



**Copenhagen
Business School**
HANDELSHØJSKOLEN

Department of Business
and Politics
Steen Blichers Vej 22
DK-2000 Frederiksberg
Tel. +45 3815 3585
Fax. +45 3815 3555
e-mail dbp@cbs.dk

When globalization hits home. Mobilization effects in national innovation networks.

Susana Borrás & Stine Haakonsson

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Department of Business and Politics
Copenhagen Business School
Steen Blichers Vej 22
DK-2000 Frederiksberg
Phone: +45 3815 3585
E-mail: dbp@cbp.cbs
www.cbs.dk/dbp

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Susana Borrás, Professor

Department of Business and Politics
Copenhagen Business School
Steen Blichersvej 22
2000 Frederiksberg
Denmark
Tel: +45 38.15.35.68
Email: sb.dbp@cbs.dk

Stine Haakonsson, Associate Professor (corresponding author)

Department of Business and Politics
Copenhagen Business School
Steen Blichersvej 22
2000 Frederiksberg
Denmark
Tel: +45 38153124
Email: sh.dbp@cbs.dk

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Abstract

Lead firms are increasingly reorganizing their innovation activities into global innovation networks. Such reorganization has potentially major impact on their existing home-based innovation networks. Based on 31 interviews in four case studies of lead firms in the Danish food industry, the paper analyzes the dynamics of five key features of home-based innovation networks: 1) size of the national networks, 2) type of organization, 3) content of collaboration within the network, 4) concurrent globalization of organizations in the network, and 5) degree of formalization of network interactions. The dynamics are generally differentiated according to the type of lead firm strategy, i.e. knowledge augmenting or knowledge exploiting. The qualitative and exploratory findings point towards some effects on national innovation networks. Hence, the paper concludes by hypothesizing that the globalization of lead firms' innovation has a mobilization effect on pre-existing national innovation networks. The hypothesis says that lead firms' engagement in global innovation networks can mobilize the organizations that are part of the lead firms' innovation networks at home. This mobilization effect differs according to the lead firm's strategy.

Key words: Global innovation networks; Denmark; R&D off-shoring; System of innovation; globalization of innovation, mobilization of home networks

JEL codes: F60, L2, O31, O32, O38

1. Introduction

There is growing evidence that lead firms in a variety of manufacturing sectors have been globalizing their innovation activities. This evidence appears not only in the aggregate data – showing increased flows of foreign direct investments (FDI) and higher levels of foreign-financed research and development (R&D) activities – but increasingly also in specific, well-known examples of lead firms' outsourcing and off-shoring innovation-related activities to locations outside their home regions (Lundvall and Borrás, 1998; Archibugi and Iammarino, 2002; Narula

and Zanfei, 2005). Whereas most firms' innovation activities still tend to take place in the Triad economies (Europe, Japan, and USA), several observers point to the gradual increase in firms' innovative activities and collaborations in emerging markets such as Brazil, China, India, and South Africa (even if such activity is still limited) (Bruche, 2009; Bardhan and Jaffee, 2010; Haakonsson et al., 2013; UNCTAD, 2005; Picci, 2010).

The international business literature studying the globalization of innovation activities has looked at different dimensions of this phenomenon. Globalization activity in the form of global innovation networks (GINs) and the prominent role of lead firms in those GINs are particularly relevant here. A few scholarly studies assess the nature and dynamics of GINs (Sachwald, 2008; Asheim and Isaksen, 2002). However, one aspect of the phenomenon remains unexplored, namely the concurrent changes in the innovation networks in the home countries of these lead firms. To be sure, the international business, economic geography, and development studies literatures tend to give considerable attention to the effects of relocation and off-shoring of R&D activities on firms' managerial processes and the economies of host countries (Pilat et al., 2009; OECD, 2008). However, the literature has only recently started to pay more attention to these issues in the home countries.

From the literature on evolutionary and institutional economics, as well as from the economic geography of innovation, it is well established that lead firms tend to be embedded in national and regional innovation networks in their home countries. From this inter-organizational perspective, the question remains: *what happens to innovation networks in the home countries when lead firms in those networks start engaging in GINs?* When dealing with the globalization of innovation, the literature distinguishes between firms that seek to exploit existing knowledge in new markets and those that strive to augment their knowledge¹ (Kuemmerle, 1999). This distinction is relevant for the purposes of our argument, since changes in home-country innovation networks may depend on the type of lead firm's GIN strategy.

¹ Admittedly, both purposes might occasionally coexist, as a firm's knowledge-augmenting strategy might include some aspects of knowledge exploitation as well. However, in spite of this possible yet quite limited overlap, we find it relevant to distinguish between lead firms whose strategies are predominantly knowledge augmenting and those lead firms whose strategies are predominantly knowledge exploiting.

We examine this question in an exploratory empirical study of Denmark's food industry. Based on 31 interviews in four case studies of lead firms, we analyze how different types of GIN engagement from four lead firms in the Danish food industry are associated with the evolution of five key features of the innovation networks they maintain in Denmark. The five key features of home-based innovation networks are: network size, types of organizations, content of collaboration within the network, the concurrent globalization of organizations in the network, and the formalization of interactions in the innovation networks. Section 3 describes these key features in detail.

