Paper to be presented at the

DRUID Society Conference 2014, CBS, Copenhagen, June 16-18

Can public policy regenerate a traditional industry through collaborative research? The case of the Swedish food industry

Maureen Mckelvey
UNIVERSITY OF GOTHENBURG
INSTITUTE OF INNOVATION AND ENTREPRENEURSHIP
maureen.mckelvey@handels.gu.se

Daniel Ljungberg
University of Gothenburg
Economy and Society/Innovation and Entrepreneurship
daniel.ljungberg@gu.se

Abstract
This paper studies the regeneration of a traditional industry through the intersection of business innovation, public policy and the development of capabilities in firms. Our theoretical contribution is to propose that and conceptualize how public policy can indirectly boost the competitive advantage of a traditional industry by stimulating the development of firm capabilities to innovate through supporting collaborative research between universities and industry. To illustrate this proposition, we present an exploratory case study of a specific public policy initiative for collaborative research and structural change in the food industry in Sweden, from the mid-1990s to mid-2000s. The findings from this case study suggest that such public policy initiatives over time can and do develop firm capabilities to innovate in a traditional industry such as the food industry.

Jelcodes:O30,O38

Can public policy regenerate a traditional industry through collaborative research?
The case of the Swedish food industry

Abstract

This paper studies the regeneration of a traditional industry through the intersection of business innovation, public policy and the development of capabilities in firms. Our theoretical contribution is to propose that and conceptualize how public policy can indirectly boost the competitive advantage of a traditional industry by stimulating the development of firm capabilities to innovate through supporting collaborative research between universities and industry. To illustrate this proposition, we present an exploratory case study of a specific public policy initiative for collaborative research and structural change in the food industry in Sweden, from the mid-1990s to mid-2000s. The findings from this case study suggest that such public policy initiatives over time can and do develop firm capabilities to innovate in a traditional industry such as the food industry.

1. Introduction

Regenerating a traditional industry implies that new and more vigorous life should be brought about through existing firms and/or through entrepreneurship in new organizations like corporate start-ups and academic start-ups. Most studies of business innovation, the nature of collaborative research and of the role of public policy focus upon high-tech industries like pharmaceuticals and electronics. A few recent studies suggest that low-tech and medium-tech industries have different patterns of innovation from high-tech industries driven by research and development (R&D) and therefore, traditional industries have been neglected in prior research (Robertson et al. 2009; Hirsch-Kreisen and Jacobson 2008). Science-based and high-tech industries have also been the main foci of innovation policy to stimulate economic competiveness in recent years. Therefore, more is needed to understand the potential role of public policy as well as the nature of innovation in regenerating traditional industries like agriculture and food.

The purpose of this paper is to study the regeneration of this traditional industry through the intersection of business innovation, public policy and the development of capabilities in firms. In doing so, this paper proposes a conceptual framework and empirical illustrations of how firms' capabilities to innovate can be stimulated over time in a traditional industry, thereby regenerating it. Our empirical contribution is through an exploratory case study of public policy initiatives for collaborative research and structural change in the food industry in Sweden, from the mid-1990s to mid-2000s. Our theoretical contribution is to propose that public policy can indirectly boost the competitive advantage of an industry by stimulating the development of firm capabilities to innovate, and to provide a conceptual framework to specify how this happens in the context of collaborative research.

Traditional industries like the food industry can be classified as 'low tech', due to the low percentage of turnover (sales) devoted to R&D and few employees with academic degrees, known as low levels of human capital. Traditional industries have usually been seen to be synonymous with competition on price over standardized goods, rather than innovation. Given the low investment into R&D and low human capital, these firms will likely focus upon incremental innovations around existing products and processes. Moreover, they will for the same reason have low absorptive capacity, which means that they will have lower capabilities to identify and internalize external knowledge (cf. Cohen and Levinthal 1990). Taken together, this suggests that firms in traditional industries will likely have low capabilities to innovate. However, recent research suggests that low- and medium-tech industries do innovate, and also interact with universities in order to do so.[1] A few recent case studies for instance suggest that traditional industries can use scientific knowledge as well as industrial knowledge to innovate, such as cases of the Chilean and South African wine industry (Giuliani and Rabellotti 2012) and the Norwegian fish industry (Aslesen 2009).

Topics related to agriculture and the food industry are interesting empirical areas in themselves, and also relevant to study, from a broader societal perspective. One reason is that

---

[1] See for instance the Special Issue on "Innovation in low- and medium-technology industries" in Research Policy (Robertson et al. 2009).

agriculture and the food industry remain an important industry in Europe in terms of production and exports. About a hundred years ago, the USA and most European countries had extensive plans to stimulate productivity in agriculture and to ensure 'self-sufficiency' in food (McKelvey 2005). In recent decades, the argument has shifted away from the argument of national self-sufficiency to debates about the need for national actors to guarantee food safety, animal welfare, and consumer preferences. A somewhat different reason has to do with the tremendous advances made within life sciences since the 1980s, which could potentially change agriculture and the food industry. Although the concept 'life sciences' is usually associated with R&D intensive sectors such as human healthcare, medical technology and pharmaceuticals, the concept of life sciences in fact also includes the food industry. Life sciences research could stimulate agriculture and food, as the broader area has been the target of massive public investment into research over the past half-century, and an area of new firm formation.

Conceptually and theoretically, we do not yet have a broad theory of university-industry interactions in relation to the development of firm capabilities and even less understanding of how these processes may occur in traditional and low-tech industries. We propose that an intermediary step towards such an understanding is to engage in detailed case studies and to develop a more detailed conceptualization of this process, and especially the direct and indirect outcomes that help develop firms' capabilities to innovate.

This paper therefore presents an exploratory case study of the food industry in Sweden, with a focus on the 'Innovative Food' program as an attempt by public policy to stimulate innovation and competitive advantage of firms in this industry. In this case, what was called 'needs-driven' collaborative research was financed by the government, in order to stimulate the competitive advantage of this traditional industry, due to perceived threats from globalization and Sweden's entrance into the European Union. There were two public policy initiatives, known as 'Industrial co-operative projects in the food area' and 'Innovative food'. Taken together, they form what we call the Innovative Food program, with these two phases running from 1998 to 2006. The public policy supported in total 66 projects, and 71 companies were involved.

This paper addresses the following two research questions:

RQ1: What were the perceived goals and objectives of the public policy initiatives to stimulate innovative foods in Sweden? What were the characteristics of the university and public research institutes as well as companies and organizations which participated?

RQ2: What types of outcomes can be identified from the collaborative needs-driven research projects? Which types of firm capabilities for innovation were developed?

Section 2 proposes a conceptual framework, based upon a literature overview, and its relevance to understanding innovation policy as the regeneration of a traditional industry through developing firm capabilities. Section 3 addresses the research design and methodology. Section 4 answers the first research question and Section 5 answers the second research question. Section 6 concludes with implications for public policy and future research.

2. Public Policy and Innovation in Traditional Industries

This section (i) explores the rationale for having public policy to support science, especially in relation to business innovation, and (ii) analyzes what insights the existing findings regarding university-industry interactions and especially collaborative research programs that are applicable to this traditional and low-tech sector. The section concludes with a stylized conceptual framework to understand the processes involved.

The first topic is the changing rationale for science policy, and later innovation policy. Initially, the rationale for public policy instruments to support scientific research broadly emerged from practitioners' observations after the Second World War (Bernal 1939; Bush 1945) and from theoretical ideas about the linkages between research and growth. The idea of government supporting science as a way to stimulate societal goals and growth has been subject to a long line of research. Nelson (1959) and Arrow (1962) analyzed knowledge as a particular type of public good. Arrow (1962) in particular became a key reference for understanding the balance between public and private investment in information. The rationale for government support of science is fundamentally linked to an analysis of the relative roles of public and private investment into research (McKelvey 2014).

A number of studies have demonstrated that publicly financed R&D tends to have much higher total societal returns than R&D funded by firms (Scherer 2000). The explanation is likely that the government finances more basic, long-term work, which is relevant to many different actors, and can thereby potentially have a large effect over many actors and sectors. Whereas in contrast, firms tend to finance work that is closely related to their own current products, and therefore these R&D activities have a more restricted total impact.

Therefore, in economic terms, the rationale for public policy for science is quite clear, and can be stated as follows. Public policy should invest into basic research, because this type of knowledge will benefit society in the long term. In contrast, private firms will choose to 'underinvest' especially in this more basic research because they face the problem of appropriability and because the resulting information and knowledge can transfer, or spill-over to many actors. The firms cannot capture the full returns to their investment into knowledge. Firms have incentives to invest less than a 'socially optimal' level into R&D, and primarily invest into development work. The investing firm will capture only a share of the societal benefits of new knowledge, although more modern research results that the firm has incentives to participate in R&D anyway (Winter 2006). The role of public policy is to make sure that the total amount of money that society invests into science, technology and innovation is at an 'appropriate level', so that society as a whole benefits from economic growth (Scherer 2000). Using these types of arguments, a key instrument of public policy has long been for supporting basic research.

