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Contents

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Letter from the Editor

Chemical distributors and their role of tomorrow

Recently published growth rates underline the previously forecasted development for the chemical industry. Although the chemical industry in Germany increased its production within the first few months of 2012, compared to the previous quarter, the association Verband der Chemischen Industrie (VCI) is forecasting a stagnation of chemical production for the overall year 2012. This economic situation also concerns the distribution sector within the chemical industry. Since chemical distributors represent a linkage between producers and customers, not only chemical companies, but also chemical distributors are confronted with certain challenges, especially in times of economic stagnation. Consequently, the relationship between chemical companies and chemical distributors is not rigid, but rather underlies certain modifications. Hence, we are glad to present you two articles in our current issue, which discuss the chemical distribution in Europe more detailed.

First, Matthias Hornke provides deeper insights in the future role of chemical distribution in Europe. In his commentary, he analyses and discusses customer relations as one key success factor within the chemical distribution sector. Mr. Hornke states that chemical companies increasingly realize the value of chemical distributors as value chain partners. The answers to his research questions, such as possible key success factors of the chemical distribution industry or the characterization of the future role of chemical distributors between producer and end customer, are based on a study with participants form the chemical distribution industry in Germany, Australia and Switzerland.

In the section of process innovation management, Thomas Lager and Johan Frishammar discuss the partnership between process firms and equipment manufacturers. In their research paper "Collaborative development of new process technology/equipment in the process industries: In search of enhanced innovation performance" the authors examine motives for collaborative development of new or improved process technology/equipment. Furthermore, they introduce a conceptual model of full lifecycle of process technology/equipment with a classification matrix for the selection of alternative forms of collaboration.

In the second research paper "Opportunities for- and configuration of foreign innovation: A case study of multinational companies in China" the author Jan Henning Behrens contributes to research limitations about foreign innovation management in China. Actual data from the OECD and others are used for a macroeconomic framework about innovation activities in China. In addition, this macroeconomic perspective is amplified by a functional management perspective in form of a micro-economic case study.

The current issue ends with the practitioner's section "Chemical distribution in Belgium from 2007 to 2010: An empirical study" from Genserik Reniers. The study examines the diversity in the Belgian chemical distribution sector with focus on the eight leading chemical distributors on the Belgian market. The author develops a product lifecycle model which allows a description of the heterogeneity in this sector. Data about sold volumes, turnover, added value, investment and employment over the period 2007-2010 are provided in order to assess the economic decline in 2009 and the recovery in 2010.

Now, please enjoy reading the first issue of the ninth volume of the Journal of Business Chemistry. We would like to thank all authors and reviewers who have contributed to this new issue. If you have any comments or suggestions, please do not hesitate to send us an email at: contact@businesschemistry.org.

Carsten Gelhard, Executive Editor
(cg@businesschemistry.org)

Journal of Business Chemistry

Commentary

The future of chemical distribution in Europe: Customer relations as key value lever

Matthias Hornke*

* Grosse-Hornke Private Consult, Am Dornbusch 54, 48163 Münster, Germany, matthias.hornke@grosse-hornke.de

About 10% of the overall output of chemical producers is distributed via independent chemical distributors. More than this pure figure indicates, chemical distributors bear a tremendous importance in distributing chemical products to an often very widespread customer base. Chemical distributors help the producers to lower the complexity of product distribution and customer management. In addition to the distribution function itself, they often offer technical support, laboratory or packaging/labelling services additionally.

Chemical companies increasingly realize the value of chemical distributors as value chain partners and implement structured chemical dealer/distributor management functionalities in their organisations. Fuelled by headlines that are related to the success of chemical distributors - even in times of crisis as in the years 2008 and 2009 - this industry gains interest in the Chemical Community and related publications.

What are the key success factors of the chemical distribution industry? How can the current and future role of chemical distributors between producer and end customer be characterized? What is the outlook for the merger & acquisition (M&A) activities? These and further questions have been answered by a study with 62 participants from the chemical distribution industry in Germany, Austria and Switzerland. The study has been conducted by Grosse-Hornke Private Consult in close cooperation with the University of Münster at the end of last year.

Importance of face-to-face contact

Although 2/3 of the participants apply IT-systems to support communication and interaction with their customers the personal and face-to-face contact is still of paramount importance – favoured by 92%. In particular in the specialty chemical business with complex products personal contact is the key to sales success. Personal customer contact is increasingly supplemented by sophisticated Customer Relationship Management (CRM) systems – mainly with the intention to analyse customer and market data. While the chemical distribution industry has been characterized by strong consolidations during recent years, many study participants claim that a further consolidation will lead to the risk of loosing a local footprint.

Chemical producer and chemical distributor as tandem

84% of the answers picture a cooperative relationship between chemical producers and distributors. Obviously, the role of chemical distributors as middlemen to the customers is well appreciated by the producers. This evaluation is most likely the reason why only 26% of the study participants assume that chemical producers will start to establish their own distribution entities in order to bypass the independent chemical distribution companies

Product training as key sales tool

Success in the specialty chemical industry strongly depends on know-how about products and their application – often closely linked to a specific industry. Therefore, product trainings provided by producers are rated “important” by 85% of the study participants. An increased focus on enlarged product and service portfolios (refer to figure 1) will in the future further grow the need for dedicated product and service trainings. One quarter complains that dedicated “distributor development programs” should be stronger pursued. The study results indicate that there is still room for improvement regarding better aligned marketing efforts between the chemical producers and their distributors.

Increasing focus on employee qualification programs

The growing shortage of highly skilled workers is often discussed and also our study proof (refer to figure 1). Getting the right people and keeping them is more and more becoming a challenge for often rather small chemical distribution companies. Accordingly, retention programs and employer branding are getting more important – this applies especially for rural areas.

Mergers and Acquisitions (M&A) activity staying strong

Due to the fact that the chemical distribution industry has seen strong M&A activity in the last years, big deals are getting more and more unlikely – not least due to antitrust regulations. For example, 55% of the study participants expect a constant M&A level and 34% a slightly increasing one for the German market. For family owned chemical distributors the acquisition by another distributor is often the only way to ensure business continuity.

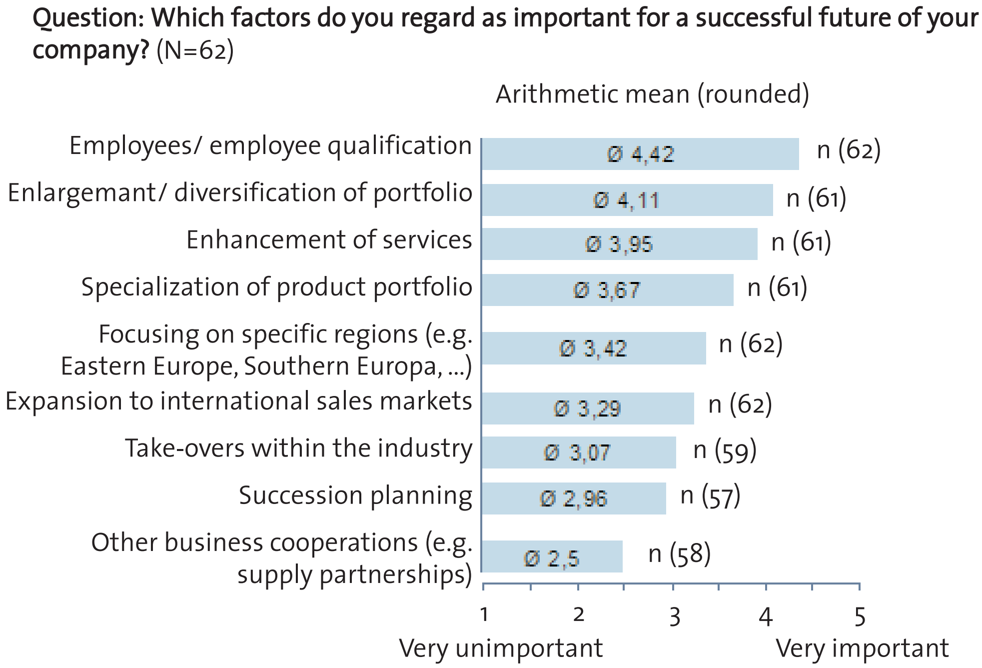
Procurement in Asia growing

Asking which markets are of strong importance regarding procuring chemical products, 87% of the study participants named China and India and 61% voted for Asia in general (excl. China and India). However, for entering new markets, companies are well aware of key hurdles like strong market saturation (60%), missing human resources (44%) or currency exchange risks (45%).

Outlook: Value of strong customer contacts in challenging times

For the year 2012 a growth of more than 4% of the world-wide chemical production is assumed by industry experts. However, for the EU-countries a heterogeneous picture is drawn. Due to the continuing Euro crisis, especially in Southern Europe, the outlook remains unsecure. In such challenging times a direct and quick feedback from the market regarding product demand is of high value. Therefore, only those chemical distributors will continue to play an important role that further professionalize their middlemen position by relieving the chemical producers from sales activities and gaining knowledge about the final source of revenue – the end customer.

Figure 1 Success factors for chemical distribution companies



Journal of Business Chemistry

Research Paper

Collaborative development of new process technology/equipment in the process industries: in search of enhanced innovation performance

Thomas Lager* and Johan Frishammar**

* Centre pour l'Innovation Technologique & Entrepreneuriale, Grenoble École de Management, 12 rue Pierre Sémard - BP 127, 38003 Grenoble Cedex 01, France, thomas.lager@grenoble-em.com
** Centre for Management of Innovation & Technology in Process Industry, Entrepreneurship & Innovation, Luleå University of Technology, SE-971 87 Luleå, Sweden, johan.frishammar@ltu.se

When a new production plant is built or an existing one upgraded, it cannot be taken for granted that adequate process technology is available off the supplier's shelves. Rather, it may require a strong commitment on the process firm's part to find competitive production solutions in collaboration with one or more equipment suppliers. The development of such new or improved process technology may be prompted by the process company's need for process development, or product development, or both. The purpose of this article is to provide theoretical insight and practical guidance on how both process firms and equipment manufacturers can address the challenges posed by joint collaboration for innovation in new process technology/equipment. Starting with a discussion of motives and the question of why collaborative development of new or improved process technology/equipment should take place at all, a conceptual model of the full life-cycle of process technology/equipment is introduced together with a classification matrix containing the dimensions of complexity of process technology and newness of process technology. The framework provides a conceptual platform for further research into this area, but can also be deployed by industry professionals in their efforts to improve inter-company collaboration.

1 Equipment supplier/user collaboration in the process industries – a background and introduction

The process industries span over several industrial sectors such as minerals & metals, pulp & paper, food & beverages, chemicals & petrochemicals and generic pharmaceuticals, and thus constitute a large part of all manufacturing industry. Firms in the process industries may focus on being efficient commodity producers, or producers of more functional products, or both (Lager and Blanco, 2010). In most situations, an efficient production process will ensure that production costs can be kept low with higher profit margins and less price sensitivity. One way to improve performance is to invest in better and more efficient process technology (Skinner, 1978, Skinner, 1992). In the process industries it is not so common any more for individual firms to develop and manufacture their own process technology/equipment, which makes them dependent on external suppliers of process equipment (Rönnberg Sjödin et al., 2011). Historically, it can be seen that many equipment-manufacturing companies have grown from collaboration with domestic process firms to the point where they now serve customers primarily active on the global market (Auranen, 2006). The process industries, especially in the Nordic countries, have such a long tradition of collaborative development between process firms and suppliers of new process technology.

Such collaboration has historically produced a win-win situation where the process companies, as early users, have gained access to novel technology and equipment needed to process domestic raw materials, whereas the equipment suppliers in a geographically close and often mutually trusting relationship have gained an efficient means of testing prototypes and developing new equipment. As process-based firms typically operate in more mature industries (Utterback and Abernathy, 1975), external actors such as equipment suppliers are important sources of innovation in process technology (Hutcheson et al., 1995, Reichstein and Salter, 2006). Similarly, equipment suppliers are dependent on process firms not only as customers for new process technology solutions, but also for testing and gaining feedback on new prototypes. The incentives for joint development efforts through mutual collaboration are therefore still strong. Changes in the external environment, such as the emergence of global markets and the appearance of global suppliers of new process technology, may however cause this situation to change (Williamson, 2011).

1.1 Integrating equipment manufacturers into the process firm's innovation processes

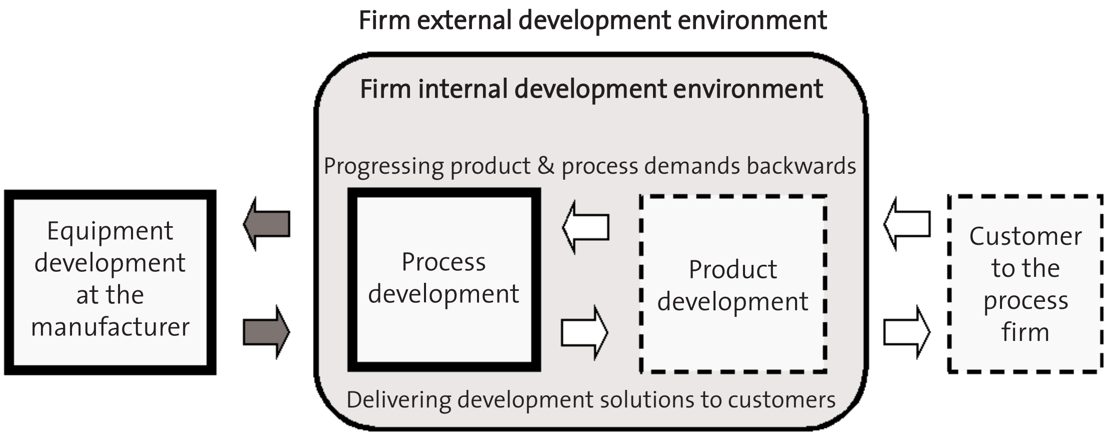
When a new plant is built or an existing one upgraded, as well as in other equipment procurement situations, it cannot be taken for granted that the necessary equipment is available off the supplier's shelves. It may require a fairly strong commitment on the process firm's part to find competitive production solutions in collaboration with equipment suppliers. The key reason for this is the often idiosyncratic nature of process technology needed by process firms. The development of such new or improved process technology may be prompted by the process firm's need for process development, or product development, or both (Frishammar et al., 2012), which is further illustrated in Figure 1. However, for most firms in the process industries, a substantial part of process and product development is not radical development, but rather an incremental refinement of existing products and processes (Lager, 2002).

In the case of incremental product development, it may not be necessary to involve equipment manufacturers in the early stages of the innovation process, while in radical product development this may often be critical. In both radical and incremental process development it is not only advisable but of the utmost importance to have good contacts and strong collaboration with equipment manufacturers in order to explore new process development opportunities. Sometimes process development is organized as a part of the firm's R&D organization, and sometimes as a part of its manufacturing function (Bergfors and Lager, 2011). Such different organizational contexts may naturally influence not only the collaborative climate but also further tests and implementation of new process equipment. In successful process development, close collaboration with an equipment supplier is often necessary right at the very start of the development of process technology. If the equipment needed is very firm-specific (idiosyncratic), it may even be necessary for the process firm to compensate the equipment manufacturer for such development. However, if the process firm has a large competitive advantage through its proprietary process technology and knowledge in specific areas, it may even have to consider carrying out such equipment development work itself. Alternatively, it may have to secure a proprietary ownership of a technology that is developed in collaboration with an equipment manufacturer, but to grant licenses to the equipment manufacturer for non-competitive customers.

