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Proximity, knowledge base and the innovation process
The case of Unilever's Becel diet margarine

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The case of Unilever's *Becel* diet margarine

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1. Introduction

In many industries, the competitiveness of firms depends primarily on their innovative capacity, which in turn relies on a continuous process of knowledge creation. Knowledge is created not only in-house, but also in collaboration with other organizations, including other firms, universities and government. A key question concerns the effective governance of interactive learning, knowledge transfer and collaborative knowledge production. Knowledge production is inherently an uncertain process regarding its outcomes. Furthermore, the interests at stake can be high and, often, conflicting.

Boschma (2005) proposed a proximity framework referring to types of inter-organizational relationships that are expected to facilitate interactive learning and collaborative innovation. Apart from geographical proximity, Boschma mentioned cognitive, social, institutional and organizational proximity as additional factors that support inter-organizational collaboration. Empirical evidence suggests that, indeed, all forms of proximity tend to be associated with increased levels of collaborative innovation, even if their relative importance varies (Autant-Bernard et al. 2007; Maggioni et al. 2007; Ponds et al. 2007; Breschi and Lissoni 2009; Balland 2012).

The theoretical contribution of our paper concerns the extension of the proximity framework with the knowledge base framework introduced by Asheim and Coenen (2005) and Asheim and Gertler (2005). They distinguished between analytical and synthetic knowledge. Analytical knowledge mainly refers to (scientific) knowledge to

understand and explain empirical phenomena. This knowledge is highly codified, even if tacit knowledge remains a necessary complement to understand and validate analytical knowledge. Synthetic knowledge refers to know-how and is more tacit and problem-driven. Typically, it is used to design an artifact or a solution to a practical problem.

Asheim (2007) and Asheim et al. (2007) later added symbolic knowledge to the knowledge base classification as a third type of knowledge. Symbolic knowledge is used to produce cultural meaning, often in the form of cultural artifacts like text, photo, film, fashion design as in media and advertisement industries. Our paper relates the five proximity dimensions to the three knowledge bases. For each knowledge base, we theorize about the likely proximity dimension that is most effective in supporting processes of collaborative innovation among organizations.

A second theoretical contribution is that we then use the proximity-plus-knowledge-base framework to explain the *changing* configuration of innovation projects as they unfold over time. We restrict our framework to innovation in science-based industries, where one can appropriately distinguish between a first *Research* stage to a second *Development* stage and a third *Marketing* stage. In each stage, different knowledge bases are expected to dominate with analytical knowledge being key to research, synthetic knowledge to development, and symbolic knowledge to marketing. In this view, the challenge for firms is to manage the relevant proximities as a project moves from one stage to another, while at the same time integrating the different types of knowledge into a single innovation output (e.g., a new artifact or a new service).

As an illustrative case, we focus on *Becel* as a product innovation from the multinational Unilever. Becel, a revolutionary diet margarine introduced in the 1960s, represents a key innovation for Unilever, while at the same time it serves as an exemplar of modern, science-base product innovation. The history of Becel shows that the ability to 'bridge distances' formed an essential part of Unilever's innovative capabilities. Indeed, in different stages of product development, the company coped with different forms of distance by creating proximity in other dimensions.

The main results from the case study hold that: (i) as expected, analytical knowledge creation dominates in the research stage, synthetic knowledge in the development stage and symbolic knowledge in the marketing stage. Nevertheless, all different types play a role in all stages of product development, and in a combinatorial manner; (ii) specialized knowledge production (cognitive proximity) and shared academic norms (institutional proximity) are the tenets of collaborations in the research stage; (iii) in-house coordination (organizational proximity) and on-site collaboration (geographical proximity) are especially important in the development stage; and (iv) public relations management (institutional proximity) within national borders is especially important in the marketing stage.

We elaborate on the case findings by proposing a general theoretical framework associating the relevant proximity dimensions for each of the three knowledge base type (which in turn, is associated with the three stages of product development). We believe

our framework can provide a new and general theoretical framework for the analysis of science-based product innovations.

