Chapter 17
Offshoring of Innovation: Global Innovation Networks in the Danish Biotech Industry

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Abstract This chapter is an investigation into the internationalization of innovation in the Danish food-related biotech industry. The process of the internationalization of innovation in food and ingredients into new markets has followed a similar path: first, the companies enter new markets with their products developed in the home economy; secondly, they increasingly adjust their products to the new markets; and thirdly, some of the more high-tech companies have developed international techno-scientific networks. These companies explain the development as a strategy for 'tapping into new knowledge' by collaborating with local research facilities and suppliers. The companies engage in various constructs of global innovation networks more or less simultaneously according to the type of technology. The type of engagement and entry mode relates to the host location. Similar companies develop different network constructs. Furthermore, companies face many difficulties in organizing innovation internationally. These challenges are dealt with through either virtual or physical centres of excellence. Communication and communication tools provide a key for companies to manage these centres, and new forms of qualifications are needed to facilitate this.

Keywords Internationalization of innovation · Home-base exploiting · Home-base augmenting · Agro food industry · Biotech · Global innovation networks

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17.1 Introduction

Innovation in the Danish food industry is increasingly taking place in networks that involve many more actors than earlier innovation models found in this industry. These new network constructs involve actors such as companies, consultancies and public research institutions. Innovation networks are as such not particularly new in this industry, which has developed a strong embeddedness in the Danish national innovation system, and hence, today it represents one of the largest and most internationalized and innovative food clusters in Europe (ECO 2010). However, new actors are entering the innovation processes, and the organization of innovation in the companies is changing. Consequently, the networks are undergoing a complete reconfiguration, both in terms of the type of actors, where it previously was predominantly innovation collaboration within the value chains, that is, with suppliers and customers (Hansen 2009). In addition to this, innovation collaboration is increasingly internationalized beyond the national innovation system with mobilizing consequences for the home networks (Borrás and Haakonsson 2012).

Where the Danish food industry is perceived as well established through history, the companies are today facing organizational challenges and forms of competition which are not possible to solve on the basis of mere experience. Looking from the point of view of companies, there are three main reasons for internationalizing activities. First, the industry has developed from a small open economy (Katzenstein 1985) and needs to expand its markets in order to cover the increasing costs of innovation. Secondly, some companies produce ingredients and enzymes for global lead firms who are increasingly operating on global markets and therefore require their suppliers to adjust products to local tastes and raw materials. Finally, many companies are specialized within biotechnology for which knowledge is spread and companies need to actively create their own access to knowledge. We know from foreign direct investment (FDI) statistics that the biotech industry has the highest share of research and development (R&D)-related investment in total FDI. From 2003 to 2009, 36 % of FDI in the biotech industry was R&D related as compared to the second and third highest shares of R&D-related FDI in total FDI, namely the pharmaceutical industry (21 %) and software and IT services (7 %) (FT FDI 2009).

The aim of this chapter is to investigate the extent to which Danish lead firms internationalize innovation and how they deal with the organizational challenges that follow. Hence, the chapter analyses the internationalization of innovation in four of the largest and most knowledge-intensive Danish food companies, that is, the biotech-related food companies. All four are multinational companies (MNCs) with global market reach and have internationalized production and markets. Two of the companies are specialized in the production of ingredients and enzymes and are among the world leaders in their field. The ingredients and enzymes industries have a strong foothold in Denmark but supply ingredients to food producers globally. The other two companies are also knowledge-intensive and engaged in

R&D. However, their products are final products for direct consumption. Accordingly, this chapter will investigate how different types of companies (in different segments of the food value chain) follow different strategies in terms of organizational design in their construction of global innovation networks (GINs).

The chapter is structured as follows. The next section looks into the theoretical approaches to the internationalization of innovation. Section 17.3 is the methodology. In Sect. 17.4, there is a presentation of the Danish food industry. This is, in Sect. 17.5, followed by the analysis at the case level of the companies' restructuring into GINs. Finally, the discussion in the Conclusion takes an overall perspective on the types of innovative networks Danish food companies engage in, and how they manage them.

17.2 Global Innovation Networks Under Construction

Innovation is increasingly globalized, and today many companies are reorganizing R&D and other innovation activities through a process of constructing what have recently been coined 'GINs' (Chaminade 2009; Barnard and Chaminade 2012). These networks are encompassing many more actors than earlier innovation constructs and reach much wider geographically. The actors found in GINs are both internal and external; hence, the networks may consist of headquarters, subsidiaries, suppliers, customers, competitors, research institutions, universities and others (Ernst 2002, 2006; UNCTAD 2005, 2009; Narula 2003). Still, although operating these networks creates new opportunities to access complementary and new knowledge, reduce cost and/or engage in new markets, these networks are also very complex and costly for companies. Therefore, companies engage in GINs on ad hoc decisions based according to location specificities and company strategies (Haakonsson 2012). Moreover, as internationalization of innovation is a relatively new phenomenon, these companies operate in uncertain environments. Therefore, it is relevant to look at different ways of engagement in networks. So far, the impact of environment (Dill 1958), company specificities (Burns and Stalker 1961) and evolutionary aspects (Lewin and Volberda 1999) remains unexplored in the work on internationalization of innovation.