From the equipment supplier's perspective, the development of new process technology/equipment may be prompted by the identification of customer needs on the world market or internal idea generation and technology push.

As Figure 1 shows, external customer demands on the products from the process firm may prompt not only a need for the development of new or improved products but also the development of new process technology to enable the production of such products (Lager, 2010 p. 92). In addition, customer-driven needs for more efficient and low-cost products may also fuel the development of improved process technology. Successful development of such new process technology, however, depends to a large extent on close collaboration with equipment manufacturers. A noteworthy observation on the collaborative development of process technology/equipment is that it may be called either product development or process development depending on the viewpoints of the parties concerned. From the equipment supplier's perspective, this kind of development is often discussed in terms of entering into a "product development project", whereas from the process firm's perspective it is typically

Figure 1 The internal and external innovation environment for firms in the process industries. In the external innovation environment not only external customers prevail, but also the suppliers of necessary process technology/equipment



discussed in terms of entering a "process development project". It may, however, be advisable for both the equipment supplier and the process firm to speak in terms of developing both a "product concept" and a "process concept". That is, for the process firm, product development is prompted by the needs of its customers for improved process technology, which as a consequence may prompt a need for the development of new process technology (see Figure 1).

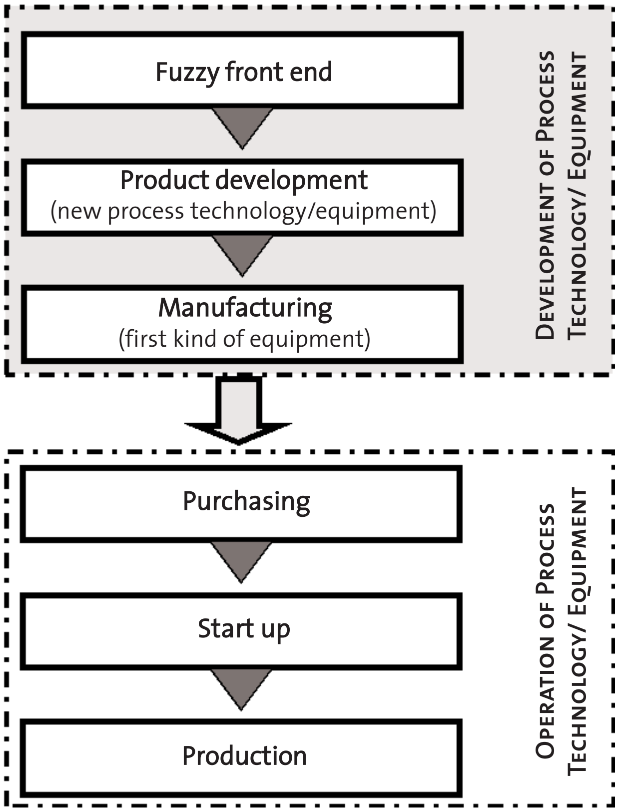
A similar situation typically occurs for the equipment supplier when the development of a new process technology for the customer (process firm) prompts the need for the development of a new product (the new equipment). The improved use by its customers of a process firm's already existing products is usually called "application development" in the process industries (Lager and Storm, 2012). In a similar vein, the use of the equipment supplier's product in the customer's process may thus also, when the product is further marketed to other customers, be regarded as application development and as improvement of the customer's further use of the product (equipment). The consequence for the process firm of using this "mental map" is that it focuses the development activities more on improvement of the customer's process than on the development of the actual product. The consequence for the equipment manufacturer may be that it focuses the customers' use of the equipment more firmly on improvement of the customer's production gains, than on the actual development of the equipment as such.

These arguments and examples indeed emphasize the importance of good collaborative efforts. The supply chain perspective presented in Figure 1 also illustrates the importance to the equipment supplier of not only understanding the customer's needs but, in their long-term development, also of understanding the customer's customer's needs. Successful process technology/equipment development by the equipment manufacturer is thus often largely dependent on access to a knowledgeable process firm as a collaborative development partner. One way to speed up the product and process development processes for both the process firm and the equipment manufacturer in the future may be to "short-circuit" the product and process innovation chain presented in Figure 1. Such a desired effect may be best achieved by stronger integration and improved internal and external cross-functional collaboration, a topic that will be further explored and discussed in the following sections.

1.2 A life-cycle perspective on the collaborative development and operation of process technology/equipment

Acquiring and purchasing new or improved process technology/equipment is not, however, necessarily preceded by collaborative development of the equipment (between a process firm and an equipment manufacturer) . The full life-cycle of process equipment, broken down into two distinct stages, is illustrated in Figure 2. The full equipment life cycle has been conceptually split up into two distinct stages.

Figure 2 The full life cycle of new or improved process technology/equipment



In the first stage, the development activities are often in the hands of and controlled by the equipment manufacturer. In the second, non-shaded stage, the operation of new process technology/equipment is mainly in the hands of the process firm (Lager and Frishammar, 2010).

The two stages are interlocked only if the process firm that collaborated during the development stage also decides to buy the equipment being developed. From the equipment manufacturer's perspective, the development of new or improved process technology/equipment should preferably be followed by a consecutive sale of such equipment, preferably in quantities which allow a profitable overall business objective to be achieved. The development of such new or improved process equipment for the process industries is therefore in most cases carried out in close collaboration with one firm or a consortium of process firms, often also targeted as future potential customers for the equipment.

In the development stage, the equipment manufacturer is often the “promoter”, most interested in securing development support and collaboration, whereas in the operation (production) stage the process firm is the one who decides whether and on what premises collaboration should take place. In the first stage, successful collaborative innovation depends first of all on input of present and future needs for process technology and good ideas in the fuzzy front end (sometimes from different firms). Further on, the execution of an efficient product development phase often uses process firms' production plants for testing or installation of demo plants if such a collaborative approach has been selected. Finally, judicious design (engineering) of the new equipment to meet future needs for low-cost operation and good availability is crucial. In the second stage the enhancement of production productivity through technology transfer by means of different forms of collaboration between the equipment manufacturer and process firm could then be a combination of a judicious joint selection of proper process equipment for company-specific production applications, a mobilization of joint resources for a smooth start-up (Lager, 2012) and a following efficient operation utilizing the combined expertise of both parties.

In this paper we will focus only on the first stage of the process technology/equipment life-cycle, although there may be an interlocking grip between the two stages. Despite the issue of sometimes diverging interests, collaboration during the various phases of the development part of the life cycle of process technology/equipment is likely to be of even greater importance in the future both to process firms in order to secure an efficient production process and to equipment suppliers to secure the development of a competitive portfolio of process equipment. It is therefore justified to ask how such collaboration in the future should be managed, organized and implemented to the maximum benefit of both parties.

1.3 Purpose and research approach

The purpose of this article is to provide theoretical insight and practical guidance on how both process firms and equipment manufacturers can address the challenges posed by joint collaboration for innovation of new process technology/equipment. The theoretical framework could thus be deployed by industry professionals in their efforts to better decide on and improve a collaborative development approach. The framework is also intended to provide a platform for further research into this area. In this study one of the authors' own industrial experience has given him a status of not only author but informant (Yin, 1994), sharing his knowledge of equipment development in the process industries. On one hand, there is naturally a risk that this author´s pre-understanding will result in research that is not open to the alternative theories and the empirical world, and that new findings will be adjusted and distorted to fit preconceptions. On the other hand the advantages of pre-understanding in research can be many; they have been rather well expressed by Markus (1977):

> *"The problem is how to get beyond the superficial or the merely salient, becoming empirically literate. You can understand little more than your own evolving mental map allows. A naive, indifferent mental map will translate into global, superficial data and interpretations – and usually into self-induced bias as well. You have to be knowledgeable to collect good information."*

In his paper "Theory Construction as Disciplined Imagination" Weick gives an interesting quotation (1989):

> *"Theorists often write trivial theories because their process of theory construction is hemmed in by methodological strictures that favor validation rather than usefulness (Lindblom, 1987). These strictures weaken theorizing because they de-emphasize the contribution that imagination, representation, and selection make to the process, and they diminish the importance of alternative theorizing activities such as mapping, conceptual development, and speculative thought. Theory cannot be improved until we improve the theorizing process, and we cannot improve the theorizing process until we describe it more self-consciously, and decouple it from validation more deliberately."*

This somewhat philosophical statement concerns whether a good theoretical framework is necessary for good empirical research, or whether the study of the empirical landscape is the best starting point for the development of "true" theories. For case-study research, both alternatives are advocated by scholars from different domains of theory of science (Yin, 1994). Since the area we are addressing in this study is sparsely researched to say the least, a good theoretical platform is consequently lacking, which has prompted the development of this framework and the following research question:

> *RQ1 In the development of new process technology/equipment in the process industries, why, when and how should a collaboration between process firms and equipment manufacturers be the advised route to follow?*

The article is organized as follows. After the introductory part, a review of extant research in the area of external collaboration is presented. Afterwards the development of the framework is introduced and industry implications are discussed. The framework presented here is thus to be regarded as results from this study to be used in further empirical research for which a preliminary research agenda is provided.

2 A theoretical point of departure: external collaboration

Collaboration issues have been extensively studied over the past decades. One side of the literature has focused on collaboration within firms (Frishammar and Hörte, 2005, Kahn, 1996) with a prime focus on collaboration among functions and departments. Other scholars have studied external collaboration, e.g. (Ahuja, 2000a, Ahuja, 2000b) with a prime focus on collaboration among firms. While collaborations "within" and "among" firms represent two different ideal types of collaboration situations, the concept of collaboration is in itself ambiguous. Notably, several different and complementary terms have previously been used in the extant literature. These include *cooperation* (Hillebrand and Biemans, 2004), *interaction* (Ghosal and Bartlett, 1990) *integration* (Barki and Pinsonneault, 2005) and *coordination* (Kogut and Zander, 1996). Although there is an overlap among these concepts, as researchers often refer to them interchangeably; see for example (De Luca and Atuahene-Gima, 2007), we use the term collaboration in subsequent discussions for two reasons. First, it emphasizes long-term, affective and continuous relationships between firms, as opposed to limited transactions and/or exchange of information (Frishammar and Hörte, 2005). Second, our focus is on collaboration between and among firms, rather than within firms. In this context, collaboration is the most commonly used term to characterize joint development efforts.

The literature on intercompany collaboration spans different research domains or traditions. Writings on intercompany collaboration have for example been grounded in the resource-based view of the firm (Grant, 1991, Menon and Pfeffer, 2003), the organizational learning literature (Cohen and Levinthal, 1990, Lane et al., 2001), knowledge management (Sveiby, 2001), and product innovation (Chesbrough and Appleyard, 2007). External collaboration may take a variety of forms, ranging from tightly coupled to loosely coupled arrangements. Although an extensive list of forms is presented in the literature, some appear more relevant than others. Specifically, joint ventures, strategic alliances and consortia represent tightly coupled forms, while networks and trade associations (collaborative sectorial research projects) represent more loosely coupled forms (Barringer and Harrison, 2000). A joint venture is created when two or more firms pool a portion of their resources, and create a separate jointly owned organizational unit (Inkpen and Crossan, 1995). A consortium may be viewed as a special form of joint venture (Brooks et al., 1993), consisting of a group of firms which share similar needs and who then create a new entity which satisfies this common need (Kanter, 1989). Alliances, on the other hand, represent an arrangement between two or more firms in the form of an exchange relationship that has no joint ownership involved (Dickinson and Weaver, 1997). Networks are constellations organized through social rather than legally binding contracts (Jones et al., 1997). Nevertheless, in collaboration between equipment manufacturers and process firms, the actors can choose from an array of potentially relevant collaboration modes, ranging from tightly coupled to more loosely coupled ones arranged on an informal basis.

Supplier involvement refers to the resources (capabilities, investments, information, knowledge, ideas) that suppliers provide, the tasks they carry out and the responsibilities they assume regarding the development of a part, process or service for the benefit of a buyer's current or future product development projects (Handfield et al., 2000, Walter et al., 2001, van Echtelt et al., 2008). A recent study entitled "Supplier involvement in customer new product development: new insights from the supplier's perspective" (Klioutch and Leker, 2011), reports the results from a survey of chemical suppliers.

In their distinction between innovative and non-innovative suppliers they found that mutual support in NPD and open networks are imperative triggers for the involvement of innovative suppliers. Many authors state that it is largely agreed that world-class R&D performance can no longer be achieved by a firm on its own, and that nowadays meeting customer requirements increasingly needs R&D collaboration in buyer-supplier relationships (Collins et al., 2002, Hurmelinna et al., 2002). This further underlines the importance of using external information and establishing strong external collaborations, a fact that has been stressed in publications in the area of open innovation (Chesbrough and Crowther, 2006, Chiaroni et al., 2010, Sieg et al., 2010, Florén and Frishammar, 2012). In the process industries such collaborative behaviour, e.g. with equipment suppliers, is however nothing new (Aylen, 2010). By combining a product with service (service in the form of innovation), or vice versa, firms may improve both their bottom and top lines (Lichtenthaler, 2006). The conclusion is thus that it is important for a supplier to carefully examine its products and analyse how potential application development could support its product marketing and sales activities.

Regardless of collaboration mode, however, external collaboration as such has both advantages and disadvantages. Advantages include access to resources, economies of scale, risk and cost sharing, enhanced product development, learning, and flexibility (see for example (Grandori, 1997, Hagedoorn, 1993, Hamel, 1991, Kanter, 1989, Kogut, 1988). Disadvantages typically include loss of proprietary information, increased complexity in management issues, financial risks, increased resource dependence, loss of flexibility and antitrust issues (Doz and Hamel, 1998, Gulati, 1995, Hamel et al., 1989, Jorde and Teece, 1990, Kogut, 1988, Singh and Mitchell, 1996).

Although both the benefits and drawbacks of external collaboration have been discussed extensively, the literature seems biased in the sense that collaboration is usually pictured as being a good thing, while in reality the results of joint collaborative efforts may be both positive and negative, depending on the goals and circumstances of each collaborating partner (Cox and Thompson, 1997, Eriksson, 2008). This is apparent in the process industry, where joint collaboration can lead to major improvements in new process technology, but simultaneously allow "unintended knowledge transfer", as when core knowledge is spread to competitors via equipment manufacturers active on a global basis. So while the literature on external collaboration seems a feasible point of departure, our objective is to further theorize on why, when and how collaboration for innovation should take place between process firms and their equipment manufacturers.

3 The development of a theoretical framework

As external collaboration contains both positive and negative effects and outcomes, it seems justified to ask why, when and how collaboration should take place, rather than just assuming that firms should collaborate for innovation in new process technology/ equipment. Despite the objection that it may not be logical to start with potential outcomes from collaboration, we will nevertheless do so since this is probably where an industry professional would like to begin the journey.

3.1 Why collaborate: expected outcomes from collaboration

A collaborative mode in innovation is not something new in the process industries, where strong collaborative efforts with equipment manufacturers have always been customary. The external collaborative approach and co-development partnerships in innovation are nowadays often referred to as "open innovation" (Chesbrough and Crowther, 2006), talking about the use of purposive inflows and outflows of knowledge during a distributed development process across organizational boundaries.

The motives for defining the business objectives before partnering are stressed and tentatively listed as: increased profitability, shorter time to market, enhanced innovation capability, increased flexibility in R&D, and expanded market access (Chesbrough and Schwartz, 2007). To develop new or improved process technology/equipment as a collaborative effort with equipment supplier(s) and process firms is not a matter easy to decide upon, however, since such collaborative development may have strong strategic implications for both parties. The driving forces behind collaboration between process companies and equipment suppliers are not always obvious and may vary, because such collaboration involves both advantages and disadvantages for each collaborating partner.