2. Proximity, knowledge base and the innovation process

Innovative activities are highly clustered in space (Audretsch and Feldman 1996; Paci and Usai 2000). This observation has opened up a new field of investigation generally labeled as "the geography of innovation" (Asheim and Gertler 2005). The primary question holds why innovation is clustered in space, and what explains differences in the degree of geographic clustering of R&D across industries. It is commonly argued that clustering stems from the need for face-to-face interaction in the joint production and exchange of tacit knowledge. Reasoning from this argumentation, one can explain differences in geographic clustering across industries from their underlying knowledge base. Industries primarily based on tacit knowledge, then, would be more geographically clustered than industries based on more codified knowledge, *ceteris paribus*.

Despite the tendency for innovative activities to cluster geographically, the number of international R&D collaborations has increased markedly as well (Narula and Zanfei 2005; Picci 2010). Innovation projects increasingly involve partnerships that span the globe, be it within or between organizations. Though the people involved have different permanent locations, they still regularly meet face-to-face. Temporary interaction can be organized through travel to short meetings or through the exchange of personnel for short

periods of time. This common practice implies that permanent co-location within a cluster is not necessary for effective knowledge transfer and collaboration to take place (Boschma 2005). Rather, what is necessary for collaborative knowledge production is to organize effective forms of "temporary geographical proximity" at different stages of an innovation process (Torre and Rallet 2005; Torre 2008). The question, then, to ask is why collaborative knowledge production in certain industries takes place primarily locally between permanently co-located actors, while in other industries such collaborations generally take place over large geographical distances.

To probe the spatial logic of effective collaborative innovation, it is useful to distinguish between three types of knowledge bases (Asheim 2007; Asheim et al. 2007): *analytical*, *synthetic* and *symbolic* knowledge. Analytical knowledge mainly refers to (scientific) knowledge to understand and explain empirical phenomena. This knowledge is highly codified though tacit knowledge remains a necessary complement to understand and validate analytical knowledge. Synthetic knowledge refers to know-how and in nature is more tacit. Typically, it is used to design an artifact and solution to a practical problem. Finally, symbolic knowledge is used to produce cultural meaning often in the form of cultural artifacts like text, photo, film, fashion design.

In each industry, all three types of knowledge are being used and produced. However, one can reasonably argue that the key type of knowledge underlying innovation processes differs markedly between industries. Analytical knowledge is key to the innovation process of science-base industries, such as the pharmaceutical, biotechnology and

nanotechnology industries. By contrast, synthetic knowledge is dominant in artifact engineering as in vehicle, electronics and construction industries. And, symbolic knowledge is associated with knowledge of cultural codes underlying cultural industries and advertisement industries. Based on this classification, hypotheses regarding the spatial organization of collaborative knowledge production have been derived. While for all forms of knowledge production, face-to-face is generally required to a significant extent, the exact extent differs per industry. This depends on the degree to which knowledge is formalized – with analytical knowledge being most formalized and least contextualized and symbolic being the least formalized and most contextualized (Martin and Moodysson 2013). Hence, one can expect knowledge production and exchange among actors to be most geographically localized in symbolic-knowledge-based industries, less so in synthetic-knowledge-based industries, and even less so in analytical-knowledge-based industries (e.g., Lui et al. 2013).

The knowledge base concept has been used mainly to classify industries in terms of the ideal-type knowledge underlying their innovation processes. Here, however, we are interested in analyzing the organization of *singular* innovation projects, rather than comparing different industries. Once one starts analyzing singular innovation processes within the context of one particular industry, it becomes clear that an innovation process typically draws upon multiple knowledge types (Strambach and Klement 2012). The relative importance of a knowledge type, then, can shift during different stages of an innovation process. In particular, at least in high-technology industries, the research stage of an innovation processes crucially depends on mobilizing analytical knowledge to

guide the search process to a useful product, while in the development stage more practical problems of large-scale production and logistics need to be solved (Moodysson et al. 2008). One can add to the two-stage model of Research & Development a third stage where the final product needs to be marketed to gain acceptance by clients. Marketing, then, entails the effective communication of the useful properties and experiences characterizing the new product to prospective users, and society at large. This stage mainly draws on symbolic knowledge as to get a new product accepted in the context of the cultural codes, values and expectations, held by users.

It is important to stress that the association of knowledge bases with particular stages in the innovation process should not be taken to mean that these stages can be neatly separated. For example, in the research stage of new product development, analytical knowledge production does not only focus on the properties of the product, but also on properties that render a product more or less costly to produce and distribute. That is, in the research stage, considerations concerning production and distribution are already anticipated. And, the development stage, which we associate with synthetic knowledge, increasingly draws on analytical knowledge as well, with the ongoing codification of knowledge in the engineering sciences over the 20th century. Furthermore, in the design of a product interfaces as developed in the research and development stages, marketing considerations are anticipated. Indeed, the product design – as an object that carries both functional and symbolic meaning – mediates between production efficiency and user experiences.