Most of the current approaches to internationalization of innovation stem from the strategic management of innovation. The terminology of *home-base-exploiting* and *home-base-augmenting* innovation strategies as developed by Kuemmerle (1999) relates to the competitive push and pull factors that companies experience regarding innovation (Kuemmerle 1999). Home-base-exploiting strategies imply that companies exploit their products developed at home in new markets, and this may eventually involve some development in the host location for adjusting the products to the local taste and environment. This strategy tends to dominate when companies face limited home market for their increasing expenses on R&D. This generates a push factor for companies to search for larger markets; here, emerging markets have recently entered their strategies for market expansion.

Home-base-augmenting strategies related to companies' need to tap into new knowledge or combinations of knowledge that are not available in their home settings and/or existing networks. Companies look for complementary knowledge and networks beyond their own competencies and capabilities. Although these two incentives for internationalizing innovation differ, they are not mutually exclusive and companies tend to construct networks containing a combination of the two strategies, following technology or locational specificities. The networks of innovation activities in GINs are often not established over night. They are likely to evolve from already established networks of, for example production or markets. Taking an evolutionary approach to organizations and their environments is not new as such (Lewin and Volberda 1999), but this is so far to be applied to innovation activities. One typology of internationalization of innovation in an evolutionary perspective was developed by Archibugi and Michie (1995); however, this is from a company perspective and does not take the environment into account.

Archibugi and Michie (1995) developed a descriptive taxonomy for companies' internationalization of innovation. This taxonomy includes three main categories, which are understood to emerge in successive stages (Archibugi and Iammarino 1999). The first category is *international exploitation*. International exploitation implies the marketing of nationally generated innovations beyond the company's home market, that is, through exports, licensing and offshoring of production. The second category is *global generation of innovation*. This entails corporations reorganizing their activities beyond their home economy and (re)locating R&D and other innovative activities both within the home country *and* in host countries, for example, offshoring of R&D to adjust products to local conditions. The third category is *global techno-scientific collaboration* where companies, research institutions and universities collaborate with joint scientific projects and innovation networks across countries, for example, for cutting edge innovation, such as second generation biofuels and genomics.

In reality, MNCs may engage in all three types of internationalization of innovation, and their engagement potentially differs according to different factors: intra-firm (size, products, innovations) (Meyer and Peng 2005), features in the host economy (Mudambi 2008; Graf and Mudambi 2005; Haakonsson et al. 2012) and the home country of the MNC (Edquist 2005). However, Archibugi and Michie's three types of globalization of innovation can be seen to add an evolutionary perspective to the terminology of knowledge exploitation and knowledge-augmenting strategies, as developed by Kuemmerle (1999). The companies are here expected to move from international exploitation towards global techno-scientific collaboration over time (Archibugi and Iammarino 1999). Hence, international exploitation relates to home-base-exploiting strategies, and global techno-scientific collaboration relates to home-base-augmenting strategies, while the second type of internationalization—global generation of innovation—relates to both, depending on whether the R&D relates to innovative research or the development of new products. Table 17.1 illustrates the relationship between the typology of internationalization of innovation and company innovation strategies.

Table 17.1 The links between the typology of internationalization of innovation and company strategies

Category—of internationalization of innovation	Strategy—in individual firms internationalizing innovation
International exploitation	Home-base-exploiting strategies
Global generation of innovation	
Global techno-scientific collaboration	Home-base-augmenting strategies

One result of companies engaging in the internationalization of innovation is the emergence of GINs. These vary on all three parameters, namely the global, the innovation and the networks (Chaminade 2009). On the first parameter, 'global' indicates an engagement in innovation beyond the triad (Europe, United States and Japan), and hence, companies' innovation may be more or less 'global' (see Rugman 2005; Haakonsson and Thompson 2010). MNCs may engage more or less globally (i.e. in Europe or worldwide). Secondly, internationalization of innovation spans from the exploitation of innovation through to the 'incremental' application of products to new markets by adding small alterations to products and to 'new to the world' radical innovations generated through international operations and networks. Finally, the types of networks range from instances of collaboration within the company across locations to strong external networks across the globe, involving many different types of actors both within the value chain (upstream with suppliers and downstream with buyers) and beyond the value chain (universities and scientific networks). Here, a highly networked company means that it has moved beyond its value chain.

Table 17.2 shows the three parameters which can be combined into eight different combinations from worldwide explorative relationships beyond the value chain to more local or regional exploitation of innovation in collaboration with suppliers and customers within the value chain as the two extremes. The following sections will show how the range of organizational designs related to the internationalization of innovation gets more complex and diffuse the more 'Highs' that are involved in the configuration of the innovation network of a particular company. The following sections are based on four in-depth company case studies. These explore the scope, innovativeness and scale of their respective innovation networks.

Table 17.2 Global innovation network typology (see also: Chaminade 2009; Barnard and Chaminade 2012)

	Global	Innovation	Network
High	G: Worldwide	I: Exploration	N: Beyond the value chain
Low	g: Denmark/Europe	i: Exploitation	n: Within the value chain

17.3 Methodology

This chapter is based on empirical data collected in Denmark in 2010 as a part of the EU FP7 project *Impacts of Networks, Globalisation, and their Interaction with EU Strategies* (INGINEUS). The data set consists of three main sources of information. First, the INGINEUS survey carried out in the industry in early 2010 in Denmark. The companies included in the survey are all in the food industry listed under NACE rev. 2 codes 10 (manufacture of food products) and 11 (manufacture of beverages). Companies with a minimum of five employees were selected in the initial download. The cleaned database consisted of 210 companies. Of the 210 companies that received the questionnaire, 48 companies responded to the survey. This is an overall response rate of 23 %.