Theoretically, the underlying question is whether and how public policy can stimulate economic growth by stimulating knowledge generation and diffusion. This is a huge question, likely to immediately stimulate extensive debate. The debate has to do with the state of knowledge in existing research. On the one hand, there is the theoretically and empirically demonstrated overall importance of knowledge for growth in the long run, but on the other hand, the role and impact of public policy in these processes is still very difficult to capture.

Some of the areas of dispute within this debate address the extent to which public policy can, or cannot, stimulate the creation of clusters, and even about whether the seminal notion of regional knowledge spill-overs can be empirically verified (Lissoni and Breschi 2001; Martin 2001). Other studies argue that public policy may simply be wasted resources, and not lead to long-term competitive impacts within regions (Lerner 2009). Much analysis of public policy – also in terms of innovation policy – uses a type of cost-benefit to see direct outcomes. Moreover, these input-output analysis often use a simplistic view of direct outcomes defined, for example, as commercialization of science through new entrepreneurial firms and patents.

A few recent research contributions about innovation and public policy, within streams of literature like innovation systems and within evolutionary and Schumpeterian economics, have suggested the need to focus upon learning. Key contributions argue that innovation policy ought to be seen primarily as a learning process in an evolving system (Mytelka and Smith 2002; Lundvall and Borrás 2005). Using the Australian case, Dodgson et al. (2009) view is that innovation policy ought to be analyzed as a self-organizing and dynamic system, understood within the specialized properties of knowledge creation for the economy. Moreover, the definition of innovation policy can include a variety of actors which may contribute to innovation and how to impact them. Kuhlman (2001:954) defines innovation policy as 'the integral of all state initiatives regarding science, education, research, technology policy and industrial modernization, overlapping also with industrial, environmental, labor and social policies'. Similarly, Edquist (2001) starts with the total set of public policy initiatives which potentially affect innovation.

Our conceptual framework builds upon a different approach, namely stimulating the development of the firms' potential capability to innovate. This concept has not yet been well developed theoretically in the literature. However, the key insight that this could be the main goal of innovation policy was developed in a public policy review for the Finnish government. Georghiou (2006) sees innovation policy as 'any policy which seeks to help firms, singly or collectively, to improve their capacity to innovate'. This paper and related work about demand driven innovation policy focuses upon the need for demand-driven policy, including procurement and other instruments.

Our analysis focuses upon a different aspect, namely how public policy – through collaborative research between university and industry – may stimulate the development of firm capabilities. Thus, in contributing to an understanding of innovation policy, our contribution is to place collaborative research and firm capabilities at the center of analysis – rather than the goals and instruments of public policy. To develop our conceptual framework and understanding of what this means, we have chosen a public policy initiative that has a stated goal to stimulate research for the needs of industry and society, but which should also be novel research.

Hence, in addressing the first research question, this paper follows the insight in existing innovation policy literature that public policy can stimulate learning and the development of knowledge, but we develop our understanding with the specific focus upon collaborative research as an intersection between business innovation, public policy and the development of capabilities in firms.

The second topic is to analyze what insights the existing results about university-industry interactions and especially results in existing literature about collaborative research programs can provide in regards to how firm capabilities for innovation are developed in a low-tech sector. The literature on university-industry interactions in general is extensive and rapidly growing, so only a few relevant references as related to new knowledge capabilities are mentioned here. Due to the lack of existing literature on low- and medium-tech industries, the literature on university-industry interactions in general will be assumed to be relevant.

In terms of university-industry interactions in low- and medium-tech sectors, existing empirical evidence and research suggests that firms in high-tech industries are more likely to interact with universities than firms in low-tech industries. Laursen and Salter (2004) use different proxies, such as R&D expenditures over sales and number of scientists in a firm, and find that firms with these characteristics tend to generally be positively related to the degree of interaction with universities and research institutes. In other words, firms in the life sciences that are R&D intensive such as pharmaceuticals can be assumed to interact more with universities than firms with low R&D intensity, such as agriculture and the food industry.

In a literature review, Salter and Martin (2001) identify six major mechanisms for diffusion of university research to society. These are: increasing the stock of useful knowledge; educating skilled graduates; developing new scientific instrumentation/methodologies; shaping networks and stimulating social interaction; enhancing the capacity for scientific and technological problem-solving; and creating new firms. Both these papers suggest that universities can impact firms through a variety of channels, and that a key impact of these channels for collaboration is to develop networks for the development and diffusion of knowledge. Based on an empirical survey of the diversity of ways to interact in different industries, Cohen et al. (2002) show that the key channels for university research to impact industry are publications, public conferences and meetings, consulting and informal information exchange.

Perkmann et al. (2013) provide a major review of the literature, which differentiates empirically and theoretically ‘commercialization’ from what they call ‘academic engagement with industry’. Commercialization is defined in terms of patents and academic spin-offs, which have been widely studied. However, based upon a review of results and a conceptualization of the individual, organizational and institutional levels, this paper argues that it is very misleading to consider commercialization as the main contribution of universities to the economy. A more important phenomenon is academic engagement with industry. This is defined as “knowledge-related collaboration by academic researchers with non-academic organisations”, which “include formal activities such as collaborative research, contract research, and consulting, as well as informal activities like providing ad hoc advice and networking with practitioners” (Perkmann et al. 2013, p. 424). In other words, academic engagement with industry is the broader perspective of different types of mechanism and rationale for researchers at universities and public research institutes to interact with others involved in processes of business innovation. Hence, the insight that we draw from this literature review for our paper is that studies of the ‘direct’ impacts of collaboration through commercialization – such as patents, start-up companies and product innovations – need to be complemented with the ‘indirect’ impacts of collaboration through academic engagement.

In addressing the second research question, the concept of ‘capabilities is key, given our development of the insight that innovation policy is a policy which helps improve the firm’s capabilities to innovate. By capabilities, we mean the knowledge, experience and skills that firms have which are appropriate for carrying out specific activities (cf. Richardson 1972). This is a classical definition, which is closest to what we mean by capabilities to innovate in this paper.

In this paper, the concept of ‘innovation’ refers to business innovation, which in a broad sense means novelty of economic value. Following international statistics such as OECD definitions used for national statistics, innovations can be conceptualized along two dimensions. One dimension is the ‘degree of novelty’, whereby the definitions distinguish whether the innovation is new to the world, new to the market or an improvement upon existing ones. A second dimension is the ‘product and services versus process’ issue. Products and services refer to a tangible or intangible sold on a market. Process refers to technical processes, machinery and also organizational factors, which relate to the production and deliver of products and services. These two dimensions are used here to define and clarify the relevant types of innovations, for the firms.

Based upon our interpretation of the above literature on university-industry interactions, this suggests that our analysis should also distinguish direct outcomes of university-industry interaction from indirect outcomes, such as the development of firm capabilities to innovate.

From this, this paper proposes the conceptual framework depicted in Figure 1. The figure presents a stylized depiction of the impacts of policy initiatives aimed at boosting the competitive advantage of an industry through collaborative research by firms and universities.

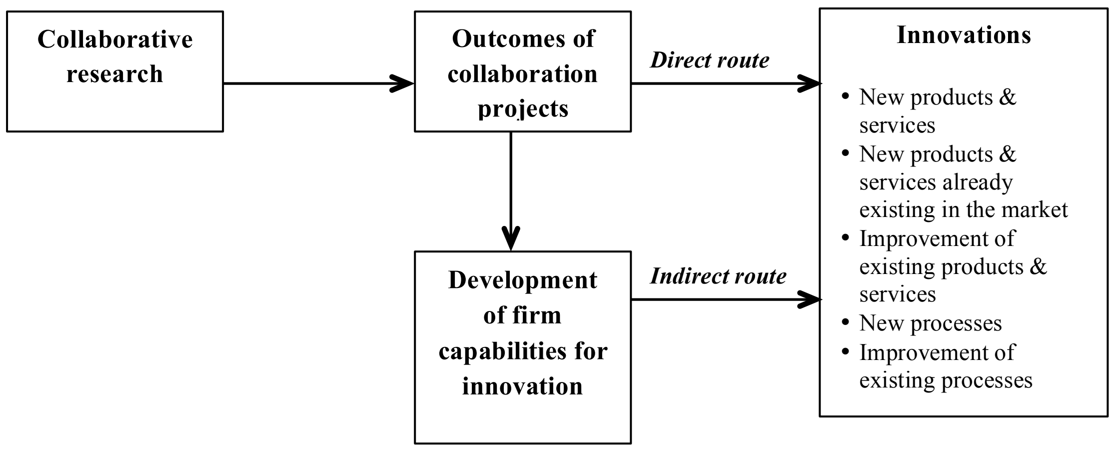

Figure 1: Conceptual framework of how collaborative research impacts innovations (in firms) through both a direct route and an indirect route

On the left side, public policy provides funding which stimulate collaborative research, which in our case involves the participation of both universities and companies as well as financing from the public policy and financing from companies. This in turn leads to direct outcomes of the collaborative research in the middle. This can either lead directly to the creation of new innovations, as depicted on the right side of the figure, or this can lead to the development of firm capabilities for innovation, which indirectly leads to the creation of new to innovations.