From the process company's standpoint, collaborative development of new process technology allows the process firm to lower its development risks, assuming the alternative would be to develop in-house, without access to important knowledge provided by an equipment manufacturer. This appears especially important in the situation of a process firm's need for "one-off" equipment, i.e. when idiosyncratic equipment that do not exist on the market must be developed. Secondly, an early involvement of equipment suppliers may provide opportunities for adapted or even custom-made equipment that better fits the specific needs of the process firm. In a similar vein, collaborative development provides the process firm an opportunity to become an early user and thus get a "first move advantage" over competitors (Liberman and Montgomery, 1988). Finally, new or improved process equipment created through joint collaboration may speed up a process firm's product and process development.

Clearly, collaborative development has downsides as well. There is a risk that the firm's "core technology" may be passed on via equipment manufacturers to competitors (Kytola et al., 2006). As a consequence, proprietary knowledge may diffuse via equipment suppliers to main competitors, who are often customers to the same supplier. Furthermore, collaborative development projects, unless prompted by specific needs on the part of the process firm, may imply high coordination costs and resource utilization, where the latter clearly constitute an opportunity cost. The process firm also runs the risk of production disturbances when installing and testing equipment that has been jointly created. Finally, close collaboration with an equipment supplier may impose on the process firm a situation where it is "taken hostage", i.e. it constitutes a lock-in effect which may favor the equipment supplier in future purchasing situations (Kanter, 1989).

Equipment manufacturers are also exposed to both advantages and disadvantages when engaging in joint development of new process technology/equipment with a process firm. Advantages to the suppliers are several. Firstly, collaborating with a demanding customer frequently allows the supplier to improve its development capabilities and its understanding of customer needs (von Hippel, 1986). In a similar vein, access to the customer's ideas and partly tacit knowledge can sometimes be transformed into new or even patentable products. Secondly, both collaborating parties often finance joint development projects. Subsequently, the process equipment being developed can be sold to other firms as well, allowing the equipment manufacturer to leverage its NPD on "somebody else's budget" (Chesbrough et al., 2006). In addition, the new process technology being developed can typically be more customized with a collaborative arrangement, which increases customer satisfaction but also provides a good reference installation. Also, joint development allows a deeper and more intense relationship through mutual asset specificity. Last but not least, the opportunity and importance for the equipment manufacturer to develop and test prototypes in a real operating process environment setting is second to none.

Disadvantages to suppliers are not to be disregarded. Firstly, development of equipment which is too company-specific or idiosyncratic may have very limited application areas outside the specific collaborative project, and the equipment firm's alternative use of these allocated resources may be much more profitable in a company perspective. Secondly, failures in joint development and subsequent implementation may hurt the reputation of the equipment manufacturer, which is especially important in the often open and information-intensive sectorial communication. Finally, important internal or even proprietary knowledge critical to the equipment manufacture may "leak" via the process firm to other manufacturers of process technology.

Summing up: reviewing the above lists in the perspective of the previously presented list of business objectives (Chesbrough and Schwartz, 2007), one can interpret many pros as objectives or expected outcomes of importance of interest to be identified before a collaborative partnership is established at the innovation stage. Given that there are both pros and cons of close collaboration from each party's perspective, it seems justified to ask whether a win-win situation can be created in such collaborations, or if it is unavoidable that either of the parties will lose. The previously presented list of potential pros and cons has been compiled in an attempt to illustrate the complexity of collaboration between equipment manufacturers and process firms during the development stage of an equipment life cycle. It is, however, also intended to serve as a starting point for the creation of an empirically grounded and more complete set of expected outcomes in order to develop a benchmarking instrument that can serve as one guideline for establishing new collaborative and well-functioning relationships. If answering the why questions indicates that some sort of collaborative partnering arrangement should be desirable, it is now time to address the issue of when such collaboration should take place.

3.2 When to collaborate: picturing collaboration over the development stage of the equipment's life-cycle

If there is a motive to start collaborative development between an equipment supplier and a process firm, the attendant questions are how such development activities should be set up and further when such commitment during the development project's lifetime should be distributed to obtain a strong but lean development project. A project involving a very complex technology and also of a radical newness may span over a very long period of time in the process industries. Development cycles over 5-10 years are not uncommon if one includes the necessary time for implementation of the new technology in a new production plant.

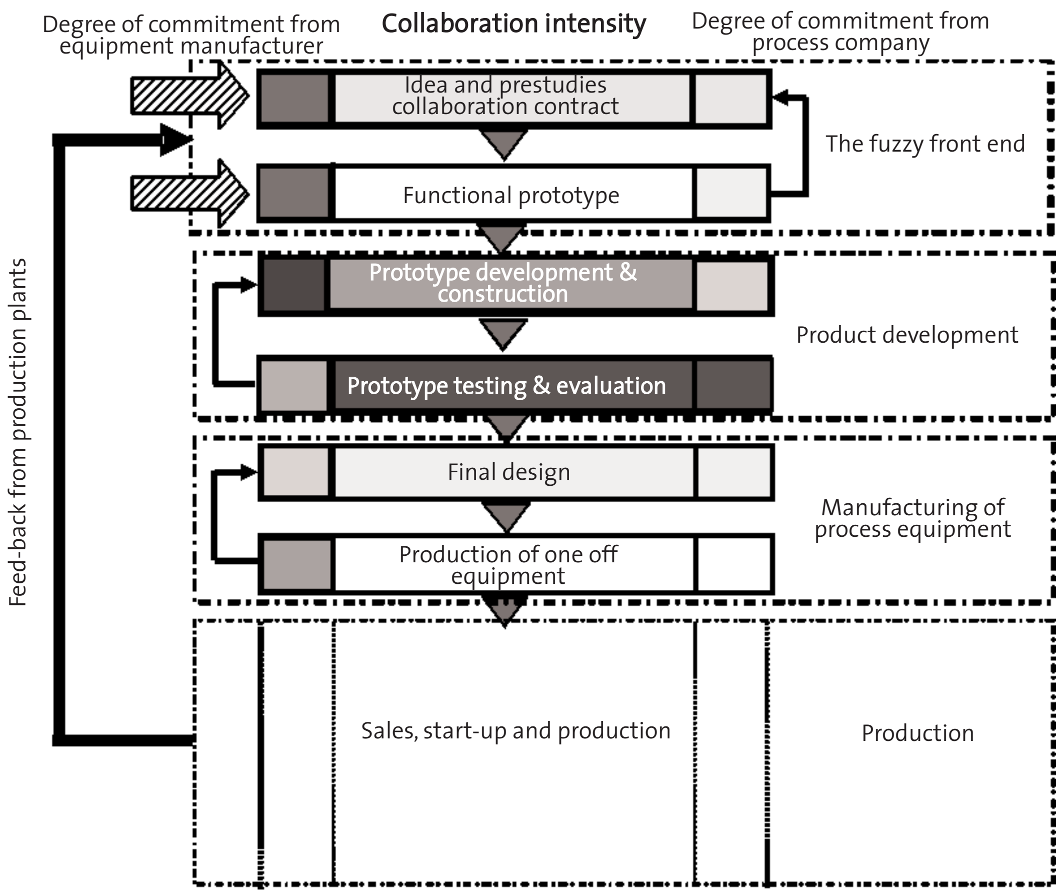
Figure 3 shows a conceptual model of collaboration over an equipment development stage of the life-cycle. The production part of the equipment life cycle will not be further discussed here but is presented and analyzed in depth by Lager and Frishammar (2010). As for Figure 3, the development process has been structured into three distinct phases: the fuzzy front end, product development, and manufacturing of process equipment. Each phase has been further divided into two sub-phases. The process company's commitment and the equipment manufacturer's commitment during the different phases and the collaboration intensities have been tentatively illustrated by different shadings (the darker, the stronger). It is thus to be observed that even if the degree of commitment is strong from both parties during different sub-phases, the collaboration intensity must however not necessarily be strong.

The shaded arrows symbolize necessary external input for the development work at the fuzzy front end. The large black arrow illustrates that necessary input from operating plants is also of importance for the development of new process technology and equipment. The iterative nature of development work is symbolized by the small arrows. How company commitments and their collaboration intensity ought to be in different kinds of projects for efficient project execution today and in the future needs to be further researched. It is also important to understand what sort of collaborative behavior is efficient during different phases of a project's lifetime. Since outcomes of alternative collaboration modes are difficult to measure, it is feasible to look for what is often called "best practice" or "success factors". The life-cycle perspective on collaboration presented in Figure 3 may then also serve well as a framework for studying *success factors for collaboration*, since they will presumably differ during different phases of the equipment development life-cycle.

Collaboration during the fuzzy front end phase

Development of new or improved process technology/equipment may be prompted by the equipment supplier's discovery and recognition of a need for such equipment on the market or, alternatively, individual process firms may in their strategic production and development plans have identified a need for a specific process technology that is not currently available on the

Figure 3 A conceptual model of collaboration over the development stage of an equipment life cycle



market. In both cases, process firms and equipment manufacturers need to engage in an array of important and interrelated activities. These include idea refinement and screening of ideas (Cooper, 1988a, Elmquist and Segrestin, 2007), early customer involvement (Gassman et al., 2006), senior management involvement (Khurana and Rosenthal, 1998), preliminary technology assessment (Kim and Wilemon, 2002, Verworn, 2006), and assessment of the NPD project vis-à-vis company strategy (Khurana and Rosenthal, 1997).

Development work in the early stages is typically exploratory with many iterative loops (Frishammar et al., 2011, Kurkkio et al., 2011). It is, however, important to articulate the needs of the process firm(s) and translate these into a product concept (Cooper, 1988a, Khurana and Rosenthal, 1997). A product definition should well represent the objective of the development process and is a statement of both technology and customer benefit issues (Montoya-Weiss and O'Driscoll, 2000).

Depending on the project's character, this is a phase when preliminary experimental tests take place, complemented in the process industries by modeling and simulation. Since this phase strongly affects future product performance and costs in the following development phase, it is important that the collaborative partners have carefully discussed and agreed upon product specifications and preliminary operating and investment costs for such equipment (Cooper, 1988b). The creation of a functional prototype is the next sub-phase when the equipment has been engineered and designed in order to study its functionality. Such studies can preferably be carried out at the equipment supplier's premises in order not to disturb the process firm and to stay in touch close to the design staff.

Collaboration during the product development phase

The different development environments for the development of process technology have been discussed in previous research (Pisano, 1997, Utterback, 1994), and in further research about the process innovation work process. The iterative loops start in the laboratory (at the equipment supplier's premises or in a process firm's laboratory), going further to pilot plant testing (at the equipment supplier's premises or in the process firm's laboratory) and further to demonstration plant testing. Because of the often necessary need for test material in larger processed quantities and a further need to handle the products from the testing, there is often a need for a "process infrastructure" that only a process firm can provide.

Taking a functional prototype into a production environment makes very strong demands on both the equipment supplier and the process firm (Lager et al., 2010). The potential operating disturbances to the firm's production processes must be carefully considered by both parties long in advance, and necessary risk analysis must have been carried out before testing starts. The privilege for the equipment supplier of operating untested equipment in such production environments must be acknowledged. How long such testing must go on depends, of course, on the character of each project and on the complexity of the process technology, but it typically takes more time than anticipated to develop robust equipment that is not oversensitive to production changes and disturbances. Now is also the time to study wear problems and other operating problems which always occur but are difficult to spot in advance.

Collaboration during the manufacturing of process equipment phase

After a successful collaborative product development phase, the commitment for the process firm typically becomes much weaker, see Figure 3. However, this is a collaborative phase when there is much important feedback from the process firm to the equipment manufacturer that can improve the final design. This can be in areas like designing equipment that is easy to operate and with the maintenance costs in focus. For the equipment supplier, this is a phase when the product development "work process" goes into a progressively more commercial phase and when there are not only strong contacts with the collaborating partner(s) but when marketing of the new equipment goes into a more aggressive phase. We may here have different scenarios, all focusing on the importance of getting a first reference installation to promote further sales:

- The process firm has already purchased the equipment for further installation in a new or already operating plant.
- The process firm may now discuss a possible purchase of such equipment.
- The process firms decide not to purchase the equipment, which puts the equipment manufacturer in a more difficult position.

Because of these foreseeable scenarios, process firms sometimes have to make preliminary purchase commitments. Summing up: Not only the overall time frame for a collaborative development project but the intensity of collaboration and commitment of company resources during different phases will vary between different collaboration projects. The previously presented driving forces and problems with collaboration during the development stage of the equipment's life cycle (see section 3.1) have already been tentatively arranged in life-cycle order, but they can now be directly connected to each individual phase of the equipment's life cycle. This will not only facilitate their use but they can also be connected to individual success factors that need to be identified and developed and which are also related to the different phases of the life cycle.

Turning problem areas from the previously presented lists of cons into success factors – a problem viewed from the opposite perspective always constitutes a success factor (Lager and Hörte, 2002) – it will be an interesting opportunity to study these success factors as independent variables and the drivers (expected outcomes) as dependent variables in further empirical research. The time span for the collaborative development of new or improved process technology/equipment is one dimension that may influence the collaboration intensity and thus also related forms for collaboration.

3.3 How to collaborate: selecting organizational forms for collaboration

Collaboration between an equipment manufacturer and a process firm may be arranged and decided on a project level, but may also sometimes have to be subordinated to other R&D or strategic considerations. The collaboration between equipment manufacturers and process firms may thus have a hierarchic dimension which is also well worth studying in further research. Holden and Konishi (1996) note that short-term, quick-gain, opportunistic behavior by firms is unproductive and will give them the reputation of being bad collaborators and will be counterproductive in the long term. Referring to the literature review on collaboration and alternative forms of collaboration, there are today an abundant number of different collaboration forms to choose among, each of them differing in the degree of collaboration intensity as well as in legal and other practical consequences. In collaborations between equipment manufacturers and process firms, may some forms be more or less suitable under different circumstances? It therefore seems justified to elaborate upon the criteria for selection of different forms of collaboration, i.e. the key contingencies that determine how collaboration should materialize.

Determinants for different forms of collaboration

There may be a number of possible criteria to consider when selecting a proper form of collaboration during the collaborative development of process technology/equipment. In a consideration of potential contextual determinants for selecting plant startup organizations, the newness of process technology, the newness of products, the complexity of technology and the size of installation are discussed (Lager, 2012). All of them are potential contextual determinants, but the time dimension previously touched upon could also be one candidate, since some collaborative developments may take a short time but others up to five to ten years. Nevertheless, we argue that "newness" and "complexity" are two key variables which could allow a deeper understanding of when different forms of collaboration are suitable.

Newness of process technology/equipment on the market

In 1982 the consulting organization Booz, Allen & Hamilton presented an investigation of product development performance which included the process industries (1982). They concluded that it was important to distinguish between different categories of new product development in order to better understand and position the company's product development efforts.

The newness of product development was considered in two different dimensions; "newness of the product to the market" and "newness of the product to the company". A matrix was constructed along those two dimensions, classifying newness on a scale from low to medium to high. The importance of a better classification of product development is now gaining acceptance in industry, and the Booz, Allen and Hamilton Product Matrix has also been used in the classification of different types of success measures for product development (Griffin and Page, 1991). Since this classification is usable both in industry and in academia, it creates a good communication interface (Cooper, 1988b).