In the following section, we give a short review of the literature and identify gaps in its analysis of changes in innovation network patterns in home countries. Section 3 describes the research design, explaining the methodological and conceptual choices in this study. Section 4 introduces the Danish food industry innovation system, which offers a fertile context for developing an in-depth understanding of this topic. The industry offers both high- and low-tech actors, and it is highly internationalized, accounting for a large proportion of Danish exports. The biotech-related part of the industry has experienced a remarkable globalization of innovation, including the creation of strong GINs, during the past decade. Meanwhile, although the traditional lead firms are globalized, their innovation activities continue to be integrated mostly in Europe and the United States; these firms are hence developing weaker forms of GINs. Sections 5 and 6 examine the changing patterns of home-based innovation networks by focusing on the five key features mentioned above. The final section summarizes the findings, answers the research questions, and discusses the possible implications of the findings for understanding the dynamics of national innovation systems in the context of the globalization of innovation.

2. Examining the Findings and Inconclusiveness of the Previous Literature

The international business and regional economics literatures have addressed several aspects of firms' globalization of innovation activities, mainly focusing on the off-shoring of R&D. However, these studies have not examined the inter-organizational aspect of this phenomenon in home countries. Several studies on R&D off-shoring show that lead firms' decisions to offshore R&D (and innovation activities more broadly) are strategically anchored in core innovative areas of the firm; therefore off-shoring tends to strengthen, rather than weaken, a company's knowledge base (Chen, 2004; Achibugi and Coco, 2004; Asheim and Isaksen, 2002). This is because firms see R&D

off-shoring as a strategy to overcome the limitations of their in-house R&D activities as well as limitations in the availability of knowledge resources in their local environments (Manning et al., 2008; Cooke, 2002; Narula and Hagedorn, 1999; Tolstoy and Agndal, 2010).

Distinguishing between product and process innovation, and between two governance models of R&D off-shoring, Nieto and Rodriguez (2011) found that R&D off-shoring has different effects on individual firm innovation outcomes. In particular, they found that R&D off-shoring has a greater effect on a firm's product innovation outcomes than on its process innovation outcomes (Nieto and Rodriguez, 2011). Likewise, firms that use a "captive off-shoring" model (based on affiliate firms abroad) have greater effects on their innovation performance than those using an "offshore outsourcing" model (based on an arm's-length relationship with independent foreign suppliers). These findings match with those of recent studies on the managerial and coordination challenges posed by the internationalization of innovation (Stanko and Calantone, 2011), as evidence shows that not all R&D and innovation off-shoring is positive for firms (Hsuan and Mahnke, 2011). This corresponds to the inverse U-shaped relationship between the firms' R&D outsourcing and their levels of innovation performance. As Grimpe and Kaiser (2010) put it, "the gains that a firm might obtain from its R&D off-shoring do not always overcome the pains" (Grimpe and Kaiser, 2010: 1483).

Another recent strand in the literature has examined the effects of firms' R&D off-shoring on the overall economic and social dynamics of the home country. Criscuolo and colleagues (2005) found that when firms engage in asset-exploiting and asset-augmenting² R&D activities internationally, they do not undertake them only on the basis of their own knowledge resources; they also draw "from the assets of innovation system of the entire home base region" (Criscuolo et al., 2005:418). Most relevant, perhaps, their results show "that both European and US affiliates still rely extensively on home region knowledge sources, although the asset-augmenting component of R&D investments from Europe into the US is in many cases as strong as the asset-exploiting component." (ibid.:430).

Another relevant study examines the effects of weak GINs in terms of productivity growth in the home region (Castellani and Pieri, forthcoming). Looking primarily at the R&D off-shoring of firms

² The attentive reader has probably noted the slight difference in the terminology here. Where we use "knowledge augmenting," Criscuolo et al. use "asset-augmenting," to refer mainly to the firm's knowledge assets. In this discussion, we have retained the original terminology of these authors.

located in 265 NUTS-2 regions in Europe, they report general evidence of a positive effect in the productivity growth in home regions. In a similar vein, but focused on knowledge bases rather than productivity growth, Piscitello and Santangelo (2010) examined whether R&D activities off-shored from OECD countries to BRICKST countries (Brazil, Russia, India, China, Korea, Singapore, and Taiwan) complement or substitute knowledge production in the home countries (Piscitello and Santangelo, 2010). Their findings suggest a positive impact in high-tech industrial sectors, which does not apply to the medium- and low-tech industrial sectors.

Although they are highly relevant, these empirical findings do not assess the inter-organizational dimension of these home-based dynamics. This is because the literature has focused either on general data of knowledge production (measuring the number of patents and patent citations, as well as the number of off-shored projects) or it has focused on specific individual stories of how the ‘brain circulation’ of highly skilled emigrants gives specific regions a global advantage. Still, these previous analytical angles and data sets do not study the qualitative changes in innovation networks in home countries.

3. Research Design

The research design of this study takes its starting point from a distinction between GINs based on knowledge exploiting and knowledge augmenting strategies respectively; as we want to explore the patterns of the five basic features of home-based innovation networks when lead firms engage in GINs. Hence, we distinguish between lead firms that follow knowledge-augmenting vs. knowledge-exploiting strategies (Kuemmerle, 1999). Lead firms engaging in *strong GINs* use knowledge-augmenting strategies seeking to create new-to-the-world innovations. Likewise, lead firms following knowledge-exploiting strategies link to *weak GINs*, as these lead firms’ strategies predominantly seek new-to-the-industry innovations. Since our research design focuses on the lead firms’ strategies with regard to these two types of innovations in their engagement in GINs, it is important to underline that the current research design does not examine all the attributes that define GINs. In other words, our independent variable is the lead firms’ strategies when engaging in GINs, not the GINs themselves.