In summary, the logic behind Figure 1, and the arguments in the current paper, is that this generation of new innovations through collaborative research are achieved both directly – through directly commercializing or implementing the outcomes of the research efforts, such as new products or processes – and indirectly – by developing the capabilities for innovation in the firms taking part in the collaborative projects.

3. Research design and empirical setting

Given the theoretical framing that public policy can impact industry regeneration of traditional industries through developing capabilities, this paper suggests that studying the food industry can provide new insights, of theoretical relevance. The case study includes the Swedish food industry, in a setting where these types of firms traditionally invested very little in R&D. Hence, the case study may be a bit of an anomaly, or an extreme case of regenerating an industry which traditionally has not engaged so much in innovation – at least not through traditional R&D nor through collaborative research and interaction with universities.

3.1 Methodology

The case study involves a retrospective examination of Innovative Food program, which is a large scale public policy initiative in Sweden, including an analysis of the two phases and the 66 collaborative projects, undertaken in the period 1998 to 2006. The case study is built upon quantitative and qualitative data, used here in order to provide a deeper understanding of regenerating traditional industries.

The first step was to develop an empirical understanding of the public policy context in Sweden and to address the first research question, about the perceived goals and objectives of public policy. The empirical material draws upon a variety of methods, including conducting and transcribing interviews of 2-3 hours each with 15 people; document analysis including all government inquiries and major stakeholder reports since the early 1990s; descriptive project data summarizing results, and other written material. We also used the triangulation of sources and source-validation between interviews and written material and in interviews with experts. Moreover, this step helped us identify persons to interview in the next step, through a snow-ball approach.

The next step was to collect data to analyze and address our second research question, with a focus upon all the projects within Innovative Food. Due to the careful public records in Sweden, we could extract detailed project data for all 66 projects out of the government archives – in paper format and occasionally electronically. We could therefore gather all documents from each specific project and also the two phases. In this process, we obtained copies of all public documents, applications, project reports (final and annual), for all the projects. This material includes detailed material about the individuals involved, their organizations, the projects conducted and the reported results, in terms of both scientific and commercial outcomes.

Another step was to analyze and categorize the specific collaborative research projects. We cleaned the data, to define the population as 66 projects total, based on our analysis of the project documentation. A few technical steps were made to clean the data. We excluded funding granted for projects specifically aimed for only purchasing equipment (which amount only to a few projects altogether), and so these have not been counted as projects. Projects awarded funding in several stages were counted as one large project, if and only if the planning studies resulted in further funding in one or several stages. So, for example, projects where a research group first received funding for a planning study, and then received funding for the actual project proposal were counted as one project. Note that there are also cases where the same project leader and/or department had several projects, but if the projects addressed separate issues, they are classified as separate projects.

Then, based upon these documents, we built a map of all involved public policy agencies, the participating actors in academic research units (universities and PROs) and different types of firms in the food industry. This map was used to develop interviews. Hence, in this next step, the mapping was used to choose persons to conduct new interviews, with the aim to increase our overall understanding of reported results, including illustrations from specific firms and projects. At this point, we did new interviews and also discussed our preliminary findings with experts in this public policy. We chose 15 persons for semi-structured interviews, chosen from the two main nodes of this type of industry and research, which is Gothenburg (West Sweden) and Lund (Southern Sweden). The interviews included primarily company representatives, but also a few public policy experts and academic researchers. Each interview was face to face and transcribed. The rationale for combining existing self-reported data from project reports with interviews was to get a more nuanced understanding of the processes and long-term effects of policy and to build a series of smaller illustrations, to provide in-depth insights into a range of phenomena mentioned in the project reports.

A final step was how to conceptualize the results of how the Innovative Food program – and the 66 projects – impacted the development of firm capabilities, as compared to other variables influencing research and/or commercialization at that time, and in those places. Before analyzing the data, we therefore started with a conceptualization of the environment, and expected effects of public policy. They are involved in doing the research together.

In summary, this paper is based upon an open-ended methodology and an iterative process. The iterative process included moving between theory and empirical material, as well as moving between the concerns of public policy and the objectives of social science. This allowed us to access many experts in a short time, to gain specific and deep insights into specific cases and processes as well as to access a broad range of projects, companies and university researchers involved in the specified projects. By definition, of course, bias can be introduced for all the reasons having to do with qualitative research on complex processes involving multiple stakeholders.

3.2 The Swedish context

Sweden is a very small economy, but seen as an innovative one. Sweden had approximately 8 million inhabitants when this public policy initiative was started, and had increased to more than 9 million inhabitants by 2014. Moreover, Sweden is often identified as innovative, such as in The Innovation Union Scoreboard[2] (2013). The Scoreboard has for the last several years identified Sweden as the most innovative country in Europe, labeling the country as one of few “Innovation leaders”.

Sweden as a national economy is highly R&D intensive, with a fluctuation over the period studied here of 2.5% to 3.7% of GDP spent on R&D. However, this R&D investment is not primarily driven by public policy. Instead, this investment into knowledge development consists primarily of industrial R&D, which makes up more than 70% of the total, and is carried out mainly by some twenty large Swedish-based multinational firms, as found in annual national statistics from SCB.

Sweden is also a highly globalized economy. Production and exports can be found in traditional industries like paper and pulp and mining and chemicals as well as high tech industries like pharmaceuticals are also represented in production and exports. Approximately half of Swedish exports are in the industrial category of machinery and transport equipment, such as heavy equipment, cars, electronics, and telecommunication. In the mid-1990s, the size

[2] Previously known as the European Innovation Scoreboard.

of the food industry was similar to the automobile/transport industry, and exported around USD 19 billion or SEK 150 billion (Li 2007).

The Swedish multinational companies are well-known but their connection to Sweden has changed in this period. The companies have also become increasingly global – and many no longer have Swedish headquarters and a few have moved out completely (Pharmacia). Many firms exist in the export-led industrial sectors like telecommunications (Ericsson), engineering (SKF, ABB), transportation (Volvo AB and Volvo Cars), and pharmaceuticals (AstraZeneca, Pharmacia). Since the mid-1980s, many successful Swedish multinationals were bought and merged into global concerns (such as Volvo Cars into Ford and then Geely) and merged with foreign competitors (such as Astra and Zeneca forming AstraZeneca). Hence, global structural changes were occurring at the time of the studied public policy initiative – and continued since – and these changes occurred within the industries that Sweden depends upon for exports.

Similar trends towards globalizations, structural transformation and decreasing employment in Sweden can be identified in the food industry in Sweden. The total food export during 2007 amounted to about 41 billion SEK, representing an export of about 20 percent of the production, which was somewhat higher than the EU food industry average. In 2007 the Swedish food industry generated in total a turnover of about 150 billion SEK (Li 2007). Moreover, at the firm level, the food industry has become much more global during the last decades since the mid-1990s. Many Swedish companies in this industry have been bought up and become business units within global corporations, illustrated by such deals as Nestlé's purchase of Findus (vegetable packaging) and BASF's purchase of Hilleshög (sugar beet seeds). Following upon a long tradition, however, the Swedish farmers' cooperative Lantmännen and many of its subsidiaries have remained Swedish.

The impact of structural change in the food industry has negatively affected employment in Sweden. The food industry in Sweden employed about 70 000 people in the 1990s, but only about 56 000 persons in 2007 (Li 2007). This has to do with the competitive situation. In more recent years, profits and firm survival have become increasingly difficult within an EU-open market, often due to low price competition whereas Swedish agriculture and food industry are expensive largely due to the nature of highly regulated for animal welfare and consumer safety. In 2014, the crisis in agriculture and the food industry is becoming acute in some industries, which some participants naming the high animal welfare and safety standards as reasons why the Swedes cannot compete with low price imports, such as in the pork industry.

Finally, we would like to point out that the institutional setting in Sweden has for several decades promoted innovation policy which develops connections and interactions between private actors like firms and public research organizations (Persson, 2008). Vinnova is a Swedish government agency, and its predecessor were STU and Nutek. Vinnova has a specific mission to stimulate sustainable economic growth.

4. Needs-driven collaborative research in the Innovative Food program

This section addresses the first research question, namely: What were the perceived goals and objectives of the public policy initiatives to stimulate innovative foods in Sweden? What were the characteristics of the university and public research institutes as well as companies and organizations which participated?

The stated purpose of this public policy was to stimulate long-term effects of needs-driven, collaborative research programs on industry and innovation, and they ran as two research programs between 1998 and 2006. An interesting question is how to define and operationalize needs-driven collaborative research, and who participated in both universities and in industry.