In a classification of different kinds of process innovation, the "newness of process innovation on the market" has also proven useful in previous studies (Lager, 2002). In the categorization of collaboration projects between equipment manufacturers and process firms, "newness of process technology/equipment on the market" was thus selected as one important determinant, composed of the values low, medium and high. One way to define a concept is to make an intentional definition, trying to describe what is contained in the concept. Varying degrees of newness, from low to high, can in this manner be illustrated by examples below from two sectors of the process industries; the petrochemical and mineral industries.

- Low: Well-known process technology/ equipment available "off the shelf" through many equipment suppliers (a valve);
- Medium: Incrementally improved process technology/equipment (an improved cracker for crude oil);
- High: A radically new process technology/ equipment not previously used and possible to protect with patent (a new natural gas liquefaction plant).

Complexity of equipment/process technology

In the consideration of different contents of the concept "complexity", two alternatives were considered. First of all the "complexity in the development process" itself, which may result in more or less resources needed or different time frames for development, and secondly the "complexity of the product/system" to be developed. The latter alternative was selected because it was easier to grasp and comprehend before development starts. In a buyer-supplier relationship, the complexity of the equipment is one factor that has been recognized as a determinant for collaboration intensity; the greater the complexity, the greater the need for stronger forms of collaboration/cooperation (Eriksson, 2008, Olsen et al., 2005). The system scope dimension proposed by Shenhar & Dvir provided an important missing link (1996). Their original trichotomy has been modified to suit the Process Industry startup context better:

- Low: Only one process unit operation (a grinding operation)
- Medium: A process system including a number of unit operations (a blast furnace in pig iron production)
- High: A super-system of process systems (a large production plant, e.g. a new paper mill for paperboard production).

A matrix using the above presented dimensions was constructed and is presented below in Figure 4. Ought collaboration on innovation and other collaborative ventures between equipment supplier and process firms to take different forms and be conducted in different ways, all according to both the complexity of the equipment and newness of the equipment? The matrix can thus first of all be used to position collaborative development projects of different kinds to evaluate whether a collaborative approach is of interest at all.

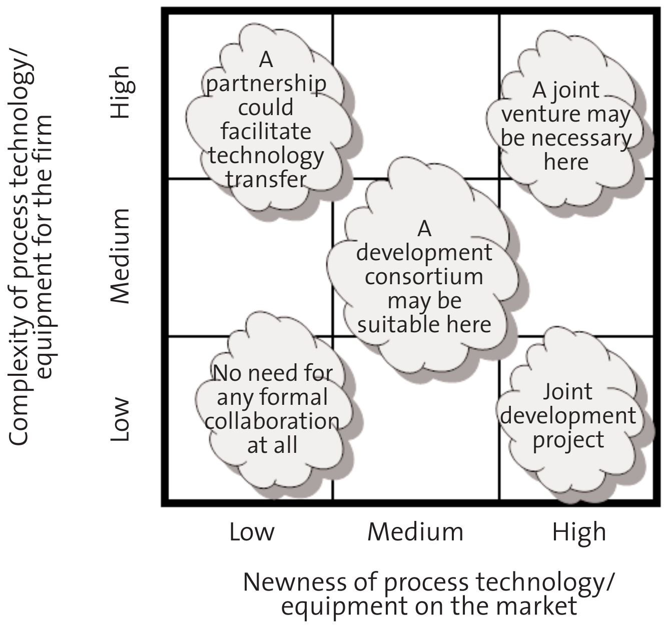
Secondly, how strong should such collaboration be (something denominated collaboration intensity in this article)? Looking at the different areas of the matrix, one could speculate that in the lower left corner the needs for formal collaboration are small if not non-existent.

On the other hand, going to the upper right corner, there seems to be a need for more tightly coupled arrangements, maybe even a joint venture. In the medium-complex area and medium-to-radical newness areas, a larger development consortium sharing costs and risk can be suitable. In the lower right corner, the ownership of the development results is something important to consider. Referring to the previous section, the theoretical point of departure, the suggested forms for collaboration can be looked upon as five propositions to be verified in further empirical research. The structural dimensions and scales from the matrix are retained but the number of areas has been reduced to five, a common practice in the analysis of sociological data (Barton, 1955).

Summing up: it seems first of all of interest to empirically research what kinds of collaboration are suitable in different areas of the matrix, and on which terms such collaboration should take place. Hence, different ideal types of development situations seem to call for different forms of collaboration.

In the previous section it was suggested that success factors for collaboration between equipment manufacturers and process firms may be related to a time dimension, more specifically to the life-cycle perspective of the equipment. Similarly, it is likely that not only the time dimension will influence such success factors but that the development project's

Figure 4 The collaboration matrix for the joint development of process technology/equipment. The matrix could first of all be used as a tool in the selection of alternative forms of collaboration. Different forms for collaboration in different parts of the matrix have been proposed. However, which collaborative forms are best suited in different parts of the matrix must be studied in further empirical research.



position in the matrix also would. The conclusions presented by Griffin & Page (1991) support this notion and suggest that the new matrix could be used not only to select suitable forms for collaboration but also to identify related success factors for such collaboration.

4 Implications for industry and academia

It is to be hoped that a solid theoretical framework has been constructed upon which future empirical research can be built. Nevertheless, our efforts are a first attempt to bring some structure into this important area of industrial enterprising. Starting with "grounded theory" where the pragmatic criterion of truth is its usability (Glaser and Strauss, 1967), and following later post-modernistic views that the value of knowledge is considered as a function of its usability (Lyotard, 1984), we encourage further testing of the usability of the proposed framework both by industry professionals and by academia.

4.1 In search of enhanced innovation performance with new process technology/ equipment.

The proposed framework and related discussions may first of all be used by industry and industry professionals as some sort of reminder of the importance of this subject area, which has been very sparsely treated in scientific journals or in other industrial publications. Hopefully it may shed some light and possibly initiate further fact-based discussions. The tentatively compiled lists of pros and cons can be used in internal brainstorming exercises at firms to create more company-specific drivers for collaboration in some sort of ranking order. In collaboration between equipment manufacturers and process firms, such a platform may be jointly discussed and agreed upon in order to ensure long-term and trustful collaborations.

Further on, when such collaboration should take place in different development environments is a question of the highest importance that should be discussed at the management level. The conceptual model of the development part of an equipment life cycle is one tool for the collaborating partners for deciding on necessary resource allocations during different stages of a development project's life cycle (degree of commitment), and not only that, but in discussions of how to successfully collaborate in practice during the different phases of the full development life cycle. Choosing among the different organizational forms for collaboration is something that must be partly guided by company-specific considerations. The proposed matrix can also be used in such discussions, never forgetting the future competitive implications.

4.2 A proposed research agenda

The development of this conceptual framework has resulted in a number of unanswered research questions, some of which have already been touched upon in the foregoing text. Three general areas of interest have however been identified, some of them also supplemented by more specific research questions not presented in ranking order:

A first critical issue concerns why firms should engage in collaboration in the first place. Should collaboration between equipment manufacturers and process firms take place at all? What are the expected outcomes from such collaborations? Clearly, both parties will experience and evaluate outcomes differently and also differently for individual projects.

A second critical issue concerns when to collaborate. What collaboration intensity is required during the development phases of an equipment life cycle? It is reasonable to believe that different project conditions and collaboration strategies need different collaboration intensities over the full life-cycle of process technology development.

It is also justified to ask how a mutually efficient collaboration between equipment manufacturers and process firms takes place, using the notion of *success factors for collaboration*. Arguably, such success factors will differ during different phases of an equipment development life cycle. *Referring to the front-end stage of collaboration, future studies should address* how an equipment supplier can secure an early input of the very long-term future product and process needs process firms may have for new equipment. How to get and secure input from operating plants that may give ideas and incentives for new product development is another important issue. Similarly, how to secure the input of new ideas from the equipment supplier’s vast number of employees who in their daily work have contacts with people in process firms.

For the process firms: should they be involved at all in this equipment development business and on what conditions – what are the possible incentives? *As far as actual development goes, a first important issue to consider* is how to arrange a win-win collaborative development. How can equipment suppliers “serve” their multiple customers in the best way without breaking someone’s confidence? It is also important to consider how to arrange collaborative development and tests that take a fair amount of resources from both parties, and how to handle the immaterial property rights and licensing in a manner acceptable to both parties. *Manufacturing issues cannot be forgotten either.* Specifically, how to develop flexible equipment that can serve different customers and how to develop equipment/ service concepts during the development phase that can serve both parties well.

A third critical issue concerns how to collaborate. What kind of collaboration between equipment manufacturers and process firms should be chosen under different circumstances and what are the possible determinants for such a selection? The matrix presented here is a feasible starting point and a tool for selecting different forms of collaboration.

5 Conclusions

A theoretical framework has been constructed based on the input from a review of previous publications related to this subject area, a review of collaboration concepts, and some practical previous experience from the authors and some industry representatives. This article can hopefully provide both theoretical insight and practical guidance on how process firms and equipment manufacturers could address the challenges posed by joint collaboration. Its main contribution and purpose is thus first of all to stimulate industry professionals in their search for enhanced innovation performance for the collaborative development of new process technology/ equipment in the process industries. Secondly, the framework is intended to provide a platform for further research into this area, which is of the utmost importance to effective R&D management in the process industries. The proposed framework includes a discussion of expected outcomes for such collaboration and a preliminary list of pros and cons from the perspectives of the different parties. A new conceptual model for the full life cycle of process technology/equipment development is presented, relating potential drivers for collaboration and success factors to be investigated to different phases of the development life cycle.

Furthermore, a classification matrix for collaboration has been constructed using the dimensions “complexity of equipment” and “newness of equipment” as determinants. The matrix is introduced as a part of the theoretical platform, to be used in the selection of alternative forms of collaboration and in the further development of success factors for such collaborations.

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Research Paper

Opportunities for- and configuration of foreign innovation: a case study of multinational companies in China

Jan Henning Behrens*

* University of Kassel, Faculty of Economics, Kassel, Germany,
Janhenning.Behrens@wirtschaft.uni-kassel.de

China has made significant progress in terms of economic development and market based reforms within the last twenty years. The country is no longer limited to a cheap production location for the rest of the world. It became a promising market with expanding capabilities for foreign direct investments (FDI) and new product development (NPD). Though Chinas NPD potential is being recognized, our knowledge about NPD-processes of foreign companies in China remain scarce. This paper contributes to research limitations about foreign innovation management in China. After a short literature review about international innovation management with a special focus on China, we present a secondary data analysis about innovation activities in China from a macro-economical perspective. We use actual data from the OECD and others to develop this macroeconomic framework about China as a (possible) place for innovation. Secondly, we augment this macro-economical perspective by a functional management perspective. We tackle the how- rather than the if-questions of foreign innovation management in China. These questions have been neglected in current research. Based on existing evidence about innovation activities of foreign companies in China we develope a case study about two German companies in China. The first company has just begun with it's innovation management in China. The second company has more than ten years experience with innovation management in China. Both companies are highly successful with their activities in China as indicated by growth rates and annual R&D budget. By comparing these two companies, we gain insights about the focus of foreign innovation management in China. We develope managerial implications for foreign companies operating in China according to maturity of their innovation management.

Introduction

Traditionally, China is no place for innovation. The country had been isolated for the rest of the world until the end of the 70'ties; intellectual property right (IPR) protection is still limited; many of the countries' scientists have not (yet) reached international qualification standards; most Chinese researchers speak Chinese only and cultural differences between 'the west' and China couldn't be greater (Zedtwitz et al., 2007). So, *why would any researcher or practitioner tackle aspects of innovation in China?*

The answer seems to be simple and challenging at the same time: China changes its future growth plans from simple technology transfer and mass production towards indigenous innovation. It began to 'climb up the value chain' which will eventually lead to more complex and more technology-advanced products and higher capabilities. (Howell et al., 201 0; Schaaper, 2009; ChinaDaily, 2010; Boutellier et al., 2008). Considering, that innovation has been identified as a main element for sustainable and competitive growth for any country and company (UNCTAD, 2010a; Buckley and Casson, 2009; Schumpeter, 1936), China most certainly began to set promising priorities for its future. Combining Chinas indigenous innovation activities with the market size of 1.3 billion consumers, provides interesting opportunities for both, researchers and practitioners. Not surprisingly, Boutellier et al. (2008) explain that China becomes nowadays one of the most promising future markets for innovation.

However, our knowledge about China as an innovative nation remains limited for three reasons. Firstly, China had been closed for the rest of the world until the late seventies. Access to information from outside scholars was not possible (Simon, 2007). Secondly, access to the nations' technological development plants is still highly restricted and mostly not compatible with OECD standards. Thirdly, existing studies about international innovation management still concentrate on the triade regions (USA, Europe and Japan); not on emerging markets such as China. In fact, any innovation activity in China is in an early development stage and the nation has only recently began to focus on indigenous innovation (Simon, 2007; UNCTAD, 2010b; Liu, 2008).

Consequentially, studies about (foreign) innovation in China are scarce. The few existing studies are descriptively (Boer et al., 1998), not analytically. They also focus more on macroeconomic perspectives (Walsh, 2003; Simon and Cao, 2009). HAN (2008) explains: "(…) *the body of knowledge on managing foreign R&D [research and development] in China is still in its infancy, considering the limited amount and scattered focus of academic contributions.*"

In this Paper, we contribute to fill this research gap. We will introduce the issue of innovation activities in China from a foreign companies' perspective. We offer a conceptual and empirical study about innovation management of multinational companies operating in China. As theory in international (innovation) management always suggests to integrate environmental specifics (Dülfer, 1982; Macharzina, 2010), we include a macroeconomic analysis of the Chinese innovation system.

Theoretical framework

In this section, we will provide a structured overview about existing studies and adequate theoretical perspectives about our research focus. This approach will eventually lead us to our research questions.

Most existing studies about international innovation concentrate on *macroeconomic perspectives within the traditional triad region* (USA, Europe and Japan). These studies deal with the level of international R&D activities and its impact on socio-economical issues within a national scale (Meyer-Krahmer and Reger, 1996; OECD, 2010b; UNCTAD, 2005; UNCTAD, 2010a; Narula and Zanfei, 2005; Belitz, 2010; Cantwell, 1995). For example, Narula and Zanfei (2005) concentrate their research on the dominating role of multinational enterprises (MNE) within global research and development activities. Belitz (2010) focuses on the R&D internationalization of German MNE based on patent data. Mansfield et al. (1979) integrates the perspective of international R&D activities from a US-point of view. Some studies focus on international innovations from a *microeconomic perspective*. They explore the management of innovation of companies within a foreign country. For example, Gassmann (1997) explored the framework, the opportunities and the organization of international R&D projects based on 89 personal interviews. Reger (1997) explored the coordination and strategic management of international innovation processes based on four case studies and additional secondary data. Recent studies include the work of Gassmann and Keupp (2005) who focus on motives, organization and human resources within international innovation activities.

Few studies concentrate on innovation activities in China, being an emerging market (Von Zedtwitz, 2004; HAN, 2008). Most of these studies focus on a *macroeconomic perspective*. For example, Walsh (2003) describes the increasing innovation capabilities in China. He concludes after 36 interviews, that Chinese innovative capabilities are likely to become important for the rest of the world in the nearby future. Huang et al. (2004) analyze the general political and social framework conditions for innovative growth in the Chinese nation. Based on a literature review and secondary (national) data, the authors identify five categories for Chinese major innovation policy demands (similar: Liu and White, 2001). Simon and Cao (2009) help us to gain valuable, but also macroeconomic orientated data about the development of (high qualified) human resources in China. Bielinski (2010) analyzes China as a possible place for R&D from an economical-geographical point-of-view. Schaaper (2009) develops OECD-related indicators to measure the Chinese national innovation system which remains highly in-transparently for researchers outside of China.