Secondly, four in-depth case studies were carried out among the largest and most innovative and internationalized corporations in the industry. Hence, they constitute critical case studies and are representative of the 'cutting edge' of the emerging trends in the industry in terms of GINs. Two of the case companies are in the part of the industry relating to biotechnology, while the other two are strong international players in more traditional products. A total of 23 interviews were carried out in these four companies. Table 17.3 shows the main characteristics of the four case companies and the number and location of interviews conducted in each. In addition to the company interviews, 6 experts related to the Danish agro food industry were interviewed representing a large agro food cluster, the Ministry of Food and Agriculture, two universities and two research institutions. Due to confidentiality agreements with the case companies, their names will not be disclosed.

Finally, a search of secondary data was undertaken, including official reports, companies' annual reports, industrial associations, Ministry of Food and Ministry of Science and Technology. In addition to this, statistical data were collected from Statistics Denmark. All Danish companies are obliged to report annually to Statistics Denmark; thus, the reliability of data is high. Finally, several industry workshops and conferences related to the Agro Food Park outside Århus were attended.

Table 17.3 INGINEUS Denmark case companies' main characteristics

Company	Type of products	Market internationalization	R&D internationalization
Company I (7 interviews in Denmark, South Africa and China)	Ingredients, biotech-related	Global	Global
Company II (6 interviews in Denmark, India and China)	Ingredients, biotech-related	Global	Global
Company III (4 interviews, all in Denmark)	Beverages	Global	Denmark
Company IV (8 interviews, all in Denmark)	Dairy	Europe	Denmark

17.4 The Danish Food-Related Biotech Industry

The agro food innovation system has previously been categorized as supply driven, with an emphasis on process innovation relying on a variety of technologies from other sectoral innovation systems (Pavitt 1984). This is generally confirmed in the Danish agro food innovation system. However, new tendencies emerge in some specific technology fields of the industry, which may be explained by the coevolution with the Danish national innovation system hosting five of the largest food-related biotech companies in the world today. As a result, this industry represents various types of internationalization of innovation—or embeddedness in global innovation networks. Looking at the strategic rationale from the companies' perspectives, these can broadly be divided into two categories of internationalization of innovation: knowledge augmenting and knowledge exploiting.

The framework conditions of the Danish agro food industry are characterized by a limited home market situated in a small open economy (Katzenstein 1985). In order to cover the costs of innovation and other investments, Danish companies need to engage in international markets by exploiting their knowledge beyond the national borders. In other words, as soon as the companies reach as certain size, there is a strong push effect for Danish companies to expand beyond the domestic market and the national innovation system. This internationalization is predominantly seen within Europe (Christensen et al. 2008). Moreover, the research environment in Denmark, although highly competent, includes a limited number of researchers as compared to larger economies. Along with the development of an increasingly knowledge-intensive economy, a strong agro food innovation system has developed, which today is one of the most innovative in the world. As most food products are relatively freshly produced, with limited shelf lives, and food tastes vary considerably over geographical area, products are predominantly aimed at the Danish and European markets. The industry accounts for approximately 20 % of Danish exports, of which 64 % are sold within Europe.

The food industry is categorized in the literature as being traditional, relatively low tech and oriented towards the local market (Pavitt 1984). However, facing towards the Danish industry, this industry is currently going through a process of international restructuring—a globalization process. This is a consequence of changes in the transport sector (e.g. developing the cold chain), companies exploring new tastes beyond their home markets (e.g. for yoghurts) and innovations related to conservation (e.g. prolonging shelf life). However, a large proportion of the recent breakthrough innovations made in the Danish food industry relates to biotech-related industrial actors providing ingredient and enzyme solutions for increasingly globalized customers.

As a result, the members of one group of large companies (in this chapter represented by case Companies I and II) have developed into specialized actors within biotechnology. In this group, innovation is performed globally and there is a high degree of collaboration between a wide range of actors generating global breakthrough innovations in their specialized niche markets. In the other group of

companies in the industry, companies focus on end markets, for example, through incremental innovations, such as applying products to new markets that are either international (local tastes) or functional (the gourmet value chain, organics, healthy foods). In this part of the industry (represented by case Companies III and IV), innovation also includes, for example, applying and developing technology from other technological fields such as robotics, preservation and packaging. These actors also engage in GINs but more with the aim of sourcing new raw materials or marketing their products in new markets.

The Danish industry is highly specialized within the areas of dairy, ingredients, beer and meat. The competitiveness of the industry relates to the innovation and research intensity (Landbrugsrådet 2006). This is also facilitated by the government support in the establishment of 'clusters' in food- and agriculture-related industries, which are seen to enhance collaboration with companies, industries and public and private actors, such as the Agro Food Valley (Agrotech 2009). According to the European Cluster Observatory, Denmark has the third largest food cluster in the European Union (ECO 2010), measured by the number of people employed in the industry, and it is categorized as innovative and export-oriented as compared to other food clusters in the European Union. Moreover, the industry is highly collaborative vertically as well as horizontally (Hansen 2009). The industry has a high degree of collaboration upstream and downstream, that is, with suppliers and customers. Many companies collaborate with and perform a 'from farm-to-fork' integration of production (*Fra jord til bord*) (Hansen 2009). A large proportion of the companies are small or medium enterprises (SMEs); however, these are highly internationalized in terms of market.