In order to study the changes in home-based innovation networks, we analyze five key features of these networks (the dependent variable):

- Size,
- Types of organizations forming the network,
- Content of collaboration among partners,
- Concurrent globalization of the partners in home-based innovation networks, and
- Degree of formalization of interactions in the home-based innovation networks.

These five items refer to the basic empirical features of innovation networks. As seen above, the goal of this paper is to conduct an exploratory qualitative analysis of the patterns of those national innovation networks when lead firms have started to globalize innovation activities. Hence, the five items above are what empirically define those basic features of national innovation networks.

We designed an interview guide to collect qualitative data on these five features of home-based innovation networks. The size of the innovation network refers to the number of national organizations involved in a network, e.g. whether they have been shrinking or expanding. The second feature is the types of organizations included in the home-based innovation network (e.g., suppliers, customers, universities, public research organizations, consultancies) to assess whether more (or less) different types of organizations appear in the lead firms' home-based innovation networks.

The third feature to be analyzed is the content of the collaboration within the home-based innovation network. As was introduced in the literature review, lead firms engaging in GINs might base their strategies on the need to access more specialized knowledge competences (in contrast to more generic competences). The fourth feature explored is the concurrent globalization of the partners in home-based innovation networks. We examine the extent to which lead firms' engagement in GINs has taken place simultaneously with the process of globalization of the lead firms' home-based innovation partners. Last but not least, the fifth feature we study is the formalization of interactions in the home-based innovation network. In the context of the increasing globalization of innovation, lead firms might become more aware of intellectual property issues and seek to formalize their interactions within the national innovation network.

The next sections will examine in detail each of these aspects of national innovation networks in the Danish food industry during the past decade. The choice of this particular industry in Denmark is

justified on three grounds. First, this industry has experienced a significant degree of global innovation networking during the past two decades, and it is the most globalized and innovative food cluster in the European Union (European Cluster Observatory, 2010). Second, this industry incorporates a mix of low-, medium-, and high-tech segments. The mix of knowledge-augmenting and knowledge-exploiting strategies allows us to provide a nuanced and differentiated account of the changing patterns of home-based innovation networks. Finally, the small size of the Danish innovation system, together with the centrality of this industry to the Danish economy (food and beverages account for approximately 20% of all Danish exports) offers a good context for a case study. This particular combination circumvents the analytical problem of distinguishing between the national and local dimensions of network interactions in the home country of lead firms. For these reasons, we believe that the current study will generate some valuable exploratory results, complementing the findings of the studies reviewed above.

This article is based on empirical data collected in Denmark in 2010 and 2011. The data set consists of two main sources. The first is four in-depth case studies of Danish lead firms that have engaged in a significant level of globalization of their innovation activities. For reasons of confidentiality, the names of the four lead firms will not be disclosed. However, they are among the most innovative, largest, and most globalized firms in the Danish food industry. All four are among the world leaders in their technology fields. The case studies are based on 31 qualitative and semi-structured interviews with central innovation managers in these four lead firms and central actors in their innovation networks; the questions consider the changing patterns and the nature of interactions with the organizations that are part of their innovation networks in Denmark during the past 10 years, in relation to the firms' growing engagement in GINs. The interviews, which were mainly conducted face to face, took 45 to 60 minutes; in most cases, the interview was followed by an informal discussion during a tour of the company. The case interviews were complemented by in-depth background information collected from six interviews with experts and non-firm network actors in the food industry.

The second source of data is quantitative data derived from the national statistics office. All Danish firms are required to feed their data into this database annually. These data are used to describe the Danish food industry in Section 4. Other relevant secondary data include annual reports of the four firms studied, documents and presentations generated by the Danish food industry association, and

other relevant sources from reliable organizations such as the Danish Agro Food Science Park, the Danish patent office, and the corresponding Danish ministry.

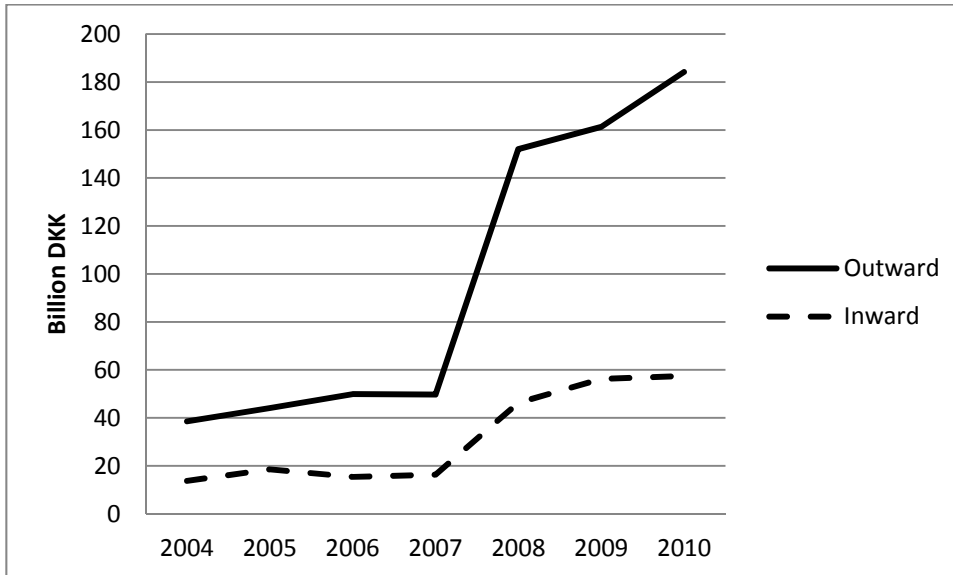
4. The Danish Food Sector: Its Lead Firms and Their Home-Based Innovation Networks

The food industry in Denmark has developed from the low-technology backbone of an agrarian economy into an industry that consists of a few large, global actors and a large number of small- and medium-sized enterprises. During the 20th century, most of the small-scale cooperative businesses merged into a few very large units (Hansen, 2009). Within these units, farmers generated economies of scale for international competition and pooled their resources to engage in innovation within their fields of specialization, for instance, sugar, ingredients, dairy, beer, or meat. These firms have gradually developed their technological capabilities in agro-food technology fields, as well as in fields such as biotech, robotics, and cold-chain development.