4.1 Launching Collaborative Research in the Context of Internationalization

The Innovative Food program came out of a national debate about the future of the agriculture and food industry, at the time of Sweden's entrance into the European Union in 1995. Surprisingly, one rationale often reported as a reason for why Sweden should enter the EU was framed as 'cheaper food'. It is a surprising argument, given that while food costs might be reduced for the individual consumer due to competition, the European agriculture and food industry is heavily subsidized and can therefore be seen as 'expensive' at the societal level. Moreover, the Swedish agriculture and food industry had few export barriers and in some dimensions had to be 're-regulated' upon entry to the European Union.

This is also a longer history, where the Innovative Food program can be contextualized as part of a series of public policy initiatives directed towards the food industry. STU, the predecessor of Vinnova and Nutek had run programs in the food area in the 1970s and early 1980s, but by 1986, their efforts specifically targeted at the food area had decreased considerably.

A main reason for public policy for food at that period was internationalization, but in a different sense than competition. In the early 1990s, prior to EU-membership, Swedish researchers had to pay from national funds to participate in EU-projects. Therefore, STU/Nutek (and SJFR[3]) enabled Swedish participants to engage in the different EU framework programs directed towards the food area (FLAIR) by providing funds to cover their costs. In addition, Nutek/Vinnova also sponsored research groups' participation in EUREKA, COST and the NORDFOOD programs in which Sweden was very active.

By the mid-1990s, however, the Ministry of Industry (*Näringsdepartementet*) began expressing interest in the food industry again, in part because of the so-called Björckska inquiry (SOU 1997). This governmental inquiry pointed to the new competitive landscape of the Swedish food sector resulting from the EU-membership, as well as the lack of public efforts directed towards the area. The inquiry also strongly urged for a larger research program directed towards the food industry.

---

[3] Skogs- och Jordbrukets Forskningsråd (now Formas).

The rationale was related to national specificities and the need for Swedish firms to take a better market position. The new competitive situation of the EU market, coupled with some natural disadvantages such as climate, harsh winters, and high costs for raw material, was argued to make R&D of decisive importance to strengthen the food industry's international competitiveness. This was also highlighted in the government bill on research (Proposition 1996/97:5). In particular, as the SOU (1997) report argued, such R&D efforts should develop those conditions that provide opportunities for competing with production from countries with lower costs for raw material production, that is, efficient production, distribution and marketing. If something was not done, the report argued, a fate similar to that of the textile industry, which essentially disappeared in the 1970s, could well become a reality. Thus, this governmental inquiry proposed a four-year program of in total MSEK 360, divided into four policy initiatives. However, of the proposed funds of MSEK 360, only MSEK 20 for was granted for Phase I.

Phase I was initiated with a call for the program Industrial cooperative projects in the food industry (*Industriellt samverkansprojekt*), and it was announced in 1998 by Nutek (1998). The call was broad, reflecting to a large extent the tone of the governmental inquiry introduced above, SOU 1997 (as well as in some previous government reports such as *Forskning för bättre mat* (SJFR 1986)). The stated purpose of the Industrial Cooperative program was:

> To give companies and constellations of companies an increased opportunity to work on specific problems and at the same time develop contacts with the R&D-system. The R&D-system can, at the same time, develop its understanding of the problems that face companies. The aim is to bring together different actors from different parts of the food chain, from industry as well as from the research community, in order to achieve a better integration. (translated by authors)

More specifically, eligible projects could "treat widely disparate areas with significance for the food industry, for example, food security, process- and production techniques, quality, environment- and resource efficiency, product development and innovations, packaging systems, logistics and work environment" (Nutek 1998).

With the building of the new governmental agency Vinnova, the second phase was launched, now called Innovative food. The name itself was more of a compromise between different stakeholders, as well as in line with the contemporary concepts such as smart food and intelligent food. There was also less focus upon the whole food industry. According to the first call in Innovative food:

> The overarching knowledge development of the program includes, for example, the development of methodology and/or systems in areas of product safety/security, traceability in the whole food chain, increased efficiency/rationalization and reduced environmental effects, innovation and product development, understanding of consumer preferences and enhanced consumer communications (Vinnova 2001).

The call states that important knowledge can be in many areas, linking it to health. There were comments, for example, about the development and usage of experimental models to ensure more links between diet and health; methods for scientific evaluation of foods health effects; identification of biomarkers in humans which can be used to measure effects on health and/or sickness; and an overall understanding of how links between diet and health can vary with individuals and thereby deepen the knowledge about how the individual genome affects physiological response

Thus, above all, the Innovative Food Program was initiated because the national policy-makers were concerned over the long-term competitiveness of both agriculture and food processing, given that once the national market was opened up, they knew there would be cheaper imports from the EU. However, the reason for narrowing down the focus in the second program was that the limited resources did not allow for a continued broad effort for the competitiveness of the industry, and because diet and health could be motivated as more vital to society.

4.2 Analyzing what needs-driven research might mean in the food industry

A key issue remains – what is needs-driven research? Our interpretation after reading the historical material is that the starting rationale for implementing Innovative Foods as 'needs-driven' innovation policy is based upon the need to help firms in this industry be 'competitive'.

The concept 'needs-driven research' was argued in the historical documents to be different from basic and applied work, in that the industry sets a broad agenda, but the knowledge developed should still be still novel and front-line research. This may be considered to be following similar line of thought as a book popular amongst Swedish public policy makers at the time, namely *Pasteur's Quadrant* (Stokes 1997). In the book, the author identified a third category of scientific research in addition to the traditional basic and applied research, namely fundamental (basic) research inspired by the consideration of use. Note that this formulation of Pasteur's Quadrant can be related to the notion of 'needs-driven research' as used in our case.

We would also like to point out that the conceptualization of 'needs-driven' shifted between the two phases of the Innovative Food program. The first phase defined a number of issues where Sweden was seen as lagging behind (or, needing new competences), if the industry was to compete on the European market. The role of R&D was conceptualized as being driven by the perceived needs of existing industry. The second phase was announced in 2000 with funding starting in 2001. This one used similar terminology, but shifted the focus to a more consumer and health-driven view about the need for more nutritional food, or 'functional food'. In this later definition of 'needs-driven research', one could say that the government would play an even more important role in trying to formulate the needs of consumers and health care system. In other words, in the two phases, there is shift from boasting the competitive advantage of the industry to a focus upon emphasizing the consumer-based societal benefits.

4.3 Universities and research institutes involved in projects

The Swedish policy in the area of innovative food was explicitly designed to get university researchers and firms to interact within areas of knowledge relevant to both research and industry. For the academic applicants, getting industry involved was a prerequisite for obtaining grants, because the programs call for 50% public and 50% private investment into each project.

Table 1 provides an overview of the projects financed, divided into the two phases of Innovative Food. There are 66 projects, when we aggregate continuations of the same project; and 70 separate projects, if they are not aggregated.

Table 1: Overview of projects in Innovative food

	Duration	**No of projects**	**Funding, total (MSEK)**
Phase I: Industrial cooperative projects in the food area	1998-2001	23	24,86
Phase II: Innovative food	2001-2008	38	96,98
Projects in both programs	1998-2006	5	Included above
Total	**1998-2008**	**66**	**121,84**

The total financing was 121,84 million SEK. There were total 66 projects, of which 5 projects were funded in both phases; 23 projects were funded in Phase I and 38 projects in Phase II. Most projects were in areas related to quality of food, new characteristics of food, new equipment, and health and safety issues in food production. A few projects (<10 projects) were directly related to clinical trials and to evaluations of the health effects of food.

The size of the projects differs, as see in Table 2. On average, each project received MSEK 1.8 in funding.

Table 2: Characteristics of funding of the projects

Characteristics of funding	**Amount in SEK**
Average funding per project	1 857 000 SEK
Median funding per project	1 230 000 SEK
Highest funding for a single project	8 300 000 SEK
Lowest funding for a single project	100 000 SEK

If we look at more detailed differences, Table 2 indicates that funding per project could vary, ranging from a mere 100 000 SEK to 8,3 million SEK.

Our examination of the projects shows that the project leaders in the majority of projects (and by far most of the money) were located at universities and public research institutes. There is a concentration of project leaders into specific universities and research institutes as shown in Table 3.

Table 3. List of projects, in descending order of funding. Details on organization of the project leader, number of projects and total funding in SEK

Organization of the project leader	**Number of projects where the organization is project leaders**	**Total funding in SEK**
Lund University	17	33 472 497 SEK
The Swedish Institute for Food and Biotechnology (SIK)	18	31 023 555 SEK
Uppsala University	7	17 398 200 SEK
Chalmers University of Technology (Chalmers)	4	13 098 000 SEK
Swedish University of Agricultural Sciences (SLU)	11	11 639 000 SEK
Karolinska Institutet (KI)	2	8 600 000 SEK
Umeå University	3	2 870 000 SEK
Institute for Surface Chemistry (IYK)	3	1 797 000 SEK
Company	2	1 551 854 SEK
National Food Administration	1	531 150 SEK
Royal Institute of Technology (KTH)	1	300 000 SEK
University of Gothenburg	1	300 000 SEK
Total	**70**[4]	**122 581 256 SEK**

The most successful research group received 33 million SEK – or equivalent to USD 4 125 000 – during the two phases. Moreover, the list contains 8 universities, 2 public research institutes, and one regulatory agency. Note, however, that while the table seems to suggest that the organization of the project leader receives the full sum, the project funding was later distributed to project members, and there was also co-financing from industry.