The industry is innovative. At the national level, there were 3512 people employed in R&D in food in 2008. Approximately 60 % of these were in the private sector, which spent a total of DKK 2.1 billion on R&D in 2008, an increase of 28 % (from 1.6 billion) from 2007 (Ministry of Science and Technology 2010).[1] Overall, the food industry accounts for 5 % of the total private R&D spending in Danish industries. According to the Ministry of Science and Technology (2010), 246 of the Danish agro food companies carried out R&D in 2008. Ninety per cent of their R&D spending was funded by the companies themselves, 6 % was funded by other national sources and 4 % was financed by foreign actors, mainly within the European Union (ibid.).

The Danish food companies are generally export-oriented. Fifty per cent of the companies reported a significant share of their sales activity abroad, and 38 % of the companies had their largest market outside Denmark (see Table 17.4).

However, the industry is supra-regionally embedded in the European context. Of the companies with an export market as their largest market, 69 % report that their largest market is within Europe, with only 31 % reporting destinations in the rest of the world. This does not necessarily imply that these companies do not sell

[1] This is the second largest amount within the Danish industrial sectors (after DKK 5.9 billion spent in the pharmaceutical industry).

Table 17.4 Location of largest market for Danish food companies

Location of the largest market	Percent (%)
Internal to the enterprise	7.1
A regional market	14.3
Domestic market (Denmark)	40.5
An export market	38.1

Source INGINEUS Survey

Table 17.5 Source of technology for Danish food companies

The most important source of technology for the company	Percent (%)
We produce most technological inputs in-house	22.0
We buy most of our inputs from other branches of our own MNC	12.2
We buy most of our technological inputs from non-MNC firms	31.7
We buy most of our inputs from MNCs with which we are not formally connected	34.1
We buy most of our inputs from public sector organizations, for example research institutes or universities	0

Source INGINEUS Survey

beyond Europe, but that their main geographical destination of export is within Europe.

The companies engage in various collaboration constructs when exploring technology (see Table 17.5). Two-thirds of the companies rely on collaborations with other private companies as their most important source of technology. This shows the highly networked nature of the industry. One explanation for this is integration of research along their farm-to-fork value chains. Some have formed one-stop shops for customers. A current example is a consortium of five companies in the development of ice cream. This network includes suppliers of ingredients for texture and flavour, a dairy producer, a producer of machinery for ice cream production and a large ice cream manufacturer.

Summing up, the Danish food industry is an integrated innovation system based on domestically embedded knowledge and networks among different actors, of whom the majority are SMEs. The industry is innovative, and companies have a relatively high level of engagement in collaboration around and investments in innovation. In terms of market, the companies are internationalized, but predominantly within Europe. The sectoral innovation system has an international outlook and links to research beyond the national innovation system and also beyond the sectoral innovation system. Competitiveness of the food industry in Denmark is strongly related to innovation. Furthermore, the companies are embedded in the overall Danish national innovation system. Accordingly, the food industry in Denmark is a solid platform, well embedded in the national innovation system, with strong horizontal and vertical linkages.

17.5 Internationalization of Innovation, a Story of Four Large Companies

Knowledge-intensive activities increasingly take place across national boundaries and involve more external actors than before. This is particularly the case for the large companies. The four case companies are all among the most research-intensive companies in the Danish food industry. All four companies have internationalized their R&D, and their innovation activities are increasingly dispersed internationally. These companies are in a process of developing network constructs beyond market and production; they are entering and establishing GINs. As a general trend, these are constructed via company subsidiaries linking into local research environments, also in emerging economies (e.g. in Bangalore or Beijing). Most of the outsourced R&D activities carried out by the companies are kept in-house for various reasons—but the companies expressed a need and desire to link into local knowledge for two main reasons, namely exploitation and augmentation strategies.

When exploitation is used as a strategy, the companies adapt current products to local tastes, local raw materials and markets (e.g. the development of yeast for local wheat varieties in sub-Saharan Africa, or identifying the use of enzymes for pasta into new products, such as noodles). For this type of internationalization, local customers seem to be important network actors, as are locally present global customers who are important partners in the overall global innovation network of, for example, ingredient companies (i.e. for those not producing for the end consumer). At the other end, augmentation is used as a strategy to tap into knowledge the companies do not access elsewhere or which is better or cheaper in an existing setting abroad (e.g. one of the companies bought an Indian producer of surface-grown proteins). For this type of internationalization of innovation, local institutions, competitors, universities and research organizations are important actors. These two models of the internationalization of innovation are not mutually exclusive. Often both these strategies explain a company's presence in a location and are often both important elements in its location strategy. However, they have different implications for the organizational design regarding innovation processes in the companies.

To develop a more in-depth understanding of the challenges Danish food companies face and processes at play in internationalizing innovation, this chapter now analyses four of the innovation leaders. The first two companies are specialized within the biotech part of the industry. The other two produce traditional products developed in Denmark. Companies I and II are engaged internationally *in research* into breakthrough innovation within biotech-related segments of the food industry, whereas Companies III and IV are more 'traditional' in their production and predominantly engaged in *development* of their products. *Research* implies carrying out development of new products and core research. Company I and II are interested in accessing relevant knowledge actors and environments. This was expressed in the interviews as 'not all good knowledge and innovation come from

Denmark'. Hence, they are looking for supplementary skills, specialists, etc. by reorganizing R&D into 'global operations'. Projects are taken care of by the most specialized in the particular field, often spanning across R&D locations/sites. *Development* here relates to adapting existing products to new markets. Within the agro food market, there is a high degree of diversity, for example, in tastes, textures, raw produce, quality. Therefore, companies while internationalizing their markets need to engage in some development of their products with reference to local markets, local raw materials and local conditions. This relates to a market access exploitation strategy. All the case companies were engaged in development of their products for local markets. However, while this distinction may be a useful heuristic device, it should be noted that companies in either camp will do R&D to different degrees.