The small size of the Danish home market explains the industry's high export ratio. Almost half of the industry's sales are generated by exports, for which the five largest markets are Germany (20%), China (12%), the United Kingdom (11%), Sweden (9%), and Japan (6%) (Landbrug og Fødevarer, 2011). Once a Danish company reaches a certain size, it tends to push towards larger markets to recover the costs of innovation and product development (Christensen et al., 2008). Figure 1 illustrates the increasing internationalization of the Danish food industry through FDI (Forsknings og Innovationsstyrelsen, 2010). Within the past five years, China and other BRIC countries have gained importance as attractive markets for Danish food companies.

Figure 1: FDI in the Danish food industry (stock)

Source: Statistics Denmark 2012, accessed July 9, 2012



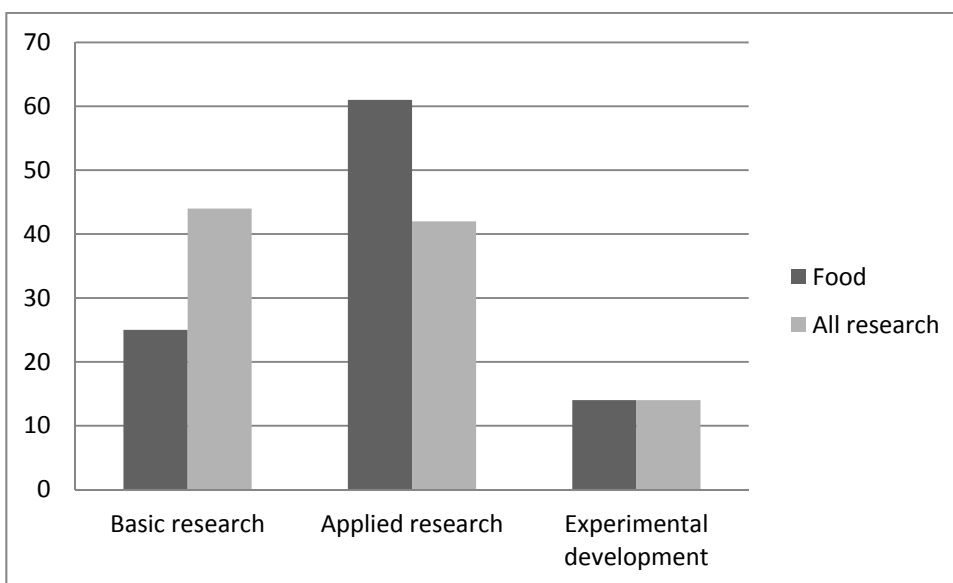
According to the European Cluster Observatory (2010), the Danish food industry is currently among the largest, most internationalized, and most innovative food industries in Europe (European Cluster Observatory, 2010). It has a total of almost 80,000 employees and a considerable share of the world market for pork (30%), cheese (8%), and butter (8%) (Hansen, 2009). Along with its cooperative ownership structure, the Danish industry has traditionally developed strong national innovation networks involving farmers, universities, and business actors. In addition to the ubiquitous home-based innovation networks, there are a series of relevant government initiatives like the Agro Food Science Park and the formalized food cluster. These networks enhance the innovation capacities of smaller firms and their connections to international markets. Small- and medium-sized enterprises use their networks to generate innovation, either by linking up with larger companies or by collaborating with suppliers or customers (Statistics Denmark, 2008).

The high concentration of knowledge workers in this field sets the scene for strong national innovation networks around the industry's lead firms. Actors from the Danish food industry networks come together to produce more scientific publications in this field than any other OECD country. The industry also has a high level of patenting. The type of research is, to a large extent, applied (Figure 2). This has a positive effect on the competitive situation for industry actors: "The

long history of collaboration between research institutions, the farmers, and the industry is unique to Denmark” (Interview, Case 4). This is also the case for researchers: “I really appreciate the collaboration between us in the research community and the industry. This provides a high level of trust, and with this communication, knowledge transfer gets easier. This is a win-win we create by giving a bit of time and a lot of recognition” (Interview, Professor, Danish Technical University, DTU). The majority (68%) of food firms collaborate with other industry actors to create innovation, among which 81% collaborate with suppliers and 75% with customers. In addition, 57% of firms collaborate with Godkendte Teknologiske Serviceinstitutter (GTS),³ 55% with public research institutions, 44% with universities, and 29% with other food firms (Forsknings- og innovationsstyrelsen, 2010).