More generally, we should not understand the three-stage model of innovation as a linear model (Kline and Rosenberg 1986). Problems arising in one stage may motivate a return to a previous stage. For example, when fundamental problems in production arise, scientific research may be required to solve such problems. Furthermore, innovation processes lead to unforeseen results resulting in modification of goals or even of a re-definition of products. Hence, our stage model is meant as a way to distinguish between different types of activities, which empirically do not necessarily occur as a simple activity sequence in real time.

According to the association of stages of product development and the associated key knowledge type, one can derive hypotheses regarding the changing spatial scales of singular innovation projects over time. Initially, during the research stage, one expects most of the international relationships to occur. In the development stage, relationships are more often over shorter distance, mainly within the company or within the region (e.g., with suppliers and distributors). The marketing stage, then, is characterized by relations that are less constrained by geographical distance, but more by cultural codes. Typically, then, marketing is organized at the specific territorial level (regional, national), where the relevant codes are shared most widely. In rare cases, international relations may still matter as well, provided that partners or clients sufficiently share the cultural codes relevant to the product in question.

Building on the knowledge base framework, then, the association between knowledge bases and the spatial organization of innovation is based on the degree of formalism of

the knowledge that is drawn upon. More formal knowledge is more easily produced and exchanged at a distance than less formal knowledge. This explains why collaborations making use primarily of analytical knowledge are often long organized at long distances, while collaborations drawing on synthetic or symbolic knowledge are more often localized within a region due to the need for frequent face-to-face interactions to transfer tacit knowledge (as in the case of synthetic knowledge) or the need to share cultural codes, values and expectations (as in the case of symbolic knowledge).

However, a too strong association between knowledge base and the geographical distance between partners ignores the importance of other forms of proximity, which are non-spatial in nature. In this context, Boschma (2005) distinguished, apart from geographical proximity, between cognitive, social, institutional and organizational proximity:

- *Cognitive proximity* refers to the extent to which two actors share the same knowledge (Nooteboom 1999). Here, we do not mean to refer to actors sharing the same knowledge base as just defined (analytical, synthetic and symbolic), but to actors sharing the same knowledge discipline (e.g., scientific field or technology class) (Nooteboom et al. 2007; Breschi and Lissoni 2009; Hardeman et al. 2014). That is, for each type of knowledge base, one can distinguish different disciplines: natural science disciplines being the most relevant in the analytical knowledge base, engineering disciplines in the synthetic knowledge base, and humanities disciplines as well as genres in popular culture in symbolic knowledge base.

- *Social proximity* is generally associated with personal relationships between actors (Uzzi 1996), for example, resulting from friendships or family ties. Social proximity can also be indicated using information on past collaborations, for example, by looking at repeated ties (Hardeman et al. 2014) or whether two prospective partners had a common third partner in the past (Balland 2012).

- *Institutional proximity* is high when actors share norms, practices and/or incentives. Importantly, the literature distinguishes between two forms of proximity: co-location in the same territory where cultural codes and economic institutions are widely shared (Gertler 1995; Boschma 2005), and joint participation in the same social subsystem, in particular, within academia, industry, or government (Ponds et al. 2007; Balland 2012). Below, we make use of both meanings.

- *Organizational proximity* refers to the membership to the same organizational entity, as it is the case, for example, for two subsidiaries or departments of the same parent company (Balland 2012).

Importantly, the fundamental unit of analysis in the proximity framework is a department (or corporate unit) within the firm. Accordingly, the concept of organizational proximity refers to departments belonging to the same firm. In analyzing a singular innovation

process, the choice of department as the unit of analysis also follows from the fact the main locus of innovative activity within a firm is generally shifting from one department to the next. Ideal-typically, the research stage involves primarily the R&D department, the development stage members from R&D, production and sales departments, and the marketing stage primarily the sales departments. Hence, to understand the role of proximity between the relevant employees in the firm and other actors, one has to define proximity vis-à-vis the main department in charge of the innovation stage in question.