Given that the projects in the Innovative Food program were designed to be novel needs-driven research – and not simply applied research or development work within companies – it is an interesting question about the researchers acting as project leaders. The results indicate

[4] Note: 66 when aggregate to continuation of same project; 70 when not aggregated

that some of these individual project leaders are well-known academics, who are well-published and highly cited internationally.

On average, each project leader had published approximately 67 publications, e.g. throughout their career to that point. The minimum was 1 publication and the maximum 359 publications, as seen in Figure 2.

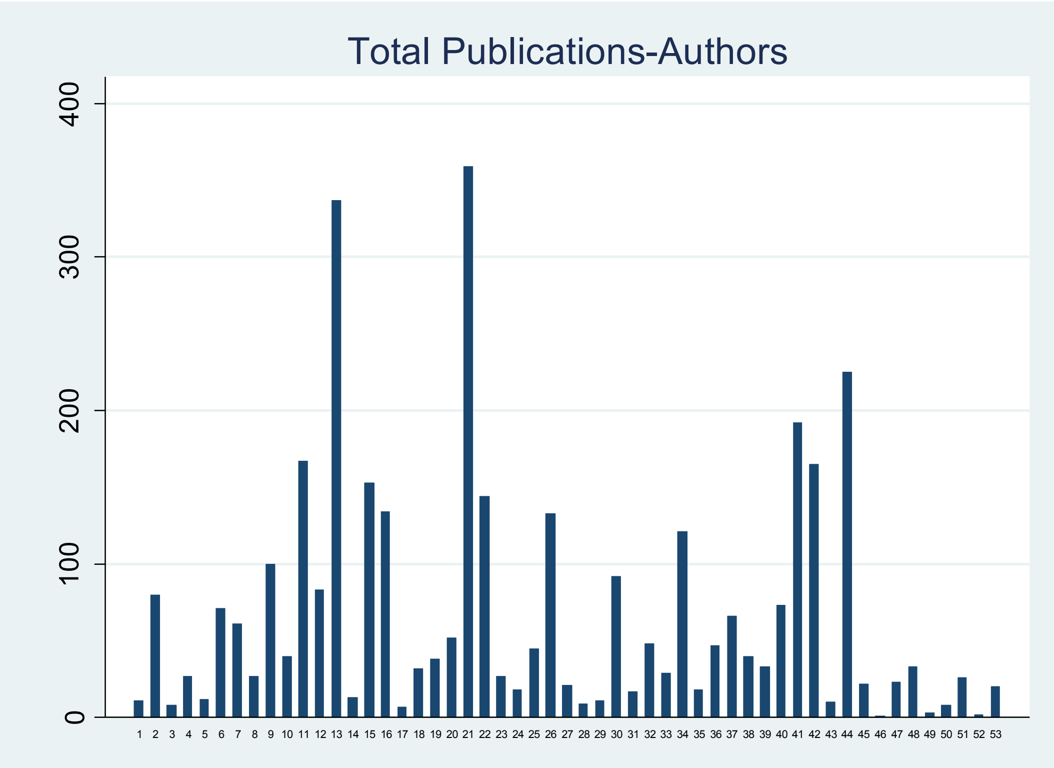

Figure 2: Number of publications per project leader, based upon ISI in 2009

Figure 2 indicates the publications per project leader, and a similar analysis was done for the number of citations per project leader in Figure 3. On average, every author was cited 1320 times, but with a similar skewed distribution as above.

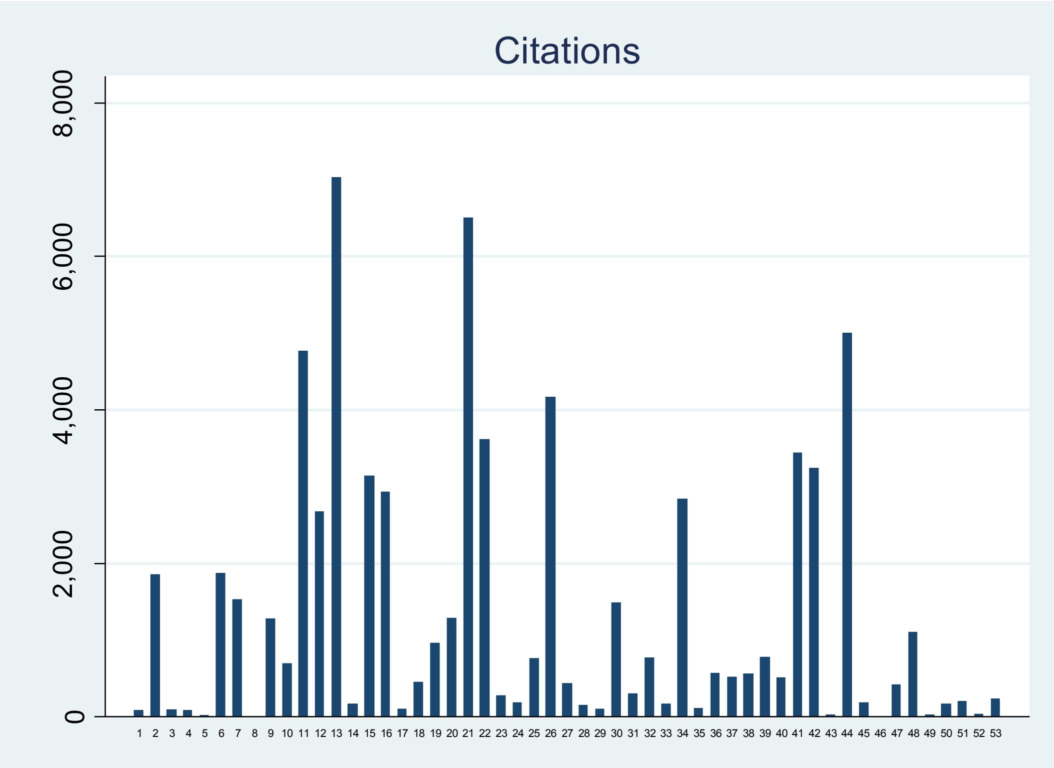

Figure 3: Number of citations per project leader, based upon ISI in 2009

Indeed, the same individuals can be found at the top positions in both publications and citations. Finally, in 2009, an analysis of the project leaders in Innovative Food found that six rank amongst the 61 most highly cited Swedish researchers in ISI web of science for any field

4.4 Companies and other organizations involved in the projects

Let us turn to the companies and other organizations, to better understand what capabilities they may have had when they started and whether and how, we may conceptualize that the public policy initiatives can help develop new capabilities, of relevance for knowledge and business innovation.

In total, the programs included 187 instances of participation, of which 71 company groups were involved. A few companies and organizations have been particularly frequent in project participation, and also collaborating with several different research groups. For example, after aggregating subsidiaries to the group level, Lantmännen was involved in about 1/3 of all projects, and Arla and Orkla were involved in 1/4 and 1/5 of all projects respectively.

In practice, the companies and organizations engaged in different ways, ranging from actually funding some research carried out by others into the center, to counting a percentage of employees' time to the project, to providing access to equipment and instrumentation. In addition to the financing from the government to the projects addressed above, all the participating firms had to actively finance research as their investment and participation was a necessary condition to obtain a grant. The aim was 50 percent contribution from industry but this was not strictly enforced. The partners had to invest in what is known as called 'complementary financing'.[5] However, there is a broad interpretation of complementary financing upon analyzing the projects. One extreme is when the firm or organizations puts some matching money into the program, which could be shared by partners. The other extreme is to count the wages/time of existing employees as their investment, but with no 'new' money. The latter has been very common.

The partners involved in the projects range from business units within global food companies to large farmers' cooperatives which process raw material into food (such as wheat into flour and pasta) to some branch organizations. This reflects a huge range in size and type of organizations involved in the agriculture and food industry in Sweden.

The companies and organizations involved range from companies processing and producing dairy products (e.g. Arla), food processing companies for vegetables and a range of products (Nestlé), packaging companies for food (e.g. Tetra Pak), the very large Swedish farmers' cooperative (e.g. Lantmännen), as well as academic spin-offs, which had been started in a previous period from a university (e.g. Biogaia).