Figure 2. Distribution of research funding by type of activity (%)

Derived from: Forsknings- og innovationsstyrelsen (2010)



In general terms, the Danish food industry has two main groups of firms: those that produce final food products and those that produce intermediary products such as ingredients or enzymes. As food products are subject to the influence of local traditions and tastes, firms in the first segment tend to adapt their products for new markets to accommodate local tastes and storage conditions. For that reason, these firms typically focus development activities on adapting their core products to

³ GTS (Advanced Technology Institutes) are semi-public institutes that support innovation and technological infrastructure in Denmark.

new markets. Figure 2 illustrates the increasing internationalization of the Danish food industry through foreign direct investments (FDI) (Forsknings og Innovationsstyrelsen, 2010). Most innovation that takes place in these final-food firms is not new-to-the-world innovation, and largely involves development activities. Hence, when these firms engage in GINs, they typically use knowledge-exploiting strategies.

For the second group, many of the recent breakthrough innovations relate to the biotech sector, for example ingredient and enzyme solutions for global customers. This group of firms produces intermediary products for other global firms, for example supplying yeast to global producers of bread. For that reason, when these firms engage in GINs, they typically have strategies focused on knowledge-augmenting activities, namely, creating new-to-the world products. Recent studies show that knowledge generated in new locations adds to the knowledge pool of the lead firm (Haakonsson, 2013).

The four case studies in this paper include firms that follow both of these types of strategies for engaging in GINs (knowledge-augmenting or knowledge-exploiting). Given the historical tradition of Denmark's food industry, all four of these firms have very strong innovation networks at home that predate their engagement with GINs. Two of the case-study firms produce final food products with predominantly incremental innovation, that is, innovation focused on adapting their products to new markets or consumer groups (Cases 1 and 2). Both firms are among the largest companies in Denmark and take a large proportion of their sales from exports; their engagement in GINs is mainly through knowledge-exploiting strategies. The other two case-study companies are in the biotech segment of the Danish food industry; they are developing new-to-the-world innovations in ingredients and enzymes for sale to global food producers (Cases 3 and 4). These firms have engaged in GINs mainly through knowledge-augmenting strategies. In Sections 5 and 6, the effects of these two types of innovation strategies on the five key features of the case firms' national innovation networks will be analyzed.

5. Global Innovation Networks Dominated by Lead Firms with Knowledge-Exploiting Strategies

This section analyzes Cases 1 and 2. These two cases are among the 20 largest firms in Denmark; both produce final food products for end customers; that is, their products go directly to supermarket shelves. The firms manufacture large quantities of relatively fresh products, and their facilities are large production units with many employees and substantial capital investment. The firms have specialized in a particular range of products since the 19th century. Internationalization of the market has led the firms to adapt their products to new host markets in the Triad as well as in emerging economies. These two firms are global in their market reach, employing similar strategies to generate growth by conquering large world market shares, typically through acquisitions. They both aim to become the largest firms in the world in their respective markets. Both firms are targeting emerging markets in Asia, and case company 1 also has a very strong market presence in Russia. Between 20 and 40% of both firms' sales are outside Europe.

In terms of innovation, these firms are mainly engaged in developing different taste varieties, preservation techniques, and packaging technologies. This means continuously adapting products to new markets. However, despite their overall goal to become globalized, most development activities for both firms have so far remained in Denmark and Northern Europe. Although these firms are mostly engaged in incremental innovation, both prioritize and invest considerably in research and development (R&D) (about 5% of sales, a share that has increased). Both lead firms have developed large innovation networks in Denmark over decades of interaction, and they spend between 10 and 15% of their research and development budgets externally, with national or international partners. Their focus on product adaptation and incremental innovation is related to the fact that both of these lead firms use knowledge-exploiting innovation strategies when collaborating nationally and internationally. For example, Case 1 continuously develops new varieties of their main product for new market segments and locations. However, this is done by their partners in Denmark, and only very rarely involves partners in the host location.

5.1. Size of the Home-Based Innovation Network

As mentioned above, the firms studied in Cases 1 and 2 are old actors in the Danish economy and have very solid home-based innovation networks. They collaborate with the largest Danish

universities in most of their technology fields. A research manager from case company 2 explained the firm's strong historical ties with Danish universities: “[T]hey educate our future employees . . . we have co-sponsorships for PhDs with the two largest universities. We have a long-term traditional network in Denmark and keep the existing collaborations in areas of general interest to the firm.” Danish universities, which are among the world leaders in the particular knowledge areas of interest to these firms, play an important role in developing new products. According to the business area manager for case company 2, there are economic incentives for research collaboration with Danish universities.

From the interviews in Cases 1 and 2, it follows that these two firms have not experienced a shift in the number of actors in their home-based networks, but both firms have intensified their linkages with existing innovation partners in these networks. According to an interviewee at Case 2, “we do more projects today than six years ago, and a large amount of our research budget is dedicated to external R&D.” The recipients of the external R&D expenditure are not only universities; small- and medium-sized enterprises also have important roles in these home-based networks. Hence, the innovation networks that these two firms maintain in Denmark are dynamic, but they seem to have remained stable in size during the period in which the firms started to engage in GINs. It is worth noting that the firms seem to have strengthened their ties with national innovation partners during the same period, launching more projects with them (see below for details).

5.2. Types of Organizations in the Home-Based Innovation Network

As indicated earlier, these two lead firms have a strong tradition of collaborating with Danish universities in innovation activities. From the universities' perspective, they can get better access to public research funding if they have business partners. Respondents in both lead firms expressed a belief that the national universities continue to be strong innovation partners for them. The Case 1 firm sponsors seven full-time professors connected to a Danish university and has 40 PhDs and post-docs on its payroll. The firm's vice president for R&D commented that “[M]ost of these continue their careers elsewhere—and by doing so they create a foundation for further research collaboration.” An innovation manager for case company 1 reiterated the importance of the universities to the firm's innovation program: “The Danish universities are world leaders in our technology field, particularly the universities of Copenhagen and Århus.” The collaboration with Danish universities takes the form of specific projects, as well as co-sponsoring PhD students.