A key insight from the proximity framework holds that non-geographical forms of proximity can substitute, at least partially, for geographical proximity because non-geographical forms of proximity reduce the reduced need for face-to-face interaction. For example, scientists collaborate easily over long distance as they work on narrowly defined subjects (cognitive proximity) and under the same academic incentive structure (institutional proximity) (Ponds et al. 2007). Former colleagues exchange knowledge more frequently, and in a reciprocal manner, as their social proximity built up in the past generated the required level of mutual trust (Breschi and Lissoni 2009). And, tacit knowledge transfer occurs much more easily between subsidiaries from a single multinational company compared to alternative arrangement (Kogut and Zander 1993). This means that the importance of geographical proximity when drawing on synthetic and/or symbolic knowledge should not be overrated. That is, when actors are already proximate in one or more non-spatial dimensions, the transfer of synthetic or symbolic knowledge may still be carried out effectively over long distance.

Apart from the qualification regarding the alleged importance of geographical proximity in joint innovation processes, the proximity framework allows us to explore to further elaborate the knowledge base framework. The relative importance of geographical proximity in innovation projects depends on the type of knowledge base a project stage draws upon, we can now extend this question to all forms of proximity. For each dimension (cognitive, social, institutional, organizational), the relative importance of proximity may well depend on the type of knowledge base (analytical, synthetic, symbolic), which in turn correlates with the project stage of an innovation project (research, development, marketing).

Below, we look at Unilever's development of a new diet margarine as an exploratory case study. We look at the different stages of product development, and the relative importance of each of the knowledge bases, and relevant proximity types in each of these stages. From the case study, we then move to a more general discussion from which we derive a theoretical framework for future studies.

3. Case study: Unilever's launch of Becel as a diet margarine

The introduction of Becel as a new diet margarine is an interesting case, because it is an example of an innovative product that was closely related to the scientific interest and public concern for the relationship between nutrition and health. Starting after World War II the detrimental effects of certain foods and nutrients on health received more and more

attention. A major issue was the undesirable presence of specific nutrients, especially fats and cholesterol in food, in relation to coronary heart diseases.

In November 1962 Unilever launched the diet margarine Becel on the consumer market. Initially the brand name Becel was used for the dietary fat for coronary patients that could only be acquired on prescription. When a competitive diet fat, named Crokvitol was distributed via grocery shops in 1961, Unilever decided to leave its niche strategy and to produce a diet *margarine* for the retail market. Becel became accessible for everyone via the better class of grocery shops and later also supermarkets. In fact Becel can be considered as an early functional food (Helvoort et al. 2014).

Nowadays Becel is still an important Unilever product. It is one of the fourteen Unilever brands that have sales of more than 1 billion Euros a year. Unilever sells it worldwide; in most countries under the name Becel. Consumers in some countries, like the UK, Ireland, Spain and Australia know it under the name *Flora*, while in France and the US it is sold as respectively *Fruit d'Or* and *Promise*.

3.1 Research

American research from the 1930s onwards had led to the insight that there existed various kind of fatty acids – saturated, monounsaturated and polyunsaturated (PUFAs) – with specific effects on an organism's growth and development (Holman 2000). Not

surprisingly, Unilever's research interests were closely related to the worldwide explosion of biochemical research into fats from the 1950s onwards. To be able to develop a diet margarine Unilever needed expertise and knowledge on two different domains; the ability to separate and analyze the various kind of fatty acids as well as the capacity to investigate possible effects on coronary heart diseases of fat intake. Unilever Research Laboratory (URL Vlaardingen) had built up knowledge and experience in both (closely related) research fields. This knowledge was analytical in character.

For the chemical analyses of fats URL Vlaardingen could build upon the earlier work of its director Jan Boldingh. Together with his staff, he had developed new techniques to isolate flavorings which would be extensively used to give margarine a butter-like taste. URL Vlaardingen later improved those methods for analyzing fatty acids by means of chromatography (Beerthuis et al. 1959). For the chemical analyses of fats Unilever Research Laboratory could also rely on other internal experts (Beerthuis et al. 1959; Boldingh 1953; Boldingh 1993).

Due to Unilever's long tradition of nutrition research Unilever's researchers were able to build substantial scientific knowledge base and expertise on the analysis and effects of fatty acids. They cooperated with external experts from universities and private research institutes. They established, for example, close ties with the prominent American lipid researcher Ralph Holman. Unilever researchers were also invited at scientific symposia and conferences and co-authored papers with university professors. The effect research at Unilever laboratory, however, was limited to research on mice and rats. To solve this

problem, a specific collaboration was set up with Leiden University (also located in The Netherlands) and its academic hospital, to get access to medical data on human subjects.