Note that the list includes both companies and other types of organizations. Companies are either privately owned or incorporated, and they may be global or may have the majority of activities and headquarters in Sweden. Also involved in the program, was Lantmännen which is, formally, a cooperative of farmers. They have a range of subsidiaries, ranging from products for consumers (such as bread and pasta) to intermediary steps (such as butchers) in the food value chain. Other types of organizations identified have a quasi-public or public role in developing, enforcing and sometimes leading regulation – and sometimes research – about issues of regulation, safety and further developments in agriculture and the food industry. Examples included public agencies such as, for example, the National Food Administration, the National Veterinary Institute (SVA), Packforsk and Matforsk (Norway).

Each project generally has more than one company and organization involved, with an average of 3.17 companies and organizations involved per project. The highest number of firms involved in a project exceeded 15 and the lowest was 1. Table 4 provides an overview.

[5] A few projects were 'planning grants' and were not required to have industrial partners.

Table 4: Overview of project participation by companies and organizations involved, by average number of projects and by size

Average number of projects	**Number of companies meeting criteria**	**Indicative size of companies**	**Names of company or organization**
Involved in >10 projects	3	All > 500 employees	Arla Orkla Foods Cerealia (subsidiary of Lantmämmen, cooperative)
Involved in 4-9 projects	10	5 have >500 employees 4 have 50-249 employees 1 has 10-49 employees	>500 employees Skånemeijerier Milko /NNP TetraPak Findus Lantmämmen (cooperative) 50-249 employees Karlshamns AB AnalyCen AB (Lantmännen, cooperative) Källsbergs Industri AB Lyckeby (Sveriges stärkeleseprducenter, cooperative) Svensk Mjölk
Involved in 2-3 project	15	5 have >500 employees 7 have 50-249 employees 3 have 10-49 employees	See Laage-Hellman 2009
Involved in 1 project	59	From micro-firms to large corporations	See Laage-Hellman 2009

As visible in Table 4, the majority of partners involved in only 1 project or in 2-3 projects. However, 10 organizations were involved in 4-9 projects, and these partners are of varying sizes. Three partners were involved in more than 10 projects, and all of these are large companies with more than 500 employees.

4.5 Summary and analysis

'Needs-driven research' was a key idea underpinning the policy initiative presented here. The perceived goals and objectives of the innovative food initiatives were to invest in collaborative research, in order to stimulate knowledge, which could later be translated into business and economic growth and also help solve public health issues. The debate preceding the policies pointed to the 'low' R&D capabilities of the food companies, and identified the need to increase the companies' competencies in order to among other things reduce costs and improve food quality and safety, and thereby compete upon an open European market and improve public health in Sweden.

The universities and researchers were heavily involved in the projects, especially as project leaders. Although the project participation for university researchers were based on open calls and competitive applications, the result was a large concentration of resources, with 52% of all funds going to the top two academic nodes, namely one university (Lund) and one research institute dedicated to this industry (SIK). The individual project leaders have a diverse record of publication and citations, but the top project leaders are also among the top researchers (in all fields) in terms of citations in Sweden.

The companies involved come both from the food industry directly in delivering products to the consumer (like milk, vegetables, frozen prepared food) as well as in the value chain delivering products to businesses (like processing machines and packaging).

Also, we would like to point out that the leading research groups are located in the same areas as the food industry. Geographically, most employees are located close to Lund in Skåne län (25% of the food industry's employees), followed by proximity to Gothenburg with Region Västra Götaland (21%), and Uppsala which is close to Stockholm County (16%). Of the 66 projects, the project leaders for 48 projects were located in the three geographical regions of Gothenburg, Uppsala-Stockholm and Lund-Malmö.

5. Developing firm capabilities for innovation

This section addresses the second research question, namely: What types of outcomes can be identified from the collaborative needs-driven research projects? Which types of firm capabilities for innovation were developed?

5.1 Outcomes

The stated purpose of the Innovative Food program was to impact the competitiveness of firms – and benefit public health. The competitiveness of firms depends, in turn, on their ability to introduce different types of innovations. Figure 1 includes a visualization of how collaborative research may influence business innovations in firms. Following OECD definitions and national statistics, innovations are divided into different degrees of novelty (e.g. new to world or new to market or improvements) and into product & service innovation as opposed to process innovations. As a step before innovation, Figure 1 presents a process, whereby the direct outcomes of the collaborative projects can be important to stimulating these different types of innovations in the firms.

Our analysis of the Innovative Food program categorizes the reported outcomes as related either to process innovations, product innovations or commercialization.

The outcomes of collaborative research can be:

- Related to process innovation
    - New practical method
    - New technology or new equipment
- Related to product innovation
    - Product development
    - Prototype
    - Product
- Commercialization
    - Patent and intellectual property rights (IPR)
    - Start-up company

Based upon this list, we have classified the outcomes defined in the final reports for each project. The following outcomes are reported, in descending order of importance, and providing illustrative examples, in Table 5.

Table 5: Outcome of collaborative research, reported per project and examples

Outcome category	**Number of projects reporting this in final report**	**Examples from reports and interviews**
Related to process innovation	**32 in total, of which**	
New practical method	23	Methods to reduce the amount of acrylamide that results from the bakery process in bakeries Major dairy producers in Sweden were involved in a project concerning issues of hygiene in production
New technology or new equipment	9	New sensor and filters to reduce wastes in the dairy industry
Related to product innovation	**29 in total, of which**	
Product development	14	Attributes of food, specifically to develop consistency-optimized food for the elderly
Prototype	10	Prototype takes more time and investment to turn into a product.

		For example, two years after one project ended and the participating firm started their own development work, the product were introduced on on the market and they expected a product turnover of about MSEK 10 in its first year.
Product	5	New yoghurt – specifically, fermentation in bacteria to develop new dairy products, with health benefits.
Related to commercialization	**5 in total, of which**	
Patents	3	Technical advance in sensor
Start-up companies	2	A start-up based on the online measurement based on microwave technology for the detection of foreign bodies in food
Commercialization is complex. Relations identified between patents and start-up companies ideas		The idea was originally developed in a smaller project. The researchers behind the project patented their discovery and set up a firm around the patent in order to commercialize it. The timing was, however, bad. Just after the dotcom crash it was difficult to raise money and after a few years of struggling, the rights to the patent were sold and the researchers returned to academia.

Our analysis of the outcomes of the collaborative research has generated a list of outcomes visible in this case study as well as an analysis of how often each type of outcome was reported. In Table 5, there are 32 projects classified as having direct outcomes relating to process innovations and 29 as related to product innovations. Commercialization is a minor occurrence, reported in only five project reports. Examples of each outcome are also provided in Table 5.

5.2 Development of firm capabilities for innovation

This paper started by arguing that regeneration of a traditional industry relies upon the learning and engagement of partners, in order to understand and transform new knowledge into business innovation. This section therefore explores insights from interviews from company representatives about what types of firm capabilities that they identified, which can represent an indirect route to affecting innovation in firms.

We would like to point out that the interviews presented a somewhat more nuanced understanding of the nature of the direct outcomes of these projects. In the interviews, the firms were clear that they did not want to collaborate on research that was close to commercialization in the sense of close to final products and services. For them, the actual research project had achieved a good result, if some initial ideas were identified and tested to either be reasonably viable or could be rejected. This can be seen in the following quotation by a firm representative:

> That is the way it is, you are in the project, sometimes with competitors, you learn and then you take the knowledge back home and try to translate it. And once in product development on our own, we cannot be that open about it anymore, we do not just call the researcher for help on specific problems. At that stage, the project has become a company-internal and secret project.

In contrast, the firms meant that the actual development work for a (future) product or services should be conducted in-house and not within the collaborative projects. An implication is that even outcomes identified above as a direct route to influencing innovation could mean that much development work was still necessary, once the project was moved into the firm.

So how might capabilities be developed, which were potentially useful for innovation within the firm?

A first finding about developing firm capabilities is the development of networks, which were reported as an outcome in 12 projects. Many firms drew upon previous contacts, because as stated in an interview "you rarely apply for money for something which you don't know at all or have been into before". A question is why networks were an important capability to develop. A project on hygiene issues and involving several dairy firms can illustrate this issue. Although these firms were competitors on the final market for food, such as yoghurt and cheese products, one result of the project was a network which continued to exist after the project finished. Although the companies were competitors in terms of products, the network (and project) focused on hygiene issues that was a problem common to all companies: "If one dairy company gets problems with hygiene, it does not only hit that company but all dairy firms collectively". The network enabled them to access knowledge, machinery and equipment important for identifying and solving various problems related to hygiene in production.

The analysis of data found in the project reports may give more insight to what networks means. Two opposing trends can be identified about collaboration between specific universities and public research institute on the one hand with companies and organizations on the other hand. The first trend is that sometimes, the same firm and university or research institute collaborated over many projects and years within Innovative Food. For example, the company Karlshamn and the SIK repeatedly collaborated on projects, and the same pattern can be seen between SIK and the various dairy companies, including Arla. These repeat collaborations suggest a certain increase in intensity of the linkages. Small research intensive entrepreneurial companies such as Probi and Ceba also tend to work with the same universities and even the same university departments for the projects they participate in. The second trend is that for some larger companies, such as Cerealia and Orkla, collaborations extended to all of the major research environments. The farmers' cooperative Lantmännen was heavily engaged, and active in a third of all projects run within the Innovative Food program.