In addition to the universities, both firms use public certification research institutes (i.e., GTS), which is a system of knowledge production for firms in Denmark. The lead firms' historical collaborations with customers and suppliers continue to be very relevant today. In addition, the Case 2 firm is an important actor in the Agro Food Science Park outside Århus, which has provided this lead firm a platform for further collaboration with small- and medium-sized enterprises in Denmark. Both firms have a long-term perspective on national innovation networks. As one respondent put it, "collaboration in a [national innovation] network does not terminate when there is no more funding in a project . . . the contact and synergies continue" (Business Area Manager, Case 2). Similarly, another respondent told us, "In our industry, collaboration is so good that we are almost in a symbiosis—one actors' success has great spillovers on the other" (Communications Director, Case 1). Lead firms tend to see the establishment of a consortium for a particular project as an investment in the firm's long-term home-based innovation network.

All in all, it seems that there is a large degree of stability with regard to the types of organizations with which the lead firms interact in their home-based innovation networks: "We have more or less been collaborating with the same partners since 2001. It is very stable. . . . Internationalization has not affected our type of collaboration in Denmark" (Research and Technology Manager, Case 2).

5.3. Contents of Collaboration in the Home-Based Innovation Network

There has been a shift in the content of these collaborations over time as the lead firms have requested increasingly specialized knowledge from their national innovation partners: "We urge our Danish collaborators to specialize; they should not all be good at everything, and they have specialized over the past decade" (Research Manager, Case 1). The R&D manager for the Case 2 firm explained that "our internationalization has not affected our collaboration in Denmark . . . [however] during the past years the Danish partners we collaborate with have tended to be more specialized." Moreover, the division of labor inside the innovation networks in Denmark has increased, and the lead firms we studied have increasingly taken on the role of coordinating large innovation projects with several partners. As a result, "compared to ten years ago, today we have more specialized collaboration and more on an ad-hoc basis in particular projects. In the past it was more based on relationships than concrete projects" (Senior Manager, Case 2).

5.4. Concurrent Globalization of Organizations in the Home-Based Innovation Network

“Concurrent globalization” in our study refers to the extent to which lead firms’ engagement in GINs has taken place in parallel with national partners’ own processes of globalization. The evidence of this happening in Cases 1 and 2 shows some general trends towards concurrence, though with one important caveat. The data shows consistently that concurrent globalization is taking place: “The most important thing for us is that our partners keep up their competencies at a European and world-class level and have an understanding of our industrial needs. And they have been good to keep track of our interests, so they have kept their attractiveness” (Research Manager, Case 2). This seems to link to the funding possibilities offered by international innovation policy schemes: “In the past, it was a matter of looking for research funding at the national level, but today universities also apply internationally—they are more aware of international collaborations” (Research Manager, Case 2). Likewise, the business area manager from Case 2 explained that there is no preference for Danish partners: “Our Danish partners are forced to have an international outlook if they want to attract our attention. They do. Not necessarily because of us, but the development is that there is much more global collaboration. They have their own networks.” So from this perspective, there is a concurrent globalization of national partners.

However, the lead firms are not systematically requiring their national research partners to be globalized: “This is more of a case-by-case strategy; sometimes the firm is involved in a larger international project; often the universities bring in international partners that are as good as the ones brought in by the firm” (Vice President, Case 1). Hence, it seems that from the lead firms’ perspective, national partners are relevant not just because they have globalized, but because they are able to retain specialized knowledge.

5.5. Formalization of Interactions in the Home-Based Innovation Network

The above findings illustrate how these lead firms continue to have a long-term engagement with national innovation partners, despite the lead firms’ growing engagement in GINs for the purposes of knowledge exploitation in new markets. From that perspective, it could be expected that these lead firms would have a low level of formalized interactions with national partners with whom they have historical ties. However, this is not the case. Both firms in Cases 1 and 2 have increased the formalization of their home-based innovation networks, and the use of legal offices and nondisclosure agreements has been part of the continuation of stable ties with their home-based

innovation partners. As an example, case company 2 has established a legal department of nine lawyers that deals only with contracts and intellectual property rights. The increased levels of formalized agreements on intellectual property rights and nondisclosure matters are similar with their national and international partners. In other words, lead firms have increased their formalization of innovation-related collaboration with national and international partners alike.

6. Global Innovation Networks Dominated by Lead Firms with Knowledge-Augmenting Strategies

The two lead firms with knowledge-augmenting strategies that we studied in Cases 3 and 4 are global technology leaders within their respective market segments, and both have strong national innovation networks with specialized actors within the biotech segment of the Danish food industry. Even though these lead firms both hold large shares of the world market, they do not have large production facilities or capabilities for mass production. For both companies, more than 12% of sales are spent on R&D. Knowledge-intensive activities are at the core of both firms; most employees are involved in innovation. Case company 3 has 1,000 people attached to R&D, half of whom are located in Denmark. Their largest research center in Denmark is a campus located in close proximity to the university with which the firm collaborates the most.