All the close collaborations between URL Vlaardingen and research institutes, universities and hospitals suggest that there was little distance between them in cognitive sense. Even bridging the ocean did not form a hindrance to discuss research outcomes and to cooperate. They were clearly part of the same epistemic community. Additionally, collaboration was facilitated by a high institutional proximity between the Unilever researchers and the scientific world. URL researchers participated in the academic domain visiting scientific conferences and publishing in scientific journals, sometimes in co-authorships with university researchers. They had also a shared perception with regard to 'solutions' and 'scientific progress', and all realized that more research was needed to get a *communis opinio* regarding fatty acids (particularly, how to lower the risk of vascular diseases).

The knowledge transfer and collaborations between Unilever's research laboratory and academia and other research institutes implied that organizational proximity was low. The social proximity, though, varied. With some scientists Unilever's researchers had already worked closely together in the past, like Holman, Bottcher and Van Buchem, while other connections with scientists were established from scratch. Geographically, processes took place at any scale, with Unilever scientists operating in both national and international research networks.

3.2 Development

The scientific knowledge base of Unilever generated the ability to separate various fatty acids and an in-depth understanding the effects of fat intake. However, this knowledge alone was not sufficient to develop a diet margarine. New expertise and knowledge was needed to produce a solid Becel margarine, while reducing rancidity and keeping the optimal flavor. The proposed solutions should be feasible for large-scale production, and without the loss of the margarine's presumed health effects.

Although Unilever had built a substantial technological expertise over the years in mass producing margarines, the production of a new margarine with a high content of unsaturated (healthy) fatty acids challenged Unilever development capabilities. Since such fatty acids are liquids at room temperature, a solution had to be found to produce a *solid* margarine without losing the unsaturated fatty acids. The problem was that the process of hydrogenation, which was used to give liquid oils a solid consistency, eliminated the poly-unsaturated fatty acids. Moreover, giving margarine the right consistency and keeping the optimal flavor were interrelated, because hydrogenation does not only give the liquid oils a solid consistency, but also eliminates the unsaturated fatty acids. Some unsaturated fatty acids are easily oxidized by oxygen that led to a rancid taste and smell. Therefore, giving Becel the right consistency while reducing rancidity was a real technological challenge. Different specialists from within the laboratory with different backgrounds as well as experts from other Unilever departments had to co-

operate to come with a solution. Hydrogenation experts from Unilever laboratory Vlaardingen had to come up with a unsaturated fatty acid-sparing hydrogenation process that would hydrogenate only *those* unsaturated fatty acids that reduced the product's shelf-life. At the development laboratory and in the margarine factory in Rotterdam up scaling of these processes were needed. To avoid rancidity flavor experts from the Flavor Appication Service, a research unit of the laboratory with a chemical background had to cooperate with the hydrogenation experts (Flavour research AHK).

The development of Becel as a mass product underlines not only the role of scientific knowledge generated in the research stage, but also the importance of synthetic knowledge needed for the development activities. Experts with different backgrounds cooperated to make a margarine with new properties. To develop Becel differences between various cognitive fields had to be bridged. To solve production problems geographical proximity between research and production was useful. When cooperation was based on earlier contacts between departments it would be possible that the relationships were also personal in character. Social proximity could enhance the collaboration, but it was certainly not essential. Institutional proximity, however, was more important for collaboration in development. All activities had to be focused on the cheap production of a tasteful margarine that would sell well on the market. Incentives were all aligned in that all activities were purely commercially driven and in the interest of the Unilever company as a whole. That is, the institutional logic of markets and expected profits prevailed.

3.3 Marketing

Becel diet margarine was more than just a new type of margarine. The real novelty were the health enhancing effects. Accordingly, marketing was mainly directed at stressing the scientific evidence of the health effects of Becel. In this way, the symbolic knowledge produced in marketing activities became heavily grounded in the analytical knowledge stemming from research. The understanding of the effects of consuming fatty acids, and especially findings that could be confirmed with scientific evidence, was an essential ingredient in the promotion activities of Becel as a healthy margarine.