1) secondary data is available on the MOST- website at least until the year 2007: http://www most.cn/eng/statistics/2007/index.htm

These studies provide us with a basic understanding about the framework conditions for innovation in China. However, questions about the (functional) management of (foreign) innovation in China remain largely unanswered.

The few existing studies which focus on a micro-economical perspective can be categorized into (1) Chinese or (2) foreign companies innovation management. For example, Boer et al. (1998) developed a case study to identify challenges of a Chinese Central Iron & Steel Research Institute. Xue and Tschang (2005) analyzed the structure, development and determinants of the Chinese software industry by conducting 34 interviews within Chinese companies. Studies focusing on foreign companies, remain rather descriptively than analytically. For example, Gassmann and Han (2004) conducted 18 interviews with R&D manager to explore general challenges of foreign R&D activities in China. Von Zedtwitz (2004) identified by conducting 37 in-depth interviews, main tasks, locations and organisational forms of R&D activities from multinational companies in China. HAN (2008) identified by about 100 interviews that R&D professionals, intellectual property rights and cooperation with Chinese universities are the main managing tasks for any foreign companies' R&D activity in China.

Moreover, most of these studies are not based clearly, on economical theories. For example, Boer et al. (1998) summarizes main challenges for R&D managers in China. He suggests to "apply Western R&D management theory in China" in the future (Boer et al., 1998, p. 195). Newer studies, like HAN (2008) provide insights into foreign companies' R&D activities in China. Han recommends the integration of strategic management theories in future research. The paper from Zedtwitz et al. (2007) investigates motives, growth and locations of foreign R&D in China but does not relate to economical theories. Other studies do not mentioned theoretical approaches at all (Walsh, 2003; Wu, 2000).

The rareness of management theories within (foreign) innovation management in China may be explained by the novelty of the research subject. As indicated in our introduction, China had been closed for the rest of the world until the late seventies. Since the eighties, China began slowly with market based reforms (Fischer and Von Zedtwitz, 2004, Walsh, 2003; Piotti, 2009). Only recently, China began to 'climb up the ladder' in terms of technological advanced production. Such settings require an explorative research method in order to find (not to test) causalities and theories.

To our understanding, Johanson and Vahlne (1977) from Uppsala School provide an adequate model within the research context for the following reasons. According to the model of Johanson and Vahlne (1977), companies begin internationalization by export. If the company gains positive export experience (e.g. market shares), it will expand its foreign market commitment by foreign production and, eventually, by foreign innovation activities. Johanson and Vahlne (1977) explain this process of internationalization by an incremental learning curve in foreign markets as illustrated in table 1.

In fact, most foreign companies begin internationalization towards China with sales and marketing (Walsh, 2003; Piotti 2009). They continue to internationalize their activities by the construction of production plants in China (Liu, 2008). Today, foreign direct investment (FDI) is rising significantly. China receives nowadays the second largest amount of worldwide foreign direct investments (UNCTAD, 2010b). Hence, foreign companies started incremental innovation activities, e.g. quality assurance within existing Chinese production lines or incremental product adoptions according to Chinese customers' demands. Since 2000, the number of R&D-centers increased almost constantly (Sigurdson, 2005; FAZ et al., 2008; Walsh, 2003; Festel et al., 2005; Boutellier et al., 2008; HAN, 2008; Von Zedtwitz, 2004). For example, HAN (2008) found evidence about 800 foreign R&D-centers in China; the OECD (2007) lists 750 centers.

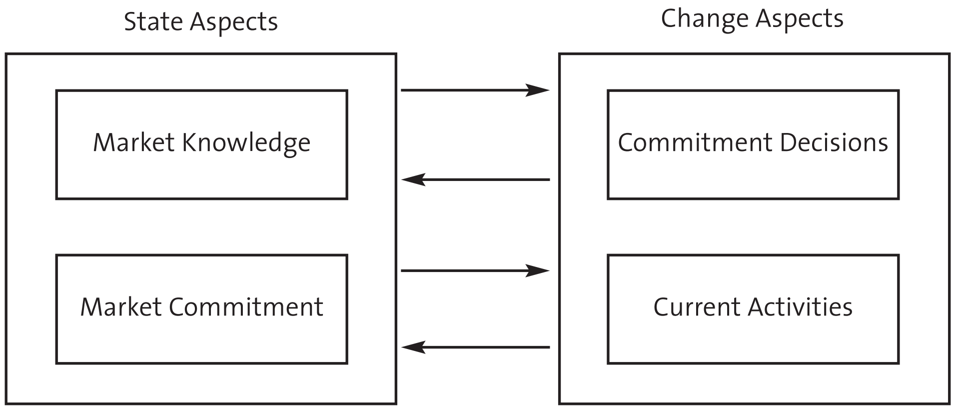
Research questions and methodology

As specified in our theoretical framework, existing studies about international innovation management in China are scare. They tend to be rather descriptively than analytically and they concentrate on macro-economical (national or regional) rather than micro-economical perspectives like the functional management of innovation within companies. Nevertheless, existing studies identify research limitations and develop our own research framework. Hence, our research question is:

How do foreign companies manage their innovation activities within the specific Chinese environment (Potentials and confguration of foreign innovation activities in China)?

We begin our analysis with a *macroeconomic*

Table 1 Internationalization of companies through incremental learning (Johanson and Vahlne, 1977)



Source: Johanson; Vahlne, 1977, page 26

perspective to gain a basic understanding about the Chinese innovative environment. Understanding a foreign environment, is an important requirement in international management theory (Dunning and Lundan, 2008; Grant and Nippa, 2006). By using these macroeconomic insights, we aim to learn more about opportunities for and configuration of foreign innovation activities in the specific Chinese environment.

Based on that macroeconomic perspective, we continue our analysis with a *microeconomic perspective*. As analyzed in our theoretical framework, it remains unclear, *if* and *how* foreign companies benefit from Chinas development towards innovativeness. Hence, we aim to explore within our microeconomic perspective the functional management of innovation from foreign companies which operate in China. Both perspectives, micro- and macro, have a coherence which we illustrate in the next table.

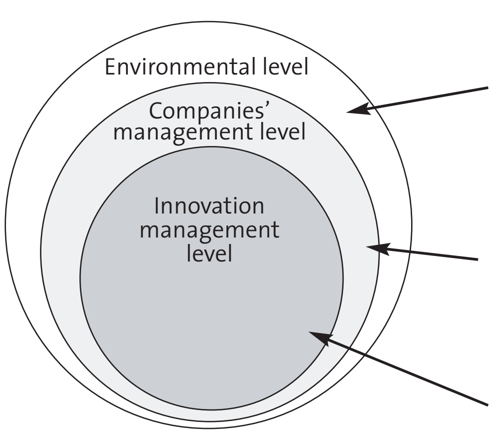
The table 3 illustrates three possible level of analysis: the environmental level; the companies' level and the innovation management level within the company. In this paper, we focus on the environmental-, and the innovation management level. We do not analyze the companies' general management level (including foreign direct investments), because literature already provides a broad range of studies about this issue.

Regarding our methodology, we firstly collected secondary data provided by the Organisation for Economic Co-operation and Development (OECD) and by the European Patent Office (EPO). The collection of these secondary data allows us to understand the environment for foreign innovative activities in China according to the table above. Secondly, we collected primary data in China according to our research interest. We did not use a quantitative approach to collect primary data because innovation activity in China is a relatively new phenomenon which points out an explorative (see theoretical framework). Hence, we do not test existing theoretical evidence to identify causalities ('relation-orientated method') but we aim to identify causal mechanisms ('mechanism-orientated method')[1]. We find evidence in the literature which supports this methodology. For example, HAN (2008) explains that future explorative studies are necessary in order to understand the under-researched field of global R&D investment within emerging markets. Boutellier et al. (2008) conclude that qualitative methods (especially semi-structured in-depth interviews) are purposive for research on foreign R&D in China.

Based on existing theoretical evidence about international innovation in China, we designed an interview guideline to arrange one-hour semi-structured in-depth interviews with foreign companies in China. Central questions included the description of the interviewees working environment especially in terms of innovation activities in China; the development of the Chinese innovation system from a foreign companies' perspective; the collaboration and/or cooperation between foreign companies and Chinese universities in terms of innovation and the functional management of innovation activities in China (past, today and future, including organizational and human resource aspects).

1) For a more general detailed discussion about the approach of qualitative methods, we recommend Gläser and Laudel (2009)

Table2 Level of analysis for foreign innovation activities in China



The Chinese innovation system
- Economic framework
- Research and development expenditures
- Availability and quality of resources
- Patents

MACRO-economic level

Companies management level
- Sales and marketing
- Production
- (Foreign Direct) investments

Type and extension of foreign innovation activities in China (FIAC)
- Potential of FIAC
- Management of FIAC

MICRO-economic level

We recorded all interviews and transcribed them afterwards, resulting in 1300 pages of data for further qualitative analysis. After transcription, we made all personal data anonymously. This has been an important postulation to create a trustful interview atmosphere and to get valuable information from each interviewee. After anonymization, we imported all data in MAXQDA for further analysis. We structured our data by the development of a coding system (Mayring, 2010a; Gläser and Laudel, 2009). We use our previous understanding about international innovation activities to build a first (theoretical based) coding system within MAXQDA. We added this theoretical based coding system with our findings within the interviews by complementing, specifying and adding (sub-) categories. Consequentially, not use the grounded theory approach,because we have a previous understanding about international innovation activities. From a data triangulation point-of-view, we included 20 (string and numerical) variables mentioned during the interviews. These variables help us to validate answers of the respondents (e.g. in terms of years of experience with innovation activities in China of the interviewee).

Data collection

For secondary data collection, we used the Main Science and Technology Indicators (provided by OECD) and patent data from the EPO. To some extent, this becomes difficult because China does not always follow OECD-guidelines, especially in terms of R&D (OECD, 2008). Thus, we limit our indicators to available data such as growth domestic expenditure for R&D; human resources in R&D as well as patent data. Moreover, we concentrated on data about researchers, not on R&D personnel. According to the Frascati Manual, researchers are experts in terms of innovative activities, whereas R&D personnel includes also supportive and administrative staff for research activities (OECD, 2002).

For primary data collection, we arranged semi-structured-in-depth-interviews between September and November 2010. With respect to time and financial restrictions, we concentrated our data collection on the greater area of Beijing. Beijing and Shanghai are the main centers for (foreign and local) innovation activities in China (Von Zedtwitz, 2004, Greatwall, 2002). We crosschecked our location preferences by the German Company Directory (GCD). The GCD is a database, powered by the German Chamber of Foreign Trade, which lists more than 4.300 German companies in China, sorted by location and industry type. According to that database, most German manufacturing companies are located in the greater area of Beijing or Shanghai.

Our target group of possible interview partners have been German companies in the industrial (manufacturing) sector. We eliminated the service sector because characteristics of these industries are too different from the manufacturing sector. We decided not to specify one certain industry-type as the possible unit of adequate interviewees is limited due to the novelty of foreign innovation activity in China. Furthermore, literature does already provide case studies from one company about R&D in emerging markets (for the case of General Electric: Dubiel (2009); for different, single company based cases about global innovation management: Boutellier et al. (2008)).

We extracted the number of relevant branches within the manufacturing industry by the following key indicators. Firstly, we chose only industry types with a high level of international R&D activities. According to Belitz (2010), the German chemistry-, pharmaceutical, machine- building- and the automotive industry have the highest degree of international R&D activities within all German manufacturing industries. The classification of OECD (1997) presents similar results for all OECD countries. Secondly, we chose industries, which are more likely to grow in China due to the Chinese' government plans. The Chinese government recently announced to strengthen its own innovation capabilities (indigenous innovation) by a special strategic promotion of the foreign and domestic high-and medium tech industries (Schaaper, 2009). Such a governmental promotion (e.g. by tax incentives and adequate infrastructure) may result in a technology pull for overseas medium- and high-tech industries towards China. In fact, many high tech companies, such as BASF, SIEMENS or MOTOROLA already have R&D units in China and they plan to increase these activities in the nearby future (Boutellier et al., 2008, Wuttke, 2005). Hence, we focused on the German chemistry-, pharmaceutical, machine-building and automotive industries for data collection. Within these specific industries, we concentrated only on companies which have an R&D center in Germany and which also have (or at least plan) innovation activities in China.

We used three main communication channels to identify suitable interviewees within our predefined target group. Firstly, we had exclusive access to the German Company Directory by the German Chamber of Foreign Trade. We filtered the existing 4.300 German companies in the database according to (1) our preferred industry and according to (2) location as stated above. Next, we invited 150 companies named in the database to join our research project. We came up with only 6 participants (response rate: 4%). The low response is not surprisingly given the sensitivity of the research subject (innovation activities in China) and the importance of 'Guanxi' in China. Han (2006) explains: "*Most of the companies are not willing to reveal deep insights into their R&D strategy and issues in China*" (Han, 2006, p.16). Secondly, by building up our own Sino-German research network, we gained another 26 participants for personal interviews in the greater area of Beijing. Thirdly, we gained a 'snowball-effect' during data collection phase in Beijing. We asked each interviewee for additional possible interviewees within his or her own network to join our research project. As each interviewee became familiar with the interviewer and the research topic itself, the acquisition of new interviewees was high (about 33%). We continued to collect data after two month in Beijing by phone conferences from Germany to China. Successful phone conferences have been almost entirely recommendations by former personal interviews in China. The acquisition of new interviewees for Sino-German phone conferences was close to zero percent due to the sensitivity of the research subject and the lack of geographical proximity. In total, we came up with 42 exploitable interviews.

We invited each possible interview partner by phone and by e-mail to join our study. We explained in letter our research focus and we described suitable interview partners (e.g. 'we are looking for innovation and/or business development managers from German manufacturing companies operating in China'). To build up a trustful relationship between the interviewer and the interviewee, each interview lasted minimum one hour. Building a trustful relationship is one of the most important pre-settings to secure adequate information flow from the interviewee to the interviewer (Mayring, 2010b).

Findings next

Secondary data findings

Based on our secondary data analysis, we find support for Chinas rise of innovation capabilities.

For a structured analysis, OECD and other sources suggest an input-output model to measure a countries' innovativeness (Grupp, 1997; Diez and Kiese, 2006; Schaaper, 2009). Thus, we begin our secondary data analysis with available input indicators (Chinese growth domestic expenditure for R&D and human resources in R&D), followed by Chinese patent activities as an available output indicator.

The Growth Domestic Expenditure for Research and Development (GERD) is an important and available input indicator. GERD in China has been risen from 0.5% in 1995 up to more than 1.5% in 2008 OECD (2010b). Even though this rise is significantly, it is still below of must OECD countries (table 3).

Our next input indicator is the level of Chinas' *absolute R&D expenditures per year*. It does not surprise, due to the nations geographical dimensions, that China already exceeded Germany since 2004 (table 3).

The next input indicator is the *absolute number of human resources* in research areas. This indicator does also support the hypothesis of Chinas' sustainable growth of innovative capabilities (table 5).