Traditionally anchored in the food industry, these firms have broadened their expertise during the past decade. They now conduct innovation to develop new-to-the-world products in non-food as well as food products, including natural rubber for tires, functional foods, and second-generation biofuels. Since they are key suppliers of ingredients and other intermediary products for global producers, the internationalization ratio of these firms in terms of market is relatively high (UNCTAD, 2009). In contrast to Cases 1 and 2, Cases 3 and 4 have R&D centers abroad, not only in Europe, but also in the United States, Japan, China, India, South Africa, and Brazil. All of these decentralized R&D centers are core locations for biotech research in collaboration with local specialized firms and research institutions. However, other location factors like low costs and proximity to customers are also important, as these firms' main products are innovation-intensive inputs to customers' final products. Still, the two firms have a strong presence in Denmark, with solid home-based innovation networks, and the coordination and strategy-definition functions of their GINs remain in Denmark. All of their specialized technology areas are represented in their

Danish networks. As an assistant product developer for case company 3 put it, “when we take over specialized firms abroad, we also need to upgrade our Danish R&D department. It is necessary for the headquarters to understand the research carried out elsewhere.” Thus, home-based innovation networks remain important for these lead firms, but they have tended to change during the past decade. The next subsections examine these changes in the national innovation networks of these two firms.

“Not all good innovation takes place in Denmark,” the innovation manager for case company 3 told us. The firms that follow knowledge-augmenting strategies in their engagement in GINs have been investing in R&D abroad for two decades, and they have recently invested in locations outside Europe. For case company 4, the distribution of research between Europe and the rest of the world has dropped from 85% in Europe two decades ago to 62% today (of which 34% is in Denmark). Since 2000, case company 4’s foreign R&D investments in India and China have increased from 6 to 15% of the firm’s total R&D budget, according to the company’s director of organizational development. For both firms, the investment in their home-based innovation networks has decreased in relative terms, in relation to the size of their total R&D budgets. However, the rapid increase in these firms’ overall research expenditures means that the amount spent at home has increased in absolute terms.

6.1. Size of the Home-Based Innovation Network

These two firms see Denmark as a dynamic place for knowledge creation and flow, and as a host for highly specialized knowledge. The environment in Denmark is also important to attract knowledge skills, as case company 3’s innovation manager told us: “Experts do not move to Denmark to get a job, but to be part of a unique research environment.” Case company 3 has strong collaborations with other Danish lead firms. In terms of the food-related research environment, case company 3 is highly involved in the Agro Food Science Park and generally finds the critical mass needed for basic research in Denmark: “When coordinating our global research efforts, we need a strong knowledge base at home” (Assistant Product Manager, Case 3). As the technology and knowledge base grows, this firm continuously develops and expands its home-based innovation network to collaborate with new actors in technology fields outside the food industry (see next section). One of the firms explained that there is a need for a critical mass for innovation at home, and they continuously engage in long-term relationships with universities and research centers, but

also built on their relations with suppliers, e.g. as partners for co-creation of machinery, in the process of internationalizing innovation. As a result, the products get more sophisticated. This indicates that the size of their home-based innovation network has continued to grow stably with the resources devoted to collaboration with national partners. This is in spite of the fact that these two lead firms' collaboration and R&D budgets for international innovation projects have tended to grow at a faster pace.

6.2. Types of Organizations in the Home-Based Innovation Network

Over the past decade, both firms have experienced a strong integration of specialized partners into their innovation networks in Denmark. The firms' strategies are focused on generating new-to-the-world innovative products; in order to do so, they rely on long-term relationships with national universities in Denmark, as well as other actors at home such as suppliers and customers. "We believe that the knowledge we can get in Denmark generates efficiency, innovation, and new ways of organizing our work practices. However, we do not have an urge to collaborate with Danish universities if they are not world class," the innovation manager for case company 3 told us. These two firms have also engaged strongly in the establishment of the Agro Food Science Park and use this cluster as a means to engage with new actors and follow new trends.

The above shows that these firms have found new national innovation partners in specialized technology fields that were not previously part of their national networks. For example, Case 3 took over two very specialized companies within gene technology in China and the United States. Meanwhile, they have broadened the scope for innovation partners in Denmark in order to integrate this new technology into their business. In the Agro Food Science Park, the company has established strong relations with new suppliers in order to make the products ready for the applications developed outside their home networks, which indicates that this lead firm has expanded the type of organizations with which it collaborates in home-based networks.

6.3. Contents of Collaboration in the Home-Based Innovation Network

When examining the content of the collaborations lead firms pursue with national innovation partners, and the changes that might have occurred in this content in relation to the lead firms' growing engagement in GINs, we are aiming to see whether national partners have become more specialized. The crucial evidence regarding the content of collaboration between these case

companies and their home-based innovation partners, especially Danish universities, is that the lead firms not only request high levels of knowledge specialization in these national partners, but are also ready to financially support the creation of that specialization. These two lead firms need a “home-base environment that attracts core competencies in such highly specialized fields in order to access the competencies needed in the initial stages of innovation” (Senior Director Protein Optimization, Case 4).

The two firms have sponsored laboratories in Danish universities that match their research profiles. For example, case company 3 has developed virtual centers of excellence that are coordinated, approved, and tested in Denmark with assistance from university partners in their Danish innovation network. Both companies have been involved in setting up a new research center on sustainability at the Danish Technical University with the aim of attracting international specialists to Denmark. Hence, the actors in the home-based innovation network are challenged, but with financial assistance from the lead firms, to meet the firms’ demands in order to keep their positions in these national networks.