According to Jones (2005, p. 117), the '(k)nowledge of the marketing of branded consumer goods' had always been one of Unilever's main capabilities. Indeed, Unilever had a lot of experience in launching new products. In the case of Becel, however, Unilever did not just launch a new product, but a whole new product *category*, namely functional food. This made the cognitive distance between Unilever and consumers even larger and extant marketing capabilities were insufficient. In contrast to product characteristics such as taste and consistency, consumers were unable to evaluate the health improving aspects of this new margarine by themselves. Hence, Unilever invested in a major marketing effort.

While unremitting suspense is inextricably bound up with scientific research, for marketing it is of prime importance that advertised health claims are sound. This contrast

is also reflected in the deliberations related to the launch of Becel. The Unilever researchers were convinced that '…although there is no absolute medical proof, the evidence is such that [they] would recommend a reasonable polyunsaturates content in dietary fats.' (AHK Co-ordination Foods I) The commercial staff hesitated because without conclusive evidence that unsaturated fats would actually help prevent atherosclerosis, there would be a risk that any health claims would boomerang against Unilever. The relation between fat consumption and cardiovascular disease was described as a 'thoroughbred in which to enter Troy' (AHK Minutes 12-12-1962).

Moreover, producing a mass product that was sold via grocery shops and, from 1963 onwards, also via supermarkets was accompanied by a lack of personal contacts between Unilever and its consumers. Only a select group of taste panelists had been in contact with the industrial researchers. Social and organizational proximity was therefore low. The trust of consumers in Unilever's message increased when professionals (medical practitioners, nutritionists), as well as government bodies (particularly the Dutch Food Council) supported the notion that saturated fatty acids were unhealthy and that unsaturated fatty acids would contribute to lower cholesterol levels. End 1960s this became increasingly important when more people became worried about the health consequences of fat intake. The Unilever researchers had an excellent reputation, with some even acting as advisors for the Food Council, which regularly published nutritional recommendations.

Interestingly, although at the end of 1960s specific functional food legislation was lacking, the Dutch government strived to influence the consumption pattern of its population with specific recommendations. The advice was to consume less fat, to switch to products like low-fat milk and to replace animal products, such as butter, certain margarines and animal fat by products made from vegetable oils (De Wijn 1969). In 1973 the report was even more explicit with the Food Council recommending that people should could choose more healthy industrial products like that of Becel (Den Hartog et al. 1973).

Unilever had been aware of the trust building function of experts. From the launch of Becel onwards it had addressed the medical world that was seen as a possible 'cognitive bridge' between the firm and future Becel consumers. When in 1962 the first advertising campaign of Becel was discussed within Unilever they agreed that, although it would have to concentrate on polyunsaturated fatty acids '…the methodical building of good relations with medical and scientific circles, based upon trust in Unilever as suppliers of unbiased information on dietary fats' would be the wider task (Minutes second meeting 12-12-1962 AHK). When in 1967 Unilever used television advertisements to promote Becel, part of the public approached medical practitioners for information. In response, physicians did not recommend the use of special products like Becel to lower cholesterol. Instead, they advised a low-calorie diet. As a consequence Unilever decided to invest even more in informing Dutch physicians and include more scientific information in their advertisements (Knecht-van Eekelen and van Otterloo 2000). In 1967, Unilever also started to sponsor a quarterly journal with reviews of the most important international

publications on atherosclerosis in relation to nutrition, metabolism and pathology, the results of research by the Unilever Research Laboratory at Vlaardingen, and advertisements of Becel. The journal was distributed to all physicians (De Vaal, 1967-1979). These experts functioned as intermediaries to bridge the cognitive and institutional distance between Unilever and its consumers.

Later, the importance of medical practitioners in diet recommendations declined when end 1970s the overall credibility of medical experts, and experts more generally, decreased. This was closely related to another development: debates and controversies were no longer kept within the scientific community but became public. Due to the entanglement of symbolic (marketing) knowledge and analytical (scientific) knowledge the position of Unilever's Becel weakened, because absolute medical proof for the assumption that a shift in the ratio of saturated to polyunsaturated fats in the diet would have a beneficial effect in terms of preventing cardiovascular diseases was still lacking.