Regarding output-indicators we used patent data only. Other, reliable data about China are scarce within OECD-database and official Chinese ministry websites (Bielinski, 20 10).[1]

The Chinese Ministry of Science and Technology (MOST) provides data about *patent applications* in China (table 6). By collecting these data within a four-year-period, we are able to identify a positive trend of patent applications in China. Moreover, there is a significant difference between the strong rise of Chinese (red) and foreign (grey) patent applications. Some authors explain this difference by the level of sophistication (Gassmann, 2008). Foreign patent applications tend to be "real" inventions whereas Chinese patent applications tend to be rather design and model orientated.

Moreover, the patent indicator *"foreign ownership patents of domestic inventions"* (FOPD) provides insights about foreign innovativeness in China (table 7). This indicator has been risen significantly since the turn of the century (OECD, 2010a).

The European Patent Office (EPO) counts 2.000 of FOPD by the year 2007.[2] Even though the rise of these patents is high, its level is still low within international comparisons.

Primary data findings

Based on our available primary data, we have chosen two multinational companies for a comparative study. Both companies belong to the manufacturing industry, they have a German origin and they are highly involved in innovation activities in China. Both companies have truely positive experiences in terms of the research subject. However, one multinational has just started innovation activities in China three years ago; the other multinational has more than ten years of experience with innovation activities in China. As such, we are able to analyse innovation activities of a foreign company in China in an early stage of development ('A9' with three years of experience) in comparison with an established foreign R&D center ('A24' with ten years of experience).

A9 has risen its' number of R&D personnel in China from 15 people to 150 people in only three years. The company has an annual budget for R&D activities in China of one million Euros. The second multinational, A24, has ten years of experience within innovation in China. A24 introduced R&D activities in China by the year 2000 with 50 employees. Until 2009, it has risen its' R&D staff up to more 1.000 employees and an annual R&D budget above 500 million Euros (5 billion yen). Both multinationals evaluated foreign R&D in China as highly positive and important for the companies' future strategy. We summarized more data about both multinationals in table 8.

In line with qualitative data analysis (as explained in the chapter "methodology"), we developed a coding system based on existing theoretical evidence and empirical data. Hence, we developed two main categories: *Opportunities* for German industrial companies within the Chinese innovation system (following the macroeconomic approach) and *configuration* of foreign innovation in China (following the microeconomic approach in terms of a functional management).

The absolute number of codings within each interview indicates a first relevance of the interviews' content. As indicated in the table below, both interviewees, from A9 and A24, concentrated on the configuration of foreign innovation in China in their statements (microeconomic perspective). A24 dominated the arguments, which is not surprisingly due to the companies' 10 year R&D experience in China (see table 10).

By developing sub-categories, we are able to analyse opportunities and configuration of foreign innovation in China in greater detail (see table 10).

Within the first main category *opportunities*, we can distinguish between three sub-categories:

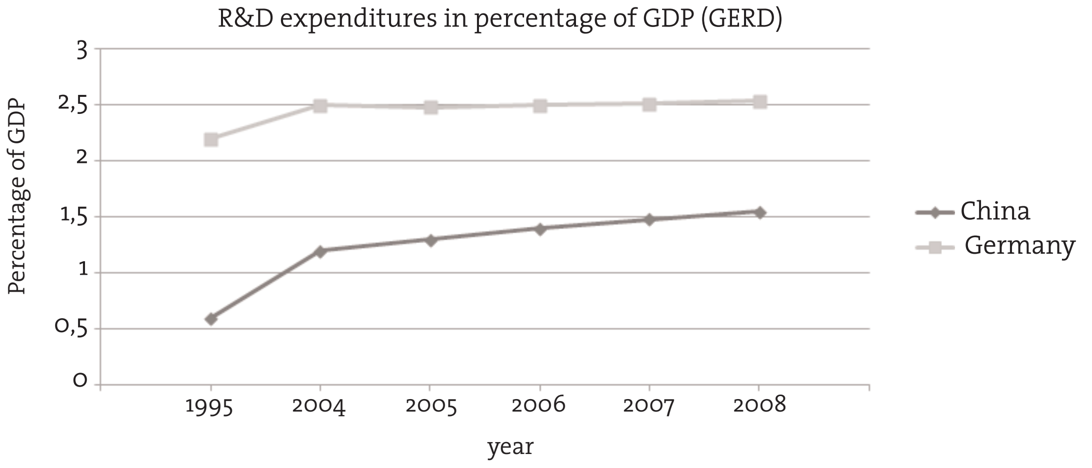
- the position of foreign companies within the Chinese Innovation System,
- internal opportunities for foreign companies operating in China (in terms of R&D),
- external opportunities for foreign company operating in China (in terms of R&D).

Within the second main category *configuration*, we can distinguish between four sub-categories: (see table 10)

- (evolutionary) development of foreign R&D

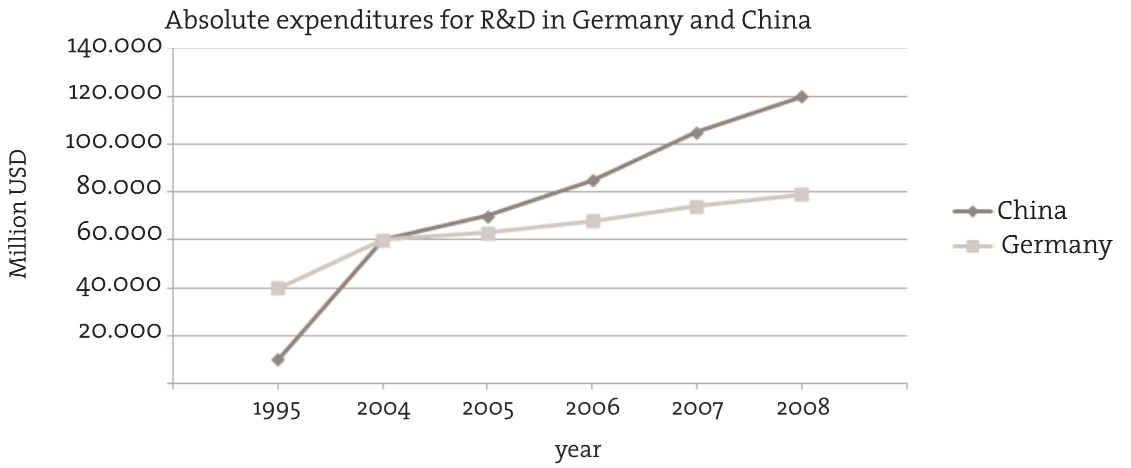
1) Last available data about statistics in China by the Ministry of Science and Technology (MOST) are from 2007 (http://www.most.cn/eng/statistics/2007/index.htm)
2) No later data available in the OECD database.

Table 3 R&D expenditures in percentage of GDP (GERD)



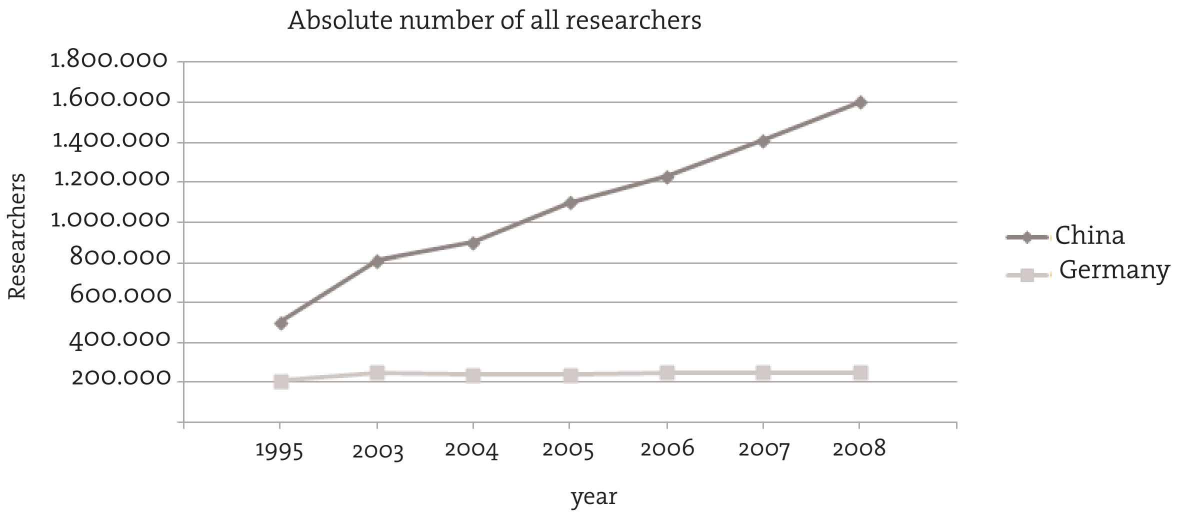
Source: Own figure according to OECD, 2010: Main Science and Technology Indicators, p. 25.

Table 4 Absolute expenditures for R&D in Germany and China



Source: Own figure according to OECD, 2010: Main Science and Technology Indicators, p. 24.

Table 5 Absolute number of all researchers



Source: Own figure according to OECD, 2010: Main Science and Technology Indicators, p. 30-31.

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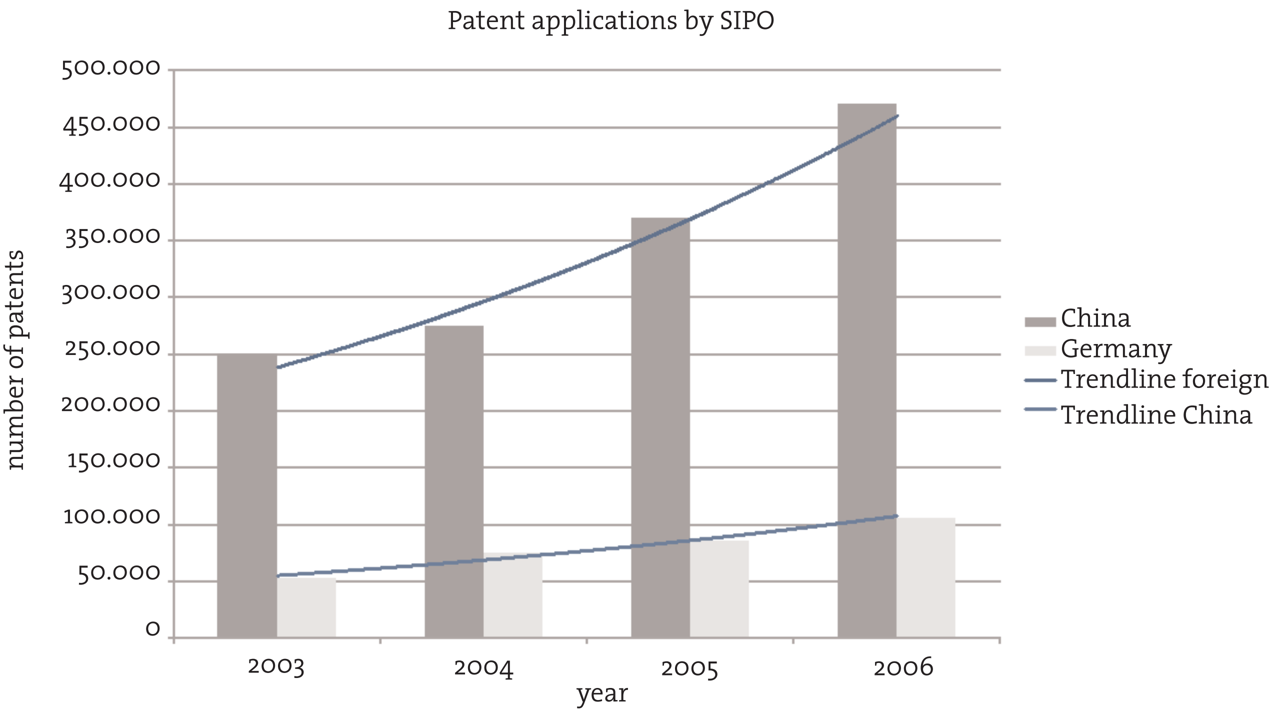
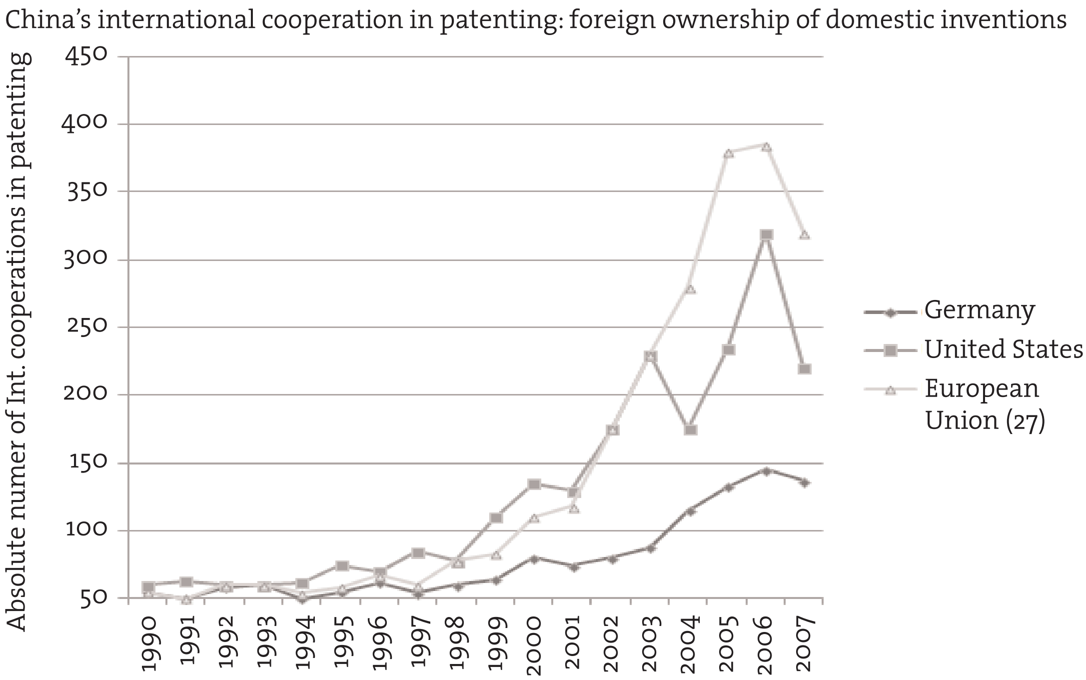
Table 6 Patent applications (foreign and domestic) by the Chinese Intellectual Property Office



Source: Chinese Ministry of Science and Technology, 2011, MOST (lastet available data).

Table 7 Foreign ownerships of domestic inventions (year 1990 until 2007)



Source: OECD statistics extracts, patent applications at EPO

in China,
- external management of foreign innovation in China (e.g. industry-university cooperation),
- internal management of foreign innovation in China (e.g. organ-isational forms and human resource management)
- typologies of foreign innovation activities in China

Using a code-matrix relational analysis, we identified *external opportunities* to be more relevant than internal opportunities (yellow labels in the table above). Furthermore, we identified *internal configuration* to be more important for multinationals than external configuration (table 10). Thus, we focus our further analysis on *external opportunities* and *internal configuration* of foreign innovation activities in China.

a) External Opportunities of foreign innovation activities

Regarding *external opportunities*, we compared A9 and A24 to find similarities and differences for successful foreign innovation in China.

Both multinationals (A9 and A24) have emphasized that the market is the main motivation to enhance R&D activities in China. Both companies underline the existence of great opportunities within the Chinese market for current and future innovation activities. We summarize the main arguments of A9 and of A24 in table 12 and 13.