Hence, our interpretation is that in the first trend, the academics involved built upon research capabilities in the leading universities in these fields, and they could have already had previous contacts with industry, given the co-location. In the second trend, the company and other organizations had reasons to be involved in a range of projects, and they were their networks may be as intense as in the first trend, but extended across the country. These projects also involved differential types of investment, in that although all projects had industrial involvement, in some cases the firms were very active and carrying out parallel research while in other cases, the firms were fairly passive and awaiting the results from the center.

A second finding is what we can call signaling effects, where the firm developed capabilities to engage with external partners in networks – with expected positive effects for future innovations. Three different reasons were given in the interviews: 1) signaling effects of quality by being chosen to interact with a well-known university; 2) publishing scientific studies which documented the health effects of food, and 3) publishing papers on the usefulness of instruments and equipment. Getting scientific papers published on your topic – or doing so through co-authoring with (independent) university and institute researchers – was argued to be particularly important in food designed to have nutritional benefits and health benefits, as well as in regards to safety and quality. For example, this was the case for research projects concerning the use of bacteria in yoghurt for promoting digestion or treating ulcers. Moreover, for companies involved in developing new instruments for quality and safety, scientific papers also provide an information and marketing channel to demonstrate the effectiveness of methods, technology, and equipment.

A third finding is the role of transfer of technology and knowledge from the research projects to the involved firms for stimulating the development of firm capabilities. Examples given in interviews include the transfer of knowledge on how to perform new methods of analysis, the transfer of a specific technology, and general knowledge on what technologies actually exist. Three of the interviewed firm representatives that have been involved in large number of projects suggest that an important part for a successful transfer of knowledge in the project is the intensity with which the company is actively working on the projects.

Transfer of technology and knowledge seems to be related to expertise in a specific area, which may help explain the concentration of resources to certain universities. The highly successful research group in Lund, for example, has over a number of successive projects developed better, and faster diagnostics and analysis in order to improve food safety. This development occurred continuously over time through roughly three stages. The first stage concerned the identification of the presence of different organisms; the second stage concerned how to determine the number of organisms in a sample, and the third stage was to determine the activity of the organisms in the sample. This last stage is important as it may be used to see how, for example, natural additives inhibit or increase the virulence of organisms in food.

Finally individual contacts and labor mobility could also be important in regenerating this traditional industry. As stated in one interview, “We don’t use the connections we make to primarily call researchers for consultation on specific problems. But if we have a research question that we need feedback on, we know where to turn to, and we can also use these connections to get a hold of right people in, for example, advisory board functions”. Another aspect may be labor mobility, with the example of the project ‘LiFT’ which was designed to finance PhD students to stimulate them to work with companies. 17 PhD students participated, and of them 15 were employed by the involved companies after graduation.[6]. However, most companies reported in interviews that the projects – and PhD students – involved in the research were working on topics that were too far from the daily concerns of the company. As one respondent from a company stated, ‘we could only hire them if the project was very, very close to our products’.

5.3 Summary and analysis

What is interesting in relation to the second research question is that collaborative research can help firms engage in innovations, through both direct routes (outcomes of projects) and indirect routes (developing firm capabilities to innovate). This section updates our proposed conceptual framework (Figure 1) to propose a new representation of our case in Figure 3 below, thus adding the results from our case study to the initial conceptual framework.

In terms of the analysis of outcomes, they can be primarily classified as relating to process innovations (32/66 projects) and to product innovations (29/66). Commercialization is a minor occurrence (5/66) as an outcome. This supports the idea derived from the literature overview that academic engagement with industry – also in our case – a much more important way of understanding collaborative research than is commercialization.

Our analysis suggests that conducting collaborative research in these projects did help the development of specific networks and new knowledge capabilities. Returning to our stylized conceptual framework, we have specified the outcomes of the collaborative projects and we have identified a list of outcomes which are added to Figure 3 below: 1) development of networks; 2) signaling effects; 3) transfer of technology and knowledge; and 4) individual contacts and labor mobility.

[6] Of course, there may be self-selection bias of which types of students participated in this project, but our point is that they were offered jobs in industry.

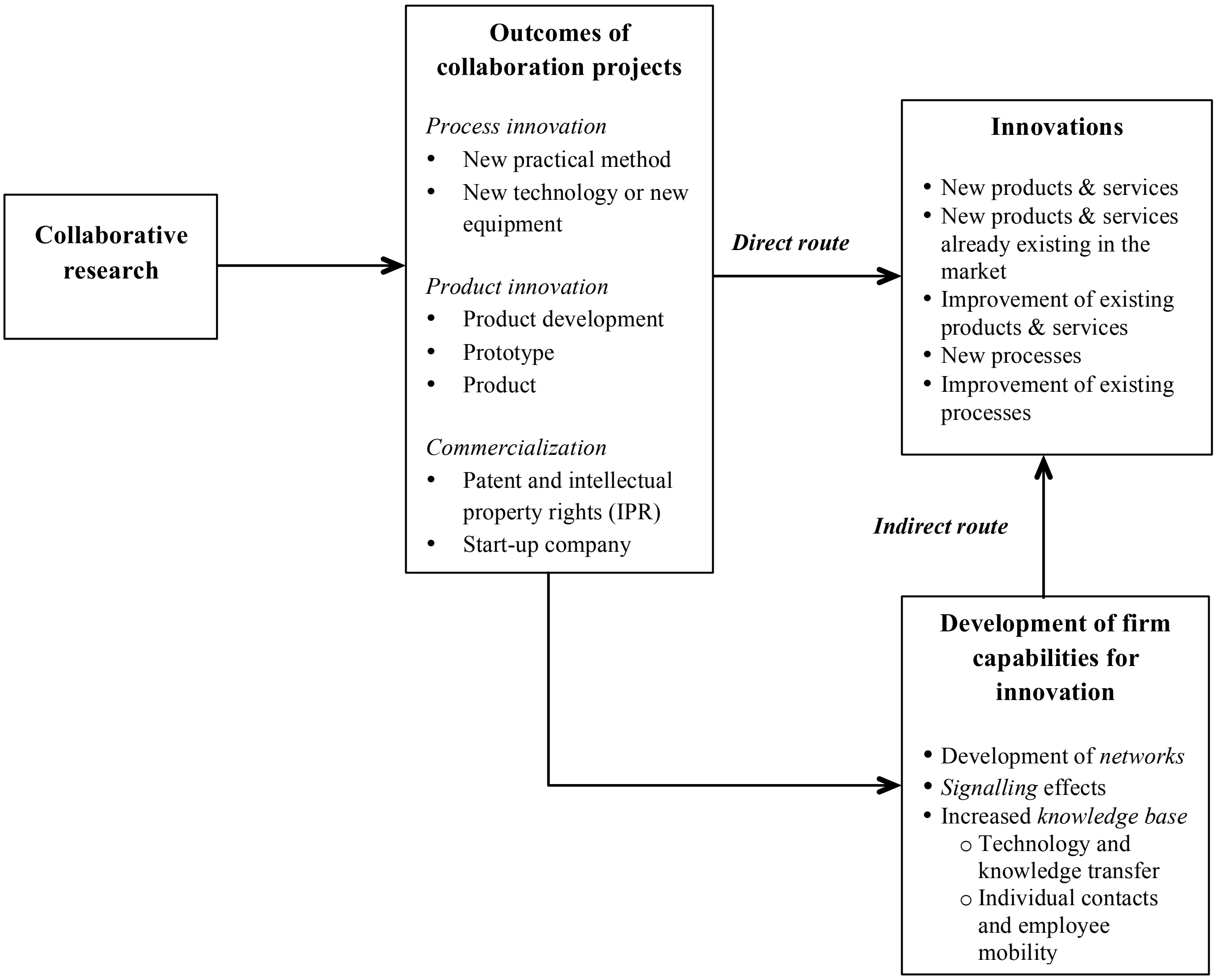

Figure 3: Updated conceptualization, based upon the case study of innovation and the food industry in Sweden

6. Conclusions: Regenerating the Swedish Food Industry through Innovation

Regeneration suggests that a traditional industry can increase its competitiveness, if new and more vigorous life can be brought about to existing firms and/or through entrepreneurship. This paper has presented a case study of Innovative Food in Sweden, which suggests that collaborative research can stimulate and develop firm capabilities to innovate.

A set of implications relates to public policy concerns and innovation management at the firm level. As introduced in the literature overview, traditional science policy defined that the main goal of government policy should be to invest in long-term, risky, and basic research. However, the public policy initiative that is studied here has a different logic, namely to stimulate 'needs-driven' research collaboratively between industry and universities, in order to promote business innovations and economic competitiveness.