The launch of Becel in The Netherlands illustrates that the various marketing strategies were organized within a national institutional framework. The same applied for other countries. Indeed, despite Unilever's international branding policy starting in the 1960s, the marketing activities for Becel remained for a long time national in character. Related to its tradition of decentralization Unilever's operating companies were – especially with regard food products – adapted to local circumstances. For example, while in Germany the operating company emphasized the medicinal role, in Belgium and the Netherlands Becel was launched as a consumer product that was 'healthy for your heart artherities'.

Additionally, expressions in advertisements and graphics on the packaging could differ geographically (Jones 2005), and often under a different names (including *Flora*, *Fruit d'Or* and *Promise*).

In terms of the proximity dimensions, one can summarize the marketing phase of Becel as being characterized by cognitive, organizational and social distance between Unilever on the one hand and its consumers on the other. Therefore, geographical and institutional proximity became even more important for symbolic knowledge creation. It is particularly the institutional proximity in the territorial sense that was exploited by following country-specific strategies in public relations vis-à-vis experts and in marketing vis-à-vis consumers.

4. Integrating proximity into the knowledge base framework

From our case study, it becomes clear that different knowledge bases play a different role in different stages of new product development. Analytical knowledge creation dominated in the research stage, synthetic knowledge in the development stage and symbolic knowledge in the marketing stage. Theoretically, this is in line with Asheim's framework of knowledge base (Asheim 2007; Asheim et al. 2007). However, whereas Asheim *cum suis* used the knowledge base concept to explain differences across industries, our case study shows that the distinction between analytical, synthetic and symbolic also applies to stages of development in a singular innovation project (research,

development and marketing). We also found that, in each stage, the relative importance of proximities shifted relate to the dominant type of knowledge being used and produced.

In the *research* stage, the key actor is obviously the R&D department. Researchers are generally familiar with the relevant scientific knowledge and the academic institutions governing its production and exchange. Indeed, to a large extent, R&D employees operate as academic scientists visiting specialized academic conferences and publishing in scientific journals, as to become part of the epistemic community that advances the frontiers of science (Rosenberg 1990). Hence, cognitive and institutional proximity can generally be expected to be high in the research stage of product development processes (cf. Moodysson et al. 2008).[1] That is, due to the formal, and often academically produced, nature of analytical knowledge, effective transfer and collaboration is made possible by the high degree of cognitive and institutional proximity. Social proximity, however, is variable depending on the contacts firm employees already established in the past within the relevant epistemic community.

Since research draws primarily on analytical knowledge, one can expect geographical and organizational proximity to be low. Companies look for state-of-the-art knowledge that is often not found within the own organization (organizational distance) nor in the vicinity of its own corporate lab(s) (geographical distance). Instead, companies tend to engage in

[1] Note that we depart from the definition of institutional proximity proposed by Ponds et al. (2007) who defined university-industry collaboration as institutionally distant. Their definition applies at the level of the firm and the university as a whole. At these levels, firms and universities indeed have different missions and incentives as they operate under different institutional regimes (market versus academia). However, going down to the level of individual innovation projects, a firm's R&D department may work closely and without conflicting objectives with a universitiy's applied research department.

research collaborations with other research-intensive organizations (including firms, universities and public labs) that are specialized in the same field of knowledge, that is, that operate in the same epistemic community.

In the *development* stage of new product development, which draws primarily on synthetic knowledge, the challenge for a firm is to translate its prototype into a well-working product that can be produced and distributed efficiently at a large scale. This part of the innovation process is dominated by practical problems that have to be worked through on site and within the boundaries of company, by aligning the knowledge and routines of several departments (R&D, production, logistics, sales) through in-house collaborative projects (cf. Moodysson et al. 2008). Hence, geographical and organizational proximity can indeed generally be expected to be rather high in the development stage of product development processes.

By contrast, cognitive proximity, is lower due to the need to combine different knowledge domains in complex production and distribution process. And, the development stage – as the intermediate stage between research and marketing – is also the most combinatorial in nature, drawing not only on synthetic knowledge, but also to an important extent on analytical and symbolic knowledge (Manniche 2012; Strambach and Klement 2012). The institutional context is given by market criteria, as user functionality and cost efficiency become the main drivers of innovation. Given these dominant criteria, one can say that in the development stage institutional proximity in collaboration remains high compared to the research stage, though shifting from an academic to market logic.

Again, social proximity is variable depending on the contacts firm employees already established in the past within the firm. In particular, for smaller firms, one can expect social proximity to be high, while for larger firms, innovation project may involve employees unacquainted with each other.