According to table 12, A9 has some innovation activities in China so far, however, the potential is not yet fully developed.A9 indicates that it still need to become independently from their German headquarter in order to fully participate from Chinese innovative (market-) developments. A9 is trying to convince its' headquarter in Germany to put more emphasis on innovation activities in China due to the requirements of the Chinese markets. On the contrary, the argumentation of A 24 is more sophisticated as indicated table 13:

A24 is an active innovation player in China for more than ten years. Their main focus is not (any more) to convince its' headquarter in Germany to support inno-vation activities in China (as A9), but to maximize profits in China by localization The interviewee states, that China is one of the most dynamical markets in the world which eventually will lead to innovation activities. Even though China may not be capable enough today for all kinds of innovation activities, China will eventually become one of the leading innovators of the world, according to the interviewee. A29 strongly emphasises (far more than A9), that foreign companies need to localize innovation activities in China to remain competitive and to become fully integrated into the dynamical Chinese markets. Though the interviewee admits, that knowledge from foreign technologies can in fact get lost to Chinese competitors during the process of localization, foreign companies will eventually lose the total Chinese market if they don't localize R&D.

We will discuss these two different argumentation lines of A9 and A24 within the chapter discussion.

b) Internal configuration of foreign innovation

Within internal configuration of foreign innovation activities in China, we identified technology (-scouting); human resources and "organization" as key aspects. In this paper, we will focus on the aspect of technology. (An analysis of all other key aspects like organization and human resources seems likewise interesting, but too comprehensive for one paper).

Even though both companies explain that the technology is very important for innovation in China, their managerial focus remains quite differently.

A9, being the company with less experience in China, is a highly technology orientated company. Being technology-guided, A9 introduced innovation activities in China mainly to reduce costs when redesigning products for the Chinese market. By redesigning its' products, the company reduces costs of the products to remain competitive while keeping standards high quality. A9 explains that cooperation with local universities is also important to enhance (cost-driven) product development. We present main quotations of A9 about the technology aspects in table 15.

On the contrary, A24, having ten years of innovation experience in China, does not enhance technological capabilities in China due to cost reasons. Their innovative activities in China are focused on a 'technological radar system' which aims to identify new technology developments in China. According to A24, foreign companies should increase their technical capabilities in China because the nation is likewise increasing its' innovative capabilities significantly. Consequentially, foreign companies are well advised to catch up with Chinese innovation developments by enhancing their

Table 8 Data about the companies for the case study (“IA” = Innovation activity)

Type within the Chinese Innovationsystem	Document’s name
Foreign company	2010-09-20-A9
Foreign company	2010-09-25_A24
Position of interviewee	**Size of the company/ institute**
Top Management	Multinational company
Top Management	Multinational company
Department	**Annual budget for IA in China [€]**
Business Development	1.000.000
Innovationmanagement	600.000.000
Existing R&D Center in China?	**Year of the budget figgures**
yes	2010
yes	2009
Existing IA in China?	**Type of products in China**
yes	customer specific
yes	non customer specific
Size of IA in China in manpower	**Number of Innovationprojects per year**
150	5
1000	50
Start of IA in China	**Education of the Interviewee (highest degree)**
2007	University
2000	PHD
Number of people at the beginning of IA in China	**Field of Education**
15	engineer
50	informatics
Opinion of the interviewee about IA in China	**Age of the interviewee**
highly positive	40-50
highly positive	40-50

Table 9 Development of 2 main codings: opportunities and configuration for foreign innovation activities in China

Table 10 Development of sub-categories for opportunities and configuration of foreign innovation activities in China

Table 11 External opportunities for foreign innovation in China (within categorization system)

Table 12 Main arguments of A9 in terms of external opportunities for foreign R&D activities in China (within categorization system)

document	segment	begin	end
2010-09-20-A9	A9: (ähm) Well, just as I have mentioned, **the Chinese market, I think, is the most important factor to motivate the headquarters in Germany to set up and support the R&D development in China.**	103	103
2010-09-20-A9	And (ähm) if you talk about a second reason, I would say (ähm) in the future, our most important competitors are located in Asia, e.g. in Japan. So **we must play a role in the local development to keep up with our competitors. That is another reason to drive the headquarters in Germany to decide** that we must support very highly the importance of R&D in China.	104	104
2010-09-20-A9	A9: (ähm) I think it is quite different with our company as to other companies. You know B12 is originally a family company and became more and more public company. And we are very market oriented. So our R&D work has already been defined as an supportive action to market growth in China. And that means, for the future, **our R&D will definitely be in line with the requirements of the market. That also means, the R&D will need to support our Chinese business growth in the future.** So we will listen to the local market and local customers and then we find out which products are needed.	98	98
2010-09-20-A9	A9: I would say this is due to the importance of the Chinese markets. You know (ähm), ten years ago the market of B12 Group here in China was almost nothing. And now we already have a very big portion of the group business. So, that means, we here in China are more and more important in the future for the whole B12 Group. I think that is also one of the main factors to motivate the board managers in Germany. **Our headquarters will have to invest a lot for the R&D in the local market here in China. But if you look deeply into the principles of the requirement of the local R&D, all R&D investments all go inline it with market requirement.** That means B12 is still very market oriented. That means if the market here in China requests that we must have an R&D work, than I believe our headquarters will support that idea.	100	101

own ability of 'technology scouting' in China. After ten years of experience, A24 explains that only the development of technological capabilities will eventually lead to competitive advantages for foreign companies operating in China. We present some quotations of A24 in table 16.

To sum up, both companies focus on technology issues within innovation management in China. However, A9, being in an early stage of innovative activities in China, uses technology issues mainly to reduce costs (and market-price) of its' products for the Chinese markets. On the contrary, A24, being in a mature stage of foreign innovation manage-ment in China, 'scouts' technology developments in China and tries to integrate relevant aspects into the companies' overall strategy to stay competitive (absorptive capacity).

Discussion

Based on our secondary data analysis, we found significant evidence for Chinas' efforts to enhance innovative, national capabilities. China is already ahead of most OECD countries regarding the absolute expenses for R&D and the absolute number of researchers. However, in relative dimensions (such as the percentage of R&D expenses on GDP), China still lacks behind all OECD countries. Most important, China proves a significant increase of input indicators (such as expenses on R&D and the available number of researchers) but a rather moderate to low increase of output indicators (such as patents). The gap between (high) input and (moderate) output indicators is not surprisingly due to Chinas status as a developing nation. In other words, it is easy to spend available funds into buildings, education and high-tech infrastructure to support innovative growth - but it takes decades. Due to our secondary data analysis and in line with others authors (Von Zedtwitz, 2004; Boutellier et al., 2008; Liu, 2009), we expect that output indicators (such as patents) will eventually rise, too, because China continuously promotes its' innovative activities.

Based on our primary data analysis, we got the unique opportunity to gain a (better) understanding about the focus and the different interests of foreign companies' innovative actions in China. Precisely, we are now able to distinguish on an empirical database between *main opportunities and main aspects of the functional management* of foreign innovation activities in China. We will begin our discussion with the first aspect, the opportunities, followed by the second aspect, the functional management (configuration) of foreign innovation in China.

With respect to the first aspect,we can now distinguish between three main categories: (1) the specific role of foreign companies within Chinas' ongoing efforts to strengthen its innovative system; (2) the internal opportunities and (3) the external opportunities of companies when operating in China. We think that all three identified categories are worthy for a further analysis. Due to the complexity of each category and due to our code-matrix relational analysis, we focused on category three (external opportunities of companies operating in China).

Based on primary data from two foreign companies in China, we conclude that the Chinese market is the main motivation for external opportunities - not only for general foreign business activities in China but also in terms of a foreign companies' innovative strategy. However, a foreign company in a rather early stage of innovation activities in China (A9) is far more depended from its (German) headquarter than from Chinese market rules. The R&D manage, of A9 stated that R&D potential in China could enhance the companies' general development far more in the future by less (tight) control from German headquarters and more independent, market-orientated business. In fact, A24, having more than ten years of innovation management experience in China, does operate highly independently from its' headquarters. The R&D manager of A24 explains that a foreign company cannot become fully integrated into the growing innovative opportunities of China by strict control from headquarters (as A9). Hence, the comparison of A9 with A24 leads us to the incremental learning process from Johanson and Vahlne (1977).

Following this line of argumentation, evidence from incremental learning (Johanson and Vahlne, 1977) seems to be one future adequate theoretical approach to broaden the existing, but rather descriptive discussions about (foreign) innovation in China.

With respect to the second aspect, the configuration of foreign innovation in China, we are able to distinguish between *four main functional management categories* of foreign innovation activities in China (table 10):

(1) incremental development stages of foreign innovation in China;

(2)external management of foreign innovation in China (industry-university cooperation);

Table 13 Main arguments of A24 in terms of external opportunities for foreign R&D activities in China (within categorization system, translated, original text in German)

document	segment	begin	end
A24	A24: The point-of-view from B2 is very much differently. Even within B2 you'll find great differences due to the huge size of the company. Though each single division has its' very own focus, **everyone focusses on the local markets on only one question: "How can I maximize my profit within that market?"**	122	122
A24	A24: Yes, Ok, I understand and I can give a easy explanation for that question. So what makes the Chinese markets so attractive in terms of foreign R&D? The first answer to that question is that every company will search for promising markets. Where do we find rather high dynamics within markets? So business people start to look around? USA? India? Maybe China? Well, I can tell you that China is most certainly one of the most dynamical markets in the whole world - you can earn a lot of money here!	73	74
A24	Ok, I understand. So the first aspects is regarding the R&D process here in China: to find ideas, to design a prototype of a new product and finally, the commercialization. Well, I think, we shouldn't think about these steps separately. Let's regard the human being in that innovation process - the boss will check and control all the single steps of that innovation chain. **So he will look for new ideas for the Chinese market, he tries to figure out if a new R&D investment is worthy and than he will begin to commercialize that product. I always think about profit here China - others aspects are not really important.**	126	126
A24	My bosses keep telling me: "Don't transfer that technology to China! If we do that, the Chinese will copy the technology and than we cannot earn a single dollar." That's correct, absolutely! However, we have to look at this situation from a different perspective: If we deny the process of R&D investment in China, than we will lose the complete Chinese market in the future. In that case we cannot earn anything because the Chinese will definitely develop in the direction of indigenous innovation with- or without us. If we work with the Chinese in their markets, than we can still make some money in these markets. **This is a process which we cannot stop as being one company in a huge market. So if we cannot block the process, we have to bring in our knowledge and join the process of innovation activities in China. We have to join that process in order to gain profits still in the future. Do you understand what I mean? That's really important.**	39	39
A24	And my second point is: **If the economy of a given market is characterized of being highly dynamically, than you definitely find support in these markets of R&D activities! A highly dynamical environment is a great and positive sign for many innovations!** I do know many Chinese and Americans who used to work at Silicon Valley. They have all returned to China in order to work here in various companies. Many of them decided to launch their own company. Others are working on the opportunities with venture capital here for China. **They are all very actively here. If you talk to them, they will explain that the situation in China today is comparable with Silicon Valley in former times!**	75	75

Table 14 Main factors of internal configuration for foreign innovation in China (within categorization system, original in German)

Codesystem	2010-09-20-A9	2010-09-25_A24
Internal (in-house) configuration of foreign R&D in China		
Technology scouting & (in-house) competence development	■	■
Organisation	■	■
Human Ressources	■	■
Strategy and mission		■
Financing		■

Table 15 Arguments from A9 in terms of technological R&D configuration in China

document	segment	begin	end
2010-09-20-A9	So basically, my responsible areas within **our group is very technology guided.** So, we need a lot of (ähm) R&D work here in China.	4	4
2010-09-20-A9	And the second argument from my point of view are the mentioned cost reduction issues. To realize price reduction means also to realize cost reductions. I believe, that this is a common phenomenon for German companies here in China. **Prices are always very high although the quality is also always top-class.**	40	40
2010-09-20-A9	INTERVIEWER: What is important to build these kinds of collaborations for you and your company here in China? A9: (ähm) From my point of view, we definitely need such kind of cooperation because, it is kind of a resource! We can optimize our resources in this way. If the resource is already exiting in the university and if we need it, than we could take it, of course only by joint efforts. We do not need to develop completely new things again, if such resources are available. It is kind of a waste for us. **I mean the technology and also the, the solutions and the ideas.**	82	85

Table 16 Arguments from A24 in terms of technological R&D configuration in China (translated, original text in German)

document	segment	begin	end
A24	Well, this is difficult to say. In former times, about ten years ago, nobody believed in technological developments within China. You know the global locations where we usually find new technologies - that's in the USA and in Europe! China, however, has been restricted to production issues for a long time. **But we began to realize a tendency here in China. We began to understand that we need some support from official Chinese governmental in order to built up our standards internationally.**	29	30
A24	**I created a of radar system to identify the best locations for a certain technology development [here in China]. With that radar system, we check the internal processes of our company. But we also scan the complete market: "What kind of opportunities are coming up? What are themes of our competitors? Which developments can we see within small firms, especially within start ups?" So we are always scanning these developments with our radar system. Our main interest are possible new technological and financial benefits for our own company.** And once we have identified a promising development, we create a strategy how to launch that development into a suitable market. "Which developments, internally and externally, are becoming important for our company?" That's the main question for the radar system here in China! What's the impact of a certain development in three years? Will we develop that specific technology by ourselves or will be buy it on the market? What are the next steps to be taken for us?	66	66
A24	Well, it's interesting to monitor my German colleagues. I am, of course, not against my German colleagues. But sometimes, they do not understand the situation here in China. I know many, many people here in China who keep saying: "Germans are arrogant." **The Germans tend to say: We are the best, we have the leading technology , the best quality and the 'made-in-Germany' label." And many Germans keep saying, that the Chinese have to learn from them. Many German managers keep coming to China and they say: " I came to China to tell you how to work." Well, I can tell you that these guys will not survive.** That's my very own experience, because the Chinese are tremendously adaptable and they keep learning all the time!	82	82
A24	**We have to place the technology at the very forefront of any R&D Center here in China. In our R&D centers, the technology dominates the scenery!**	137	133
A24	If we identify are small company, maybe a start up, which proves to be good in a specific competence, we try to buy that company to gain their knowledge. **Our main focus in that process is always the technology market! It's all about competitive advantages. Any other factors will build upon the issue of technology markets.**	141	141

(3) internal management of foreign innovation in China and
(4) an overview about different existing and initial types of foreign innovation activities in China (mainly product orientated).

All four categories are worthy for a further analysis to learn more about foreign companies' innovation management in China. However, due to the complexity of handling all four categories in one paper and due to our code-matrix relational analysis (see chapter findings), we identified category 3, the *internal management of innovation*, as most important for foreign companies in China. According to our interviews and the coding of qualitative data, we identified three subcategories within the internal management of foreign innovation (table 14): (1) 'Organisation; (2) 'Human Resource Management' and the (3) 'development of technological capabilities in China. In this paper, we have focused on aspects of technology for a further analysis while excluding organizational forms and human resource management (due to the complexity of analyzing all three categories).