The remaining parts of this section look into the location and internationalization strategies of R&D and innovation at the company level in order to, in the last subsection, develop the typology further.

Company I

Knowledge is the main product of this company: delivering solutions to customers based on recipes developed by the company—including their products as ingredients. R&D is a high priority: 4.3 % of the turnover is allocated to R&D, which is carried out in five large R&D platforms plus some supplementary smaller research units. A total of 870 people work internally within R&D, of which more than 60 % have a university degree. This company has a strong need for specialized knowledge at all levels.

While researching ingredients, the company has a high level of specialization and recruits a lot of people from specialized segments of the food industry. The company's culture is designed for innovation with an emphasis on encouraging the willingness to take risks, curiosity, freedom, trust, networks, open mindedness, experimenting at all levels and supporting entrepreneurs. To facilitate the development of ideas from within the company, the company has identified *'Cre-actors'* who are internal professional consultants supporting people who have 'a good idea' in bringing it further in the company.

Research is coordinated by an internal committee ensuring that the same structure and innovation management exist across the different locations. This committee is also responsible for the allocation of funding for R&D. For research, the company needs real experts—in biotechnology. Hence, ten per cent of R&D spending is placed outside the company, often in collaboration with universities. Development takes place in close collaboration with the customers. Food tastes differ, and even for the same products, the company needs local varieties. However, having a critical mass in a centre is prioritized more than a local presence. 'Operations are specialized and we have developed a system of exchanging knowledge so that a problem in the bread industry in South America may be solved from our specialized team in Canada.' Accordingly, innovation is designed to take place among the most qualified for the technology area.

Except for one research site, the R&D centres are placed near existing production facilities. The company links to academic institutions at home and abroad through different means, for example, annual awards for world-class researchers and through websites as 'innocentive' where actors can pose a problem for solvers to investigate. At home, the company plays a very active role in the agro food cluster and has a seat on the board of the Agro Food Park in Århus. One key characteristic about the organizational design related to innovation activities is that researchers are highly mobile. The circulation of people among the different sites is high, and on this basis, the company has intentionally developed virtual centres of excellence. This implies that for each technological field, there are relevant researchers in almost all the R&D centres.

Regarding location, the company has R&D facilities in most parts of the world. China is currently a high priority location for R&D as it is an important upcoming player in biotechnology: 'They produce a number of highly qualified PhDs every year. This area is really exciting for our business. Some of our people in the United States have spent 3–6 months at the China site to help develop the company culture.' Representatives from the company in China also pointed out that 'In addition to having access to highly educated staff and first class universities, we also find a mature biotechnology network in China, which we can use to continually enhance our advantages in the fields of enzyme discovery and protein engineering' (cit. Executive Vice President). Moreover, there is some evidence that the global production network of Company I, as a configuration, developed into the global innovation network this company is a part of today. Except for a takeover of a US company, the R&D centres have been placed nearby existing production facilities, and therefore developed from exploiting to augmenting strategies related to specific locations. As a result of increased complexity, the company developed a 'Google-like' system for keeping research and laboratory information dynamic across locations.

Company II

This company is also a global leader in its field. It is research intensive, spending more than 14 % of the revenue on R&D. All R&D sites are placed in locations with significant sales and where the company can identify an interesting and well-performing research environment. R&D projects are managed internationally. Researchers are based in different sites, so that they can engage with the people in these places: 'Practically, it is easier to talk with people in Beijing if we have researchers placed there'. Today, research centres are placed in United States, Japan, Brazil, Denmark, China, Japan, Switzerland, India, UK and Australia.

For the development of products for new markets, local presence is crucial: 'sitting in Denmark, thinking about what would work for preserving juice from fruits in India may not be the most brilliant thing to do', or as formulated by a product manager for yeast: 'their (South Africa's) bread is different and has a different look, which is important to acknowledge while developing our products' (interview). Still, the company has strong embeddedness in the local environment

in Denmark: due to the long tradition for biotechnology and many important players along with their major competitors.

Over the past decades, the company has expanded their innovation activities into emerging economies. The R&D site in China was established in the mid-1990s after the company had been in the Chinese market for 23 years. Today, the company holds a strong position in the Chinese market for enzymes and has developed partnerships with local state-owned enterprises. From being a site of development—applying the company's products to the Chinese market—the R&D site has developed into being a part of the global R&D operations. Of the research carried out in China, 80 % is for the company's global R&D operations. According to a Chinese manager, there is not so much a low-cost incentive for offshoring R&D to China as a market incentive: '… costs are really not the issue. In China, salaries have increased a lot recently also because there is a shortage of qualified researchers' (interview).

In India, the company took over one of its main competitors in 2007, including their R&D facilities and, with this, 150 employees. The technology acquired is in a specialized field supplementary to their existing global competencies. Hence, the acquisition was added to the company's global product portfolio. The particular products are now only developed and produced in Bangalore but sold worldwide. In Bangalore, the company is also able to find qualified people for their global R&D activities. The Indian Institute of Science (IIS) and the Indian Institute of Technology (IIT) are very prestigious in their product area and perform world-class research: 'it is easier to tap into these resources if you have local presence'. As a result, headhunting and networking are highly interrelated, as new employees bring about new networks.