Two further aspects of the changing contents of collaboration among partners in home-based innovation networks are relevant here. One has to do with the search for talent at the national level. The Case 3 firm grants annual awards for the best Danish researchers in their field of interest; from the award process, the firm gets valuable insights into what new and cutting-edge research is taking place in Denmark. The second aspect has to do with the changing “soft” side of collaboration. As collaboration becomes more interdisciplinary and intercultural, issues related to international project management become more important; case company 4 has developed knowledge-sharing tools designed to enhance the culture of collaboration: “Whether our researchers are in Beijing or in Copenhagen is not important, what is important is that they collaborate!” (Manager, Case 4).

6.4. Concurrent Globalization of the Organizations in the Home-Based Innovation Network

The increased specialization of the Danish partners of Cases 3 and 4 has been related to their globalization. In other words, as national partners have become more specialized, they have engaged in GINs, just as the lead firms have. A university professor and research partner of case company 3 told us that Danish universities have undergone a process of internationalization in order

to remain at the technological frontier of food research and sustain their attractiveness for their business partners. A similar process was found with Danish firms playing larger roles in the national innovation networks of these knowledge-augmenting lead firms. The innovation manager for Case 3 pointed out: “Danish companies with a global outlook are much more attractive for us than those with national connections only.” As the market reach for new solutions has reached a global scale, the suppliers of products and machinery also look into specific needs in other locations by engaging internationally. For example when developing a core ingredient of their products for the African market, all actors in the innovation network need to consider the quality of other ingredients as well as issues regarding storage capacity in Africa. As such, they engage with partners abroad to implement the innovations at all stages of production and research, not just for the core ingredient but for the whole process. However, this is not only an outward-going process: “Some of the Danish small- and medium-sized enterprises are also integrated in our internationalization. Our globalization is an advantage for these firms. Local [Danish] firms are of a very high international level” (Vice President, Case 4).

6.5. Formalization of Interactions in the Home-Based Innovation Network

The two lead firms we studied in Cases 3 and 4 are among the most patent-intensive firms in Denmark (Patent og Varemærkestyrelsen, 2010). Over the past decade, both firms have scaled up their legal affairs offices at home and abroad. As they internationalized, they needed to protect their technology in foreign markets to make the most of their new-to-the-world innovations. For every project, there is a pre-stage of contracts and confidentiality agreements to make sure that all confidential knowledge stays within the consortia, and that claims for intellectual property to be developed are properly assigned among partners at the earliest possible stage. This formalization of collaborations abroad and at home has increased immensely during the past decade. In previous decades these two firms were engaged in informal, exclusive arrangements based on trust and a common history with partners in their home-based innovation networks. However, during recent years, these home-based relationships have been formalized through nondisclosure agreements and contractual intellectual property arrangements.

7. Conclusions

The previous two sections show that home-based innovation networks have tended to change along with lead firms’ increasing engagement in GINs. These changes are different according to the

strategies behind how the lead firms have engaged in GINs, namely, whether they are mainly exploiting their internal knowledge or augmenting it.

Case companies 1 and 2 are lead firms in the Danish food industry that follow knowledge-exploiting strategies when engaging in GINs. Our findings show that **the size of these home-based innovation networks** has remained stable during the period in which the lead firms have engaged in GINs, as has **the type of national innovation partners** the firms collaborate with, which continues to be mainly national universities. When it comes to **the content of their collaboration**, the findings show that it has generally changed to more specialized tasks. The universities, which are the main national innovation partners for these firms, have **globalized concurrently** with the lead firms. The **level of formalization in research collaborations** has increased in all types of relationships, whether national or global.

Case companies 3 and 4 show some significant differences from the first two cases in this regard. Both firms have engaged in GINs with knowledge-augmenting strategies. At the same time, they have expanded and deepened their home-based innovation networks. Our findings show that **the size of these national innovation networks** has increased during the same period, and that **the types of national partners** now include more actors covering more technology fields than before. When it comes to **the content of collaboration**, previous national network partners are still highly relevant, but these partners have responded to the demands of the lead firms by becoming more specialized and more engaged internationally. Hence, as the lead firms have engaged in GINs, the organizations that are part of their innovation networks in the home country have experienced a **concurrent globalization**. Similar to Cases 1 and 2, Cases 3 and 4 have tended to **formalize their interactions** with national partners to a greater degree.

These findings illustrate the differences in terms of the size and types of organization. The home-based innovation networks of lead firms engaged in knowledge-exploiting GINs have remained stable, whereas the home-based networks of lead firms engaged in knowledge-augmenting GINs have expanded both in terms of the size and types of organizations included. Yet there are also some similarities, as the home-based innovation networks of the four lead firms we studied have experienced a similar increase in the specialization of their collaborations, a concurrent globalization, and an increased formalization of interactions. These similarities and differences are

remarkable, suggesting a potential process of “mobilization” of home-based innovation networks when the lead firms in those networks become engaged in global innovation networks (GINs).

This **mobilization effect hypothesis** emerges from the exploratory study of the qualitative data collected about the changes in the features of national innovation networks in the context of the globalization of innovation in the Danish food industry lead firms. “Mobilization effect” seems to be a suitable description of the transformation of the five features identified in our exploratory analysis. The notion of “mobilization effect” aims to grasp a set of situations in which the local organizations (firms, universities, etc.) in national innovation networks have incentives to improve their organizational structure, their product quality and innovation, and their global reach. In other words, this “mobilization effect” happens when lead firms engaging in GINs stimulate a sort of industriousness in the organizations that are part of their innovation networks at home. However, verifying this mobilization effect hypothesis (as well as its generalization) must be undertaken in future research, to be based on a large-n data set and on an explanatory analytical approach. Such future study will hopefully confirm or disconfirm the existence of a mobilization effect.

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