantage. On the positive side, it ensures that the vision on which the program builds is shared and endorsed by the participating actors and that the problem-analysis corresponds to 'real needs' of the industry. Such bottom-up, broad involvement is highly important for the development and accomplishment of regional innovation strategies. In fact, here lies a disadvantage for Food Innovation at Interfaces. Given that the initiative aspires to renew the industry by making it more knowledge and innovation intensive, some of the stakeholders may see their positions endangered. Instead of seeing the innovative ideas and products that are explored under Food Innovation at Interfaces as opportunities, they are perceived as threats to the status quo. A reservation that sometimes is raised against some of the suggestions and ideas that are launched under Food Innovation at Interfaces is that their markets are too small to be profitable for the large, traditional food firms (Sydsvenska Dagbladet, 2006). Such a 'not-invented-here' attitude may seriously hamper the necessary renewal and shift to an innovation-based strategy that Food Innovation at Interfaces advocates. Another critical dimension to the program is the lack of strong ties between some of its constituencies. The activities of the flagship initiative, Food and Health / Fuctional Food, is strongly rooted in academic system and is only remotely connected to the innovation process of the food industry.

It should therefore not be overly surprising that many of the initiatives for new product, process and service development originate within or with close ties to university. This is clearly illustrated by the strong focus on functional foods. This product group draws to an unusually great extent on analytical knowledge as it is developed at the interface between food and biotechnology. The established food companies do not have the capacity in terms of research capabilities in this field and are heavily dependent on 'outsider' knowledge, skills and competences. Moreover functional food is still an emergent technology that has not proven its value yet in consumer markets. The two leading innovative companies that seek to exploit functional foods on a commercial basis, Probi and Oatly, are still facing difficulties to become profitable. Similarly, most of the activities carried out under the functional food project area in Food Innovation at Interfaces could be considered as (basic) scientific research. The expectation, yet to be confirmed, is that functional food can serve as a platform technology that infuses the food industry with new business opportunities. This builds on a prehistory of successful academy-industry collaboration centred around functional foods. The successful co-operation between Skånemejerier and Probi in launching Proviva provides a 'best practice case' that Food Innovation at Interfaces seeks to replicate. In this collaboration, there was a clear technical division of labor where Probi provided the mix of bacterial strains contained in an oat broth and Skånemejerier carried the main responsibility for the final consumer product and the industrial production process. As such it refers quite closely to a linear view on innovation with considerable scientific input. It is however important to note that Skånemejerier had also changed its business strategy from being a regular food producer towards a high-quality, health-oriented profile. This change may be more difficult to accomplish on an industry level, even though the long-term perspective and funding of the Food Innovation at Interfaces program clearly is facilitative for more structural changes.

The convenience food project area 'better food in big scale' appears to be more in line with the food industry's own research activities. In this area university research is mainly directed at improvements in the logistics of the food value chain as well as process improvements for semi-prepared food components. Collaboration is still initiated by university but there is clearly more active involvement by companies in carrying out the innovation projects. In this project area, university-industry learning is more clearly constructed around an interactive view on innovation. Compared to the analytical knowledge base of functional food, these innovation projects are much more based on synthetic, engineering knowledge. As the TTB case clearly illustrated, research is much more hands-on and oriented to rather concrete problem solving in the production of convenience foods. Given that there is more overlap in terms of capacity, collaboration is easier. On the other hand, the potential for industrial renewal and radical product development may be less strong in this area than in functional foods.

To conclude, it can be argued that Food Innovation at Interfaces is a research / supply-driven program in which university plays a dominant role. However this does not mean that there is only science-push based on analytical knowledge. Research collaborations also take place to solve everyday, 'practical' problems based on the engineering competences found in the university. It is probably a merit for Food Innovation at Interfaces that is adopts such a two-track strategy to initiate and stimulate university-industry learning. Around the area of functional food there is still a lot of uncertainty, not the least with respect to consumer attitudes and acceptance. However, if the area proves to become a commercial success the Skåne food industry has the capacity to become a world leader and to truly upgrade and change its technological trajectory. The area around convenience foods implies less risks and mainly targets incremental innovations that can be directly applied by the industry. As such, it delivers more short-term results and projects that are easier to sell to current stakeholders. The above analysis has mainly focused on technical learning in the regional innovation system. The challenge for Food Innovation at Interfaces in the years to come is to also induce a behavioural change among the food firms to internalize the need for constant innovation to remain competitive as a traditional industry in a globalizing knowledge economy.

Table and figures

Figure 1: Two-dimensional classification of main innovation policy instruments (Asheim et al., 2003)

	Support: Financial and technical	**Behavioural change: Learning to innovate**
Firm-focused	Financial support Brokers	Mobility schemes
System-focused	Technolocy centres	*Regional innovation systems*

Table 1: Distinction between analytical and synthetic knowledge

Analytical	**Synthetic**
Innovation by creation of new knowledge	Innovation by application or novel combination of existing knowledge
Importance of scientific knowledge often based on deductive processes and formal models	Importance of applied, problem related knowledge (engineering) often through inductive processes
Research collaboration between firms (R&D department) and research organisations	Interactive learning with clients and suppliers
Dominance of codified knowledge due to documentation in patents and publications	Dominance of tacit knowledge due to more concrete know-how, craft and practical skill

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