As motivations to move abroad, one manager explained that 'not all good innovation can take place in Denmark'. Competitiveness is about being present globally—and 'you look more serious if you have local R&D'. Still, the company has no plans of cutting down on its activities at home: approximately half of R&D is located in Denmark, and more people are hired there every year. However, the proportion of researchers being located in Denmark are diminishing. 'One interesting question here is whether we can find the qualified people we need in the Copenhagen area at all, which is problematic', likewise, 'it is easier to attract US personnel to North Carolina than to Denmark'.

In designing a global innovation network, this company has also developed centres of excellence. However, these are physical. Each location has its specific specialized technology area to focus on along with the overall customer service and development. This is coordinated by the headquarters, and most travelling goes between the centres of excellence and the headquarters. In order to distribute new knowledge, this company also has developed an electronic journal system covering all new inventions, their potential applicability and development.

Company III

This company has been producing the same type of products for centuries and is mainly engaged in developing different taste varieties. It is a global lead firm within its technology area which is relatively old. The overall strategy follows the intention to become the largest producer of their products globally. Hence, the company strategy relates to growth of their production and market share. Therefore, R&D focuses on products and sustainability, for example, one of the current development priorities is to keep the products fresh. However, despite a highly globalized production and market, all R&D activities are centred in Denmark, being centralized for all business lines in the headquarters. As stated by a vice president: 'Our corporate R&D focus is no longer linked to the supply chain, but to the marketing process and the end-customer'. Products are not changing radically, but a number of smaller alterations and incremental changes take place both in the production process—focusing on making the products last longer and extending the shelf life—and in marketing (targeting new customer groups, for example women).

The company has strong historical research ties with two of the largest universities in Denmark. Seven full-time internal professors within very specialized research areas are employed in the company, and there are 40 PhDs and postdoctoral staff on their pay roll. However, the PhDs and postdocs tend to move on, as was stated by the Innovation Manager: 'most of them continue their careers elsewhere—and by doing so they create a foundation for further research collaboration'. There is some internationalized research into developing the inputs in different natural environments in collaboration with local institutions, mostly in collecting samples of raw material, while the R&D is carried out in Denmark. In addition to this, there are a few specialized R&D units elsewhere, for example, one in Russia which is developing natural ingredients.

Moreover, the corporate R&D focus is no longer linked to the supply chain but to the marketing process and end customer. To facilitate this, there is a 'front-end unit' for each market in charge of identifying the needs for innovation of each brand in the particular markets. The front-end units are responsible for identifying future needs for innovation. They are also located in the HQ.

Company IV

This company's focus is in fresh products. Their R&D is focused on ingredients and nutrition and is predominantly market-oriented. Recently, the company has experienced a process of Europeanization and today has six R&D centres in Europe of which two are in Denmark and one each in Sweden, Finland, Netherlands and UK. The R&D activities are predominantly market-oriented. Due to short shelf life and market diversity, this company is not engaged globally. The company is embedded in the Danish research environment as many of the research projects involve public funding and university partners. Most knowledge is produced in Denmark. This is explained by the company as: 'Denmark has a strong tradition for agro food' and

'Danish research is very specialized, as knowledge competences at Danish universities are very good, deep and specialized in our specific areas' (interview). One example of this is how the company has been involved in some basic genome research for which it collaborates with the entire value chain of research in Denmark, from the farmers to the end consumers. Collaboration is important for their R&D set-up. In addition to the R&D facilities in Europe, the company has recently embarked on two joint ventures (in Argentina and China).

Ten to fifteen per cent of R&D expenditure is used on external cooperation. This is carried out in long-term projects with universities, for example by industrial PhDs or short-term collaborations on specific projects. At the international level, collaboration happens in relation to very specific R&D activities: 'We buy this research or knowledge in universities where we know there are special instruments, or special knowledge competences.' The company has a network of partners for this highly codified and specialized research with three to five universities in the United States, one in Germany, one in Sweden and five in Denmark. Furthermore, the company is part of an EU consortium that includes partners in France and Spain.

Internationalization of R&D is seen as a strategy of moving closer to a market—also in terms of access to the authorities for approving the products, which is a big issue for this company. For their more specialized operations, there is a lot of international downstream collaboration with clients on potential product development. In addition to this, there are a series of collaborative arrangements with specialized suppliers for product and process development.

17.6 Conclusion: Internationalization of Innovation in the Danish Food Industry

The four companies in the case studies follow two overall strategies of internationalization of R&D—home-base exploiting and home-base augmenting. Companies I and II are both engaged in offshoring innovation as a part of a knowledge-augmenting strategy. Companies III and IV are predominantly internationalizing their markets, and only to a limited extent their innovation activities. Both strategies involve some degree of internationalization or at least of scouting new trends and specialized knowledge outside the national innovation system. However, the companies are going through different restructuring processes in their organization of innovation. Although Companies I and II are globalizing innovation both as R&D, their internal network constructs are different. For Companies III and IV, the internationalization of markets is the main driver, while innovation more or less remains based on the home economy. However, these two are also tapping into very specialized and codified knowledge at a distance on an ad hoc basis also related to new markets. Depending on the scale of their market, companies tend to internationalize some *development.*

The formation of GINs implies a process of reorganizing innovation at the global level. The result is diverse network constructs ranging from knowledge-exploiting to techno-scientific networks of specialized knowledge actors for R&D. Table 17.6 shows the engagement of the four companies in terms of GINs. The capital 'G' implies that the innovation network is truly global. The lower case 'g' implies internationalization—or Europeanization—of innovation. In terms of innovation, the capital 'I' is used for companies who introduce 'new to the world' innovations coming from these networks. The lower case 'i' is used for companies predominantly engaged in incremental innovation, for example adapting products to new markets. For the network dimension, 'N' is used when companies engage in collaborations beyond their own value chain, for example, with universities and other research institutions, while the lower case 'n' indicates that the network mainly includes actors upstream and downstream in their value chains.