Finally, in the marketing stage of new product development, symbolic knowledge becomes crucial as the new product has to be made acceptable and attractive to consumers within a particular cultural and institutional context (Wrigley et al. 2005). At this stage, the relevant geographical context becomes the territory where such cultural codes are shared. Dependent on the product in question, such contexts can be local, national (or, in some cases, even transnational). Hence, the notion of geographical proximity is less useful here; rather, what matters is institutional proximity in the territorial sense (Gertler 1995). Firms that are located within the territories targeted by marketing will have a greater understanding of the cultural meanings that prospective consumers may attribute to their new product. The cognitive proximity between users and producers will depend on the degree of novelty of the product compared to previous products and the accompanying user practices, which is – in mass markets – generally low. Similarly, the interaction with mass consumers will also lack social and organizational proximity. By contrast, in more specialized markets, proximities may vary much more.

The theoretical framework following from our discussion is summarized in Table 1. This table associated different knowledge bases and different proximity dimensions to each of the three product development stages, following our framework outlined above.

Table 1. Knowledge base and proximity per innovation stage

	Research	Development	Marketing
Knowledge base			
Analytical	**high**	variable	low
Synthetic	variable	**high**	variable
Symbolic	low	variable	**high**
Proximity			
Geographical	low	**high**	**high**
Cognitive	**high**	low	low
Social	variable	variable	variable
Institutional	**high**	**high**	**high**
Organizational	low	**high**	low

5. Discussion

We proposed a framework in which we relate the various proximity dimensions that support collaborative innovation and knowledge transfer to different types of knowledge

bases involved in new product development. The different forms of proximity include geographical, cognitive, social, institutional and organizational proximity. We argued that the relative importance of each proximity dimension depends on the type of knowledge being mobilized and produced, where we distinguish between analytical, synthetic and symbolic knowledge.

While analytical knowledge can be effectively produced over long distance as long as cognitive proximity is high, the production of synthetic knowledge generally requires permanent co-location and in-house project teams as to overcome cognitive distance between the various disciplinary expertise that needs to be integrated for operational production (Moodysson et al. 2008). The joint production and use of symbolic knowledge, however, is not so much affected by geographical proximity *per se*, but much more by institutional proximity of the territorial kind (Gertler 1995); most often, though certainly not by definition, cultural codes are shared among those residing in the same territory.

We further argued that institutional proximity is expected to be high in each of the three stages of new product development. However, the nature of institutional proximity changes over time. In the research phase, an R&D department interacts closely with academia and public research institutes, largely operating under academic norms of knowledge exchange. In the development stage, a firm's innovation process becomes organized in-house in line with the market (cost-efficiency, secrecy) as the relevant institutional environment. Finally, when launching the product in several national

markets, public relations and marketing departments address the relevant national public authorities and the national publics, using the product's content symbolically. *Thus, the ability of a firm to successfully innovate will depend on its ability to have its departments operate under different institutional environments as a single corporate identity.*

Our framework is based on the notion that in each stage of product development (research, development, marketing), a different knowledge base dominates (analytical, synthetic and symbolic, respectively). However, it should be reminded that the three knowledge bases, though clearly distinguishable and shifting in importance across stages of product development, are also very much intertwined. That is, knowledge bases are used jointly, and in various combinatorial ways (Manniche 2012; Strambach and Klement 2012). For example, analytical knowledge is not only key to the research stage, but can also play an important role in the development process. Indeed, in modern-day science-based engineering specific product properties are increasingly engineered scientifically, rather than only by trial-and-error. And, analytical knowledge can also be used directly in the marketing stage, where scientific knowledge is mobilized symbolically to convince consumers and public authorities about product characteristics that otherwise cannot be observed or experiences directly in use. This logic is especially dominant in the food and pharmaceutical industry, but may also become more prevalent in other industries, such as the electronics and automobile industry.

This leads us to conclude that our framework, which associates different knowledge bases and proximities to different stages of new product development, should be

understood first and foremost as a heuristic device for future case study research. Such cases will help to further scrutinize our theoretical reasoning and refine the framework at large. At the same time, the framework provides testable propositions regarding the relative importance of proximity dimensions in different stages of new product development. Thus, we also hope to see future attempts that systematically collect information about proximities across different product development stages, so as to test statistically the various propositions that we derived from our case study and elaborated further theoretically.

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