Our focus upon the outcomes of collaboration research – as well as the development of firm capabilities to innovation – suggests a need to better understand innovation management in low- and medium-tech industries. Within the food industry, the firms by definition of being a low-tech industry tend to do very little in-house R&D. Given the overall low investment into innovation and low human capital, the results identified in this paper would not have been developed only through private investment into R&D – because the firms would not have financed this type of research.

The Swedish food industry is interesting in terms of the long-term development of firm capabilities to innovate. The following figures are based upon national statistics and we do not mean that they demonstrate any direct effect from the Innovative Food program. Instead, a brief comparison within Sweden and over the time period studied here is indicative. The comparison includes the food industry; another low-tech industry (paper and pulp) and a high tech industry (pharmaceuticals).

Table 6: Trends from 1995 to 2007 in Swedish industries: Food, Paper and pulp, and Pharmaceuticals

	Food Industry	**Paper and pulp**	**Pharmaceuticals**
Related to process innovation (Percentage change in R&D expenditures)			
Development of new processes, methods, systems etc.	109 %	- 51 %	165 %
Improvement of existing processes, methods, systems etc.	- 7 %	44 %	300 %
Related to product innovation(Percentage change in R&D expenditures)			
Development of new products and services already existing on the market	77 %	- 64 %	- 66 %
Development of products and services new to the market	220 %	- 30 %	28 %
Related to individuals and human capital[7]			
Percentage change in			

[7] For the human capital figures, the comparison is, due to availability of data, 1995 to 2005.

percentage of employees with an academic (university level) degree	45 %	-4 %	56 %
Percentage change in percentage of employees with a PhD degree	79 %	-37%	82%

Although we cannot identify the cause or the specific role of public policy, Table 6 is interesting in the dramatic changes in the Swedish food industry over this period, and also the fact that the trends are closer to pharmaceuticals than to paper and pulp industry. This suggests that firm capabilities to innovate can, and do, also increase over time, and they are not a 'given' characteristic of an industry.

Another set of implications relates to future research. There are interesting questions about public policy, which require additional research. In particular, more work is needed on the limitations and boundaries of public policy to regenerate traditional industry. One could conceptualize that public policy can help 'shift' the path or trajectory of a national and sectoral innovation system, towards a higher knowledge and higher value-added mode. In this context, a challenge for understanding innovation policy is how small countries in the modern knowledge economy can retain a institutional context which remains 'interesting' enough to also contribute to the development of knowledge and innovation that companies require for local and global competition. More research on the innovation in traditional industries is also a top priority for research.

References

Arrow, K. J. 1962. Economic Welfare and the Allocation of Resources for Invention, In Richard Nelson (ed.), *The Rate and Direction on Inventive Activity*. Princeton, N.J.: Princeton University Press.

Aslesen, H.W. 2009. The Innovation System of Norwegian Aquacultured Salmonids. In Fagerberg, J., Mowery, D. And Verspagen, B. (eds.) *Innovation, Path Dependency, and Policy: The Norwegian Case*. Oxford University Press.

Bernal, J.D. 1939. The Social Functions of Science. Routledge and Kegan Paul, London.

Bush, V., 1945. Science, the Endless Frontier. National Science Foundation, Washington, DC.

Cohen, W.M. and Levinthal, D.A., 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. Administrative Science Quarterly 35, 128–152.

Cohen,W.M., Nelson, R.R. and Walsh, J.P. 2002. Links and impacts: the influence of public research on industrial R&D. *Management Science*, 48 (1), 1–23.

Dodgson, M., Hughes, A., Foster, J. and Metcalfe, J. 2009. Systems thinking, market failure, and the development of innovation policy: The case of Australia. Centre for Business Research, University of Cambridge, Working Paper No. 397.

Edquist, C. (2001). The Systems of Innovation Approach and Innovation Policy: An account of the state of the art. *DRUID Conference,* June, Aalborg.

Georghiou, L. 2006. Effective innovation policies for Europe ‐ The missing demand-side. Report for the Prime Minister's Office of Finland, Economic Council of Finland.

Giuliani, E., and Rabellotti, R. 2012. Universities in emerging economies: bridging local industry with international science - evidence from Chile and South Africa. *Cambridge Journal of Economics*, 36(3), 679–702.

Hirsch-Kreinsen, H. and Jacobson, D. (eds.) 2008. Innovation in low-tech firms and industries. Cheltenham, Uk and Northampton, USA: Edward Elgar Publishing.

Kuhlmann, S. 2001. Future governance of innovation policy in Europe—three scenarios. Research Policy 30, 953–976.

Laage-Hellman, J., McKelvey, M., and Johansson, M., 2009. Analysis of Chain-linked Effects of Public Policy. VINNOVA (Swedish Governmental Agency for Innovation Systems), Report No. VA 2009:20.

Laursen, K., and Salter, A. 2004. Searching high and low: what types of firms use universities as a source of innovation? *Research Policy*, 33, 8, 1201- 1215.

Lerner, J. 2009. Boulevard of broken dreams: Why public efforts to boost entrepreneurship and venture capital have failed – and what to about it. Princeton University Press.

Li 2007. Livsmedelsåret 2006. Livsmedelsföretagen (The Swedish Food Federation). www.li.se.

Lissoni, F. and Breschi, S. 2001. Localised knowledge spillovers vs. innovative milieux: Knowledge "tacitness" reconsidered. *Papers in Regional Science*, 80, pp. 255-273

Lundvall, B.-Å. and Borrás, S. 2005. Science, technology and innovation policy. In Fagerberg, J., Mowery, D. and Nelson, R. (eds). The Oxford Handbook of Innovation. Oxford: Oxford University Press. pp. 599-631.

Martin, B. R. 2001. Chapter 2 Matching societal needs and technological capabilities: research foresight and the implications for social sciences. In: *Social sciences and innovation*, Organisation for Economic Co-operation and Development, published by OECD.

McKelvey, M., 2005. Tensions in co-evolutionary processes: Three Swedish seed organizations in the 20th century. Economics of Innovation and New Technology 14, 683–696.

McKelvey, M., 2014. Science, Technology and Business Innovation. In Dodgson, M., Gann, D. and Phillips, N. (eds.) *The Oxford Handbook of Innovation Management*. Oxford University Press.

Mytelka, L. and Smith, K. 2002. Policy learning and innovation theory: an interactive and co-evolving process. Research Policy 31, 1467-1479.

Nelson, R.R. 1959. The simple Economics of Basic Scientific Research, *Journal of Political Economy*, 67, 297.

Nutek. (1998). Forsknings-och utvecklingsstöd, Till industriella samverkansprojekt inom Livsmedelsområdet. Utlysning. Stockholm: Nutek.

Perkmann, M., Tartari, V., McKelvey, M., Autio, E., Broström, A., D'Este, P., Fini, R., Geuna, A., Grimaldi, R., Hughes, A., Krabel, S., Kitson, M., Llerena, P., Lissoni, F., Salter, A., and Sobrero, M. 2013. Academic engagement and commercialisation: A review of the literature on university–industry relations. Research Policy 42, 423–442.

Persson, B. 2008. The Development of a New Swedish Innovation Policy A Historical Institutional Approach, *Paper no. 2008/02*, CIRCLE Electronic Working Paper Series, Center for Innovation, Research and Competence in the Learning Economy, Lund University.

Proposition 1996/97:5 Forskning och samhälle (Research and Society). Stockholm.

Robertson,P., Smith, K. and von Tunzelman, N. 2009. Innovation in low- and medium-technology industries. Research Policy. 38, p. 441-446.

Salter, A.J. and Martin, B.R. 2001. The economic benefits of publicly funded basic research: a critical review. *Research Policy*, 30, p. 509–32.

Santoro, M.D. and Chakrabarti A.K. 2002. Firm size and technology centrality in industry–university interactions, *Research Policy*, Volume 31, Issue 7, September 2002, p. 1163-1180.

Schartinger, D., Rammer, C., Fischer, M.M. and Fröhlich; J. 2002. Knowledge Interactions between Universities and Industry in Austria: Sectoral Patterns and Determinants, *Research Policy,* Volume 31, p. 303-328.

Scherer, F.M. 2000. Chapter 25 The pharmaceutical industry. In: *Handbook of Health Economics*, Volume 1, Part 2, 2000, pp 1297-1336.

SJFR (1986). Forskning för bättre mat. Skogs- och Jordbrukets Forskningsråd.

SOU 1997. En livsmedelsstrategi för Sverige. Näringsdepartementet. Statens offentliga Utredningar. *SOU 1997:167*.

Stokes, D. 1997. Pasteur's quadrant: Basic science and technological innovation. Washington: Brookings Institution Press.

Vinnova. (2001). Innovativa livsmedel, Program för forskning, Utveckling och demonstration Vinnova 2001-2005*, VI 2001:7*

Winter, S.G., 2006. The logic of appropriability: From Schumpeter to Arrow to Teece. Research Policy 35, 1100–1106.