All four companies have strong relationships with university partners in Denmark along with companies in their value chains. Companies I and II also collaborate with foreign universities in their host locations, among other places in the United States, India and China. They are involved in techno-scientific collaborations at the global level, tapping into knowledge not readily available in their networks at home. Consequently, their innovation activities become geographically spread and localized into specialized units, what they call centres of excellence, either physical or virtual. Meanwhile, their Danish headquarters operate within all their different technology areas and coordinate the process. This calls for new methods of designing innovation processes and new qualifications needed in the home country. Whereas access to qualified technical skills is available throughout their home networks and their GINs, these companies are facing huge challenges of how to make these networks function as smoothly as possible without missing out too many opportunities.

New positions as 'Cre-Actors' or 'facilitators', even 'orchestrators', emerge within the companies in different technology fields. As shown in Borrás and Haakonsson (2012), these efforts have a highly positive and mobilizing factor in the home network. One of the companies is also engaged in the Danish Agro Food Park and collaborates with local players in this cluster, for example, in the full-package solution for ice cream, mentioned earlier. So far, neither Company I nor Company II has reduced innovation activities in Denmark alongside their globalization:

> The company needs a mix of brains and competencies from around the world and it can be difficult to attract qualified people to Denmark (Company I).
> We believe that the knowledge capital we can get in Denmark generates efficiency and new ways of organizing our work practices. As long as this comes out of the Danish system, we feel embedded here (Company II).
> We learn a lot from our networks in Denmark. There are many good partners in our clusters in Denmark and at a high international level (Company II).
> The more we engaged with diverse markets, the more we needed local solutions for local problems (Company II).

Table 17.6 Degree of global innovation network in the four case companies

Case	Global (G/g)	Innovation (I/i)	Network (N/n)	Type of GIN
Company I	5 large R&D platforms Europe, Unite States, China	New to the world 4.3 % of turnover into R&D	10 % of R&D spending outside the company	GIN
Company II	10 R&D locations spanning 5 continents	New to the world 14.3 % of turnover into R&D	Global university collaborations (China, India, UnitedStates, Europe)	GIN
Company III	R&D at headquarters in Denmark	Marketing-driven research Focus on end customer	Collaboration with European universities Cosponsoring	giN
Company IV	6 R&D centres in Europe	R&D is predominantly market-oriented	10–15 % of R&D budget spent externally Public funding	gi/IN

The four case companies have developed different ways of dealing with the coordination and communication in their different types of GINs. Companies I and II, as those mostly engaged in GINs, have both developed their own IT systems which facilitate communication across locations. These contain electronic notebooks and search machines for researchers to be able to follow other sites' research results. However, both companies report a limit to globalization: 'every time we get a new site, communication gets more complicated' (interview, Company I). Company II has closed down some of the smaller R&D sites in order to maintain a critical mass of researchers at its sites and limit communication problems. Along with this strategy, the company has established a committee which aims to steer radical innovation centrally. Along with the committee, the company has a search engine for identifying people by their competencies. This engine makes it possible to identify people across the company within certain specialized areas. Company I has a similar approach: 'The company has the intention of becoming global, but not of being everywhere' (Company I).

Research projects in Company I are generated in their *virtual centres of excellence* across sites. While presenting one of their current core research areas, a representative of the company stated: 'This project group consists of researchers from the facilities in the United States, Japan, Denmark and China—and, to a small extent, India. Five geographical sites are simultaneously working on the same assignment. The group has the critical mass of people and cultural backgrounds that are seen as necessary for success' (interview, Company I). One of the main challenges of such a model is to create an appropriate company culture. This company also expressed difficulties in creating the virtual centres in terms of

culture: 'It is difficult to export 'the Scandinavian model' to other contexts. For example, in India, failure is something that cannot be forgiven—but for us, innovation implies constant failures and mistakes. What we cannot forgive is having people doing nothing' (Company I).

Company II has a different GIN construct. This company has established *physical centres of excellence* in clusters including actors of high capabilities in certain technologies. Compared with the virtual centres of excellence in Company I, in which the researchers in each technology team need to have a high level of mobility, the physical centres of excellence in Company II require a different model of coordination and communication between the central R&D department in the headquarters and the specialized units. The network of Company I tells us about the development of strategies, where the company has first internationalized production into global production networks which were then followed by innovation activities increasingly taking place abroad, close to markets. After a while, the local subsidiaries reached a technological capability level suitable for involving in the global research teams. In Company II, the strategy has been different. Here, the technologies are decentralized into clusters and specialized research environments. Hence, the R&D is decentralized in these specialized units, and while the subsidiaries are in charge of integration into regional knowledge networks, the intra-firm coordination and communication is kept in the headquarters. This difference is illustrated in Fig. 17.1.

Meanwhile, the knowledge-exploiting companies follow a model where they maintain R&D at home. Their products are increasingly sold beyond the Danish market as the market is small. Some products are modified by small local adjustments at the local production facilities. However, these companies generally keep R&D in Denmark and to some extent in Europe. Moreover, they engage in networks beyond the value chains, but predominantly at home. For the two GIN companies, the GINs have developed within their previously established global production networks, that is, in places where they already have significant production and sales, except in certain cases where the company in question has merged with a competing company with complementary competencies, as was the case for Company I in the United States and Company II in India.