Based on our case study data from 2 foreign multinationals in China, we identified significant differences for the understanding of technology in China (as illustrated in our chapter 'findings'). A9, the company in a rather early stage of innovation in China, mainly focus on cost-driven issues. It is not their intention to design new products or to enhance their technological capabilities but to reduce costs of existing products for the Chinese market. On the contrary, A24, having more than ten years of innovation experience in China, does not focus on cost aspects but on technological capabilities. A24 understands the Chinese market as highly dynamical with a great future potential for high-tech solutions. A24 aims to understand the Chinese technological developments by technology scouting and they try to absorb that knowledge for further internal use. This somewhat contradictory understanding of technology in China between A9 and A24 may be a result of the incremental learning process as presented in our theoretical framework. Close to the idea of Johanson and Vahlne (1977), companies in China seem to start innovation activities on a low level (technology as a cost-reduction issue at A9). However, with further market commitment and market knowledge, the company begins to 'use' China's developments for further own internal developments ('commitment decisions' according to the model of Johanson and Vahlne (1977).

Moreover, the cases of A9 and A24 also indicate a change in the motives of foreign companies to develop innovation capabilities in an emerging market like China. According to Kuemmerle (1997), we distinguish between home-based-exploiting and home-based-augmenting motives for a companies' foreign investment in R&D. Home-based exploiting means, that a company already has a certain technological standard at home and they try to exploit that expertise to abroad markets (Kuemmerle, 1997). This idea comes close to the arguments of A9. A9 already has a specific technology at home and they are not willing to change that for the Chinese market. On the contrary, home-based-augmenting means, that a company is likely to learn from a foreign market to augment its' own skills. The home-based-augmenting approach dominates for high developed, industrialised countries which can actually contribute to foreign companies' technological skills. Using the home-based-augmenting approach from Kuemmerle (1999) with the Chinese context is rather new phenomena.

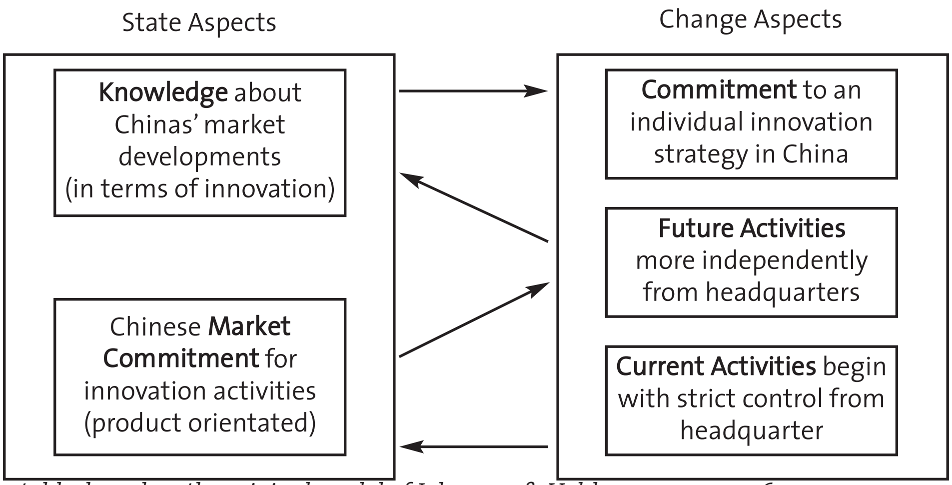
Conclusion and research limitations

In this paper, we tried to shed some light into the rather unexplored, explorative research field of foreign innovation in China.

Based on a literature review and a secondary data analysis, we support the assumption of China being an important player for future innovative developments. Even though China remains a developing nation (e.g. in terms of GERD) with a high tendency to adapt and to copy existing technologies (Zedtwitz et al., 2007), its' innovative efforts can be characterized as fast and continuously. Innovation is no longer a goal written down on paper, but a lively discussion in scientific and practical groups - pushed by generous amounts of governmental funding.

Though some of the existing macro-economical studies help us to understand the general frame-work of Chinese innovativeness, management issues of (foreign) innovation have been widely neglected so far. We tackled this subject by a micro-economical case study over and above our macro-economical approach. Through our primary data collection in China, we gained exclusive insights into the most important opportunities and aspects for innovation management of foreign companies

Table 17 The model of Johanson and Vahlne, 1977, modified by foreign innovation activities in China



Source: Own table, based on the original model of Johanson & Vahlne, 1977, page 26.

in China. We developed some major arguments within these opportunities and within the functional management from the perspective of two foreign companies operating in China: A9 with only three years-, and A24 with more than 10 years of experience with innovation in China. The comparison of the two companies has lead to an incremental learning theory approach as proposed by Johanson and Vahlne (1977). We suggest that further research should integrate such economical theories into the discussion of foreign innovativeness in China. The Uppsala model of Johanson and Vahlne (1977) seems to provide a promising perspective ro do so.

Of course, this study has several research limitations. Firstly, we are aware, that our data base with a two company comparison is rather small. A greater data base would be helpful to underline our results. Secondly and due to the complexity of the subject, we cannot provide a complete guideline of all opportunities and all aspects of a functional management for foreign innovation in China. Our aim was to shed some first light into the scenery. Thus, we provided an empirically based overview about two categories: opportunities and functional management of foreign innovation in China. Moreover, we concentrated on selective aspects (by code-matrix relational selection) within these two categories, namely aspects of (1) *external opportunities and (2) technology within internal management of innovation*. More research about the other identified aspects seems to be likewise important. For example, the human resource management (as a second identified aspect besides technology management) remains an important challenge for all foreign companies (Boutellier et al., 2008). Especially the younger generation of Chinese graduates favor foreign over domestic companies. Their international technological expertise and their Chinese background can be a great potential to enhance foreign companies' future innovation activities in China.

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Practitioner's Section Chemical distribution in Belgium from 2007 to 2010: An empirical study

Sander Mortelmans* and Genserik Reniers*

* Antwerp Research Group on Safety & Security (ARGoSS), Department of Environment, Technology and Technology Management, Antwerp University, Belgium, genserik.reniers@ua.ac.be

Chemical distribution is described from a product lifecycle perspective. The impact of the economic decline in 2009 on Belgian chemical distribution is given in figures. In 2010 the sector recovered sharply. Although the individual companies performed very differently, overall, 2010 was even better than 2008. Increasingly complex legislation on chemical products has initiated a consolidation trend in the sector which in turn has brought on trends in outsourcing and inventory management.

1 Introduction

Chemical distribution represents a relatively small and unknown sector in Belgium; nonetheless it provides essential support to many of the Belgian industries. Rather than simply selling chemicals, genuine chemical distributors add value through an extensive range of services to both customers and suppliers. Examples of services offered to customers are product expertise for formulation purposes, Just In Time deliveries, sample management, drumming, dilution and blending transformations. Services offered to suppliers include repackaging, labeling conform local regulations and language and arrangement of import authorizations and new product approvals. Thus chemical distribution originates in the gap between producers who wish to sell large lots without regulatory or logistical complications, and customers demanding small volumes and who have very specific needs on technical, regulatory and logistical level. Modern chemical distributors also provide suppliers with in-depth market intelligence and assist with the implementation of marketing strategies. In essence, chemical distributors allow their principals to profitably reach smaller customers in many industries and countries.

For the purpose of describing chemical distribution, products are commonly classified as either commodity (or industrial) chemicals or specialty chemicals, as these two types differ substantially in traded volumes, pricing mechanism, type of services offered, capital intensity of the business, outsourcing of logistics and applicable regulations on safety and environment. Commodities comprise acids, lyes, solvents, salts and other inorganic products. They are low-value high-volume products for which transport is a major cost factor. Keys to success in commodity markets are therefore competitive pricing, operational excellence and sites located nearby customer centers. Specialties comprise a countless number of products and are best characterized by their industry of application. Keys to success in specialty markets are firstly knowledge of customer needs through regular customer visits, secondly product expertise to relate customer needs to particular products and services and finally flexibility, for example being able to source and deliver on very short notice (Districonsult, October 2010; CHEManager, 2005). Specialty price increases are generally passed on to customers immediately. A more complete description of the sector's characteristics can for example be found in Districonsult (October 2010), ICIS Chemical Business (May 2010) or CHEManager (2005). Because chemical distribution involves a diverse range of products, and also serving many different industries and working with partners having very different needs, the distributors have very distinguished product portfolios, business models and growth strategies. Together they form a European sector that has changed profoundly over the last decade, see for example CHEManager (2005). More recently European chemical distribution has been impacted visibly by the economic decline in 2009.

2 Objectives, scope and methodology

The objective of this article is an empirical market study on Belgian chemical distribution. The article summarizes the results of a study carried out for the Belgian Association of Chemical Distributors. The focus is on the following eight firms who are the leading distributors on the Belgian market: Brenntag, Caldic, Univar, Quaron, Azelis, IMCD, Kreglinger and Barentz. These firms are genuine chemical distributors: they work independently of their principals, conduct business mainly through durable distribution contracts (as opposed to trading) and have no production activities of their own. In addition, they have been active in Belgium for at least ten years. The first four firms distribute both commodities and specialties, the other distribute almost exclusively specialties.

Firstly, the study investigates the diversity among the Belgian distributors and provides for this diversity an economic explanation. Secondly, Belgian chemical distribution is represented in figures over the period 2007 – 2010 detailing evolutions in sold volumes, turnover, added value, investment and employment. The main purpose is to assess how the economic decline in 2009 has impacted the Belgian distributors and how they recovered in 2010. Thirdly, the study explores management trends in the sector.

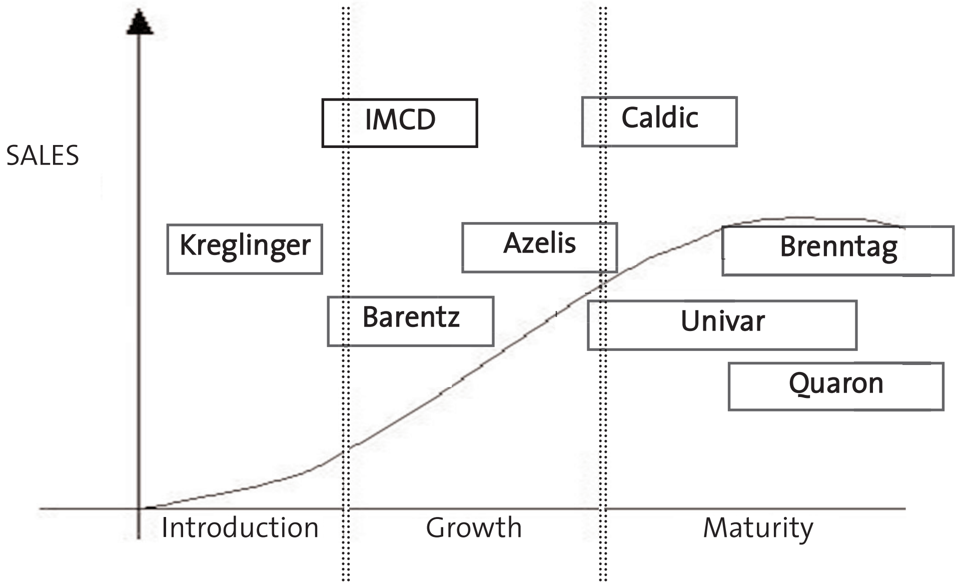
The targeted companies were approached individually to obtain detailed commercial data. In addition, in-depth interviews were held with the Belgian executives from which first-hand information was obtained on business models, management trends and expected future developments in the sector.

3 Company business models: a product lifecycle view

We previously introduced chemical distribution as a very heterogeneous sector. In this section we develop an economic perspective on the sector that allows a description of the heterogeneity. From the interviews the conclusion emerged that the different business models can be related to the phases of the product lifecycle model. As a product proceeds through its lifecycle, the supplier's needs with regard to distribution will change from phase to phase. For chemical products these changes in needs are so significant that it is difficult to combine them into one distribution company. Thus different distributors exist across lifecycle phases, with business models specifically tailored to supplier's needs. Elements of the business model include the degree of intimacy and loyalty in the relationship with suppliers, wide or narrow industry focus, offered services, geographic coverage, extent of logistics outsourcing and growth strategy. The product lifecycle view does not capture all possible characteristics of firms, however it provides an economic explanation for many of the observed differences between firms. Figure 1 shows how the eight leading distributors on the Belgian market fit into the product lifecycle view. The positioning in the plot is based on discussions with firms on their business model characteristics and the plot should therefore be interpreted rather qualitatively. Note that the developed perspective is particularly relevant to specialty distribution; commodities are by definition products in the maturity phase.

Products in the 'Introduction phase' from Figure 1 are demanded in small volumes by customers from only a few industries, typically the food, cosmetics and pharmaceutical industries. Typical activities in this phase are the dissemination of product documentation to users and the requesting of product approvals from local authorities. The supplier wishes detailed information on users and pricing and expects its distribution partner to implement a defined marketing strategy. Thus the supplier expects from its distribution partner firstly product launching services, secondly extensive feedback on customer profiles and willingness to pay, and thirdly loyalty and exclusivity. Kreglinger is very clearly positioned in the introduction phase. Kreglinger explicitly keeps logistics in-house (excluding transport) because they constitute a key part of their product launching services. Kreglinger explicitly limits its geographical presence to a handful of Western-European countries and works with local home-office salesmen instead of physical subsidiaries. This allows centralized planning and warehousing while maintaining close contact with the user industries. Finally, successfully launching a product may require that customers are provided with some flexibility in payment terms. This is particularly the case for innovators in the cosmetics industry as these customers often depend for their revenue on large conglomerates. Thus distributors in the introduction phase are typically flexible with regard to customer credit.

Figure 1 Product lifecycle perspective on Belgian (specialty) distribution



In the 'Growth phase' from Figure 1, the product is finding more applications and innovations based on the product are becoming successful. Hence demand is increasing and returns to scale in production allow prices to decline. Suppliers require a partner who can reach all relevant industries over a large geographic area. Throughout this phase we find Barentz, IMCD and Azelis. These firms still act as loyal marketing partners for their principals, however they do not disclose detailed information on customers and they set prices independently. They each focus on a select number of industries and employ an extensive sales network consisting of physical country subsidiaries. They typically outsource logistics and warehousing completely, as these activities are not key to the selling of products and expertise. Barentz and IMCD differ sharply on aspects like industries of specialization, company size, ownership model and growth strategy. However they are rather similar on aspects that are more relevant to the product lifecycle model: they both specialize in 'growth-phase products' for a few industries, offer complete solutions to these industries (e.g. all relevant products and services) and maintain intimate relationships with principals. For this reason, they occupy a similar position in Figure 1. Azelis is positioned more towards the 'Maturity phase' because it less values intimacy with principals than the others and has a wider industry focus.

Once a product reaches the 'Maturity phase' from Figure 1, the supplier wants to sell large volumes at favorable profit margins. Customer information, marketing services and exclusive relationships are no longer needed. Instead, a distributor must offer operational excellence and wide geographic and industry coverage. All of this is achieved by large company size, offering of multiple brands of the same product and extensive logistics infrastructure. In this phase we find Caldic, Brenntag, Univar and Quaron.

A feature that is not captured in the product lifecycle view, but which is a distinct characteristic of a chemical distributor, is the choice of a firm between autonomy and uniformity of its country subsidiaries. A distributor who operates internationally must constantly balance between, on the one hand, autonomy of subsidiaries to achieve flexibility towards local markets, and on the other hand, uniformity across the organization to benefit from scale efficiencies. To combine these determinants of success, chemical distributors have implemented a matrix organization made up of local country managers and international product managers. Each distributor behaves differently with respect to the above trade-off and this choice is not found to be related to the position in the product lifecycle view.

4 Belgian chemical distribution sector in the crisis: empirical results