In conclusion, the food industry is a core industry in the Danish economy. The biotech-related segments of this industry are currently experiencing a restructuring, which, to varying degrees, implies the internationalization of innovation. Due to a small home economy and high investments into innovation activities, the large companies have internationalized. For companies that predominantly supply ingredients and enzymes for global food lead firms, there is a need to follow their customers in their exploitation of new markets. These companies aim at keeping their position as turn-key suppliers and to tap into all new knowledge within their fields. Hence, knowledge-augmenting strategies through the establishment of global techno-scientific collaborations dominate for these companies. Meanwhile, companies producing traditional products directly for consumers have generally little internationalization of innovation.

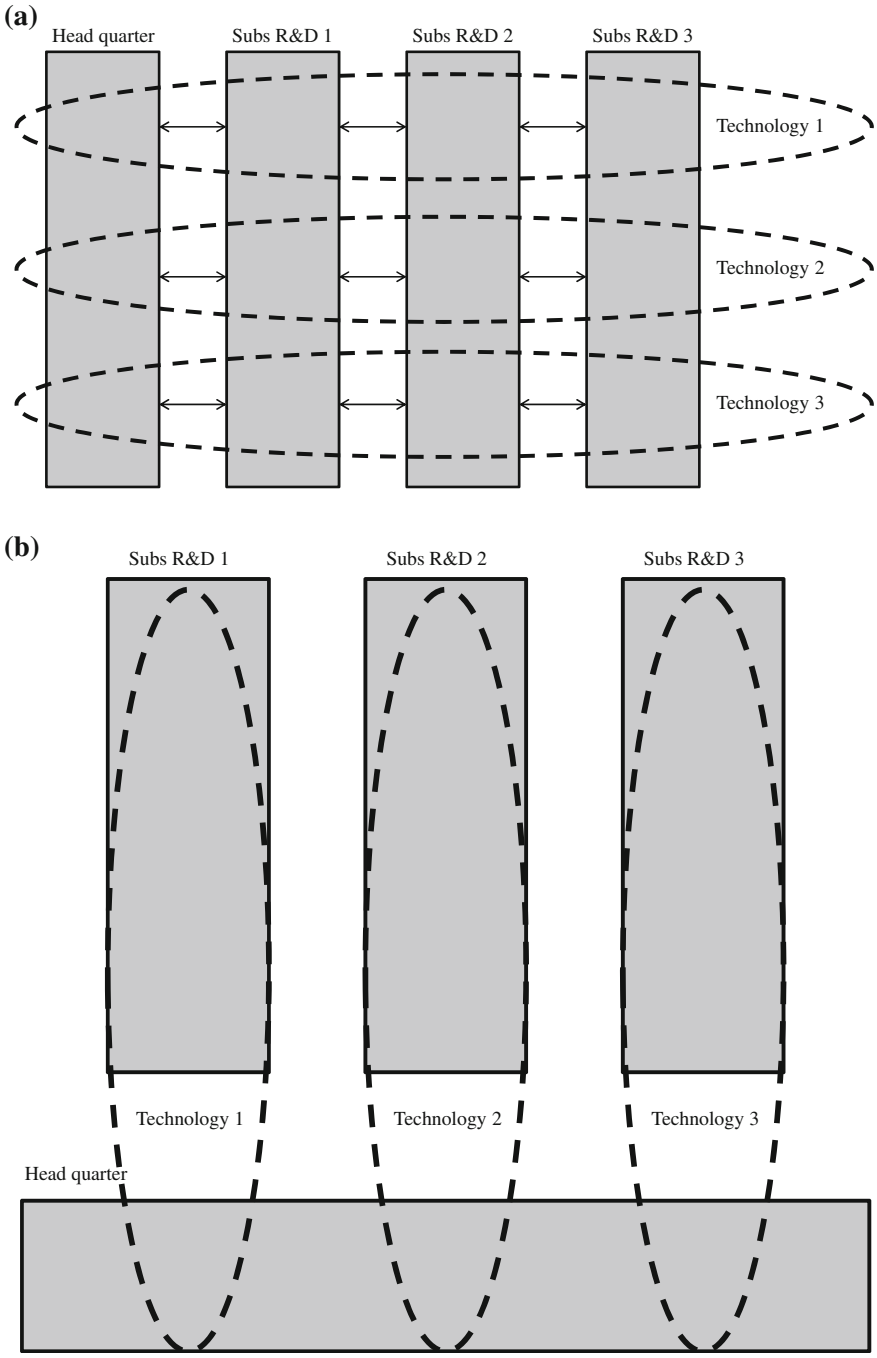

Fig. 17.1 Research-related network constructions between R&D subsidiaries and headquarters found in Company I and Company II. **a** Company I: virtual centres of excellence. **b** Company II: physical centres of excellence

The two companies with knowledge-augmenting strategies have organized their internationalization of innovation through different network constructs. One common creation is the centres of excellence. Both companies have created specialized teams for specific technology areas. However, one company uses virtually constructed centres of excellence consisting of experts around the globe. The localized experts also engage in their local external networks. The other has developed physical specialized centres of excellence in highly specialized locations. Each model requires a different form of coordination from the headquarters, why it would be relevant to look into the determinants of these two forms of organization in internationalization of innovation. For further research, insights from contingency theory into the study of complex organizations and their environments would be a potential way to research under which circumstances which network configurations appear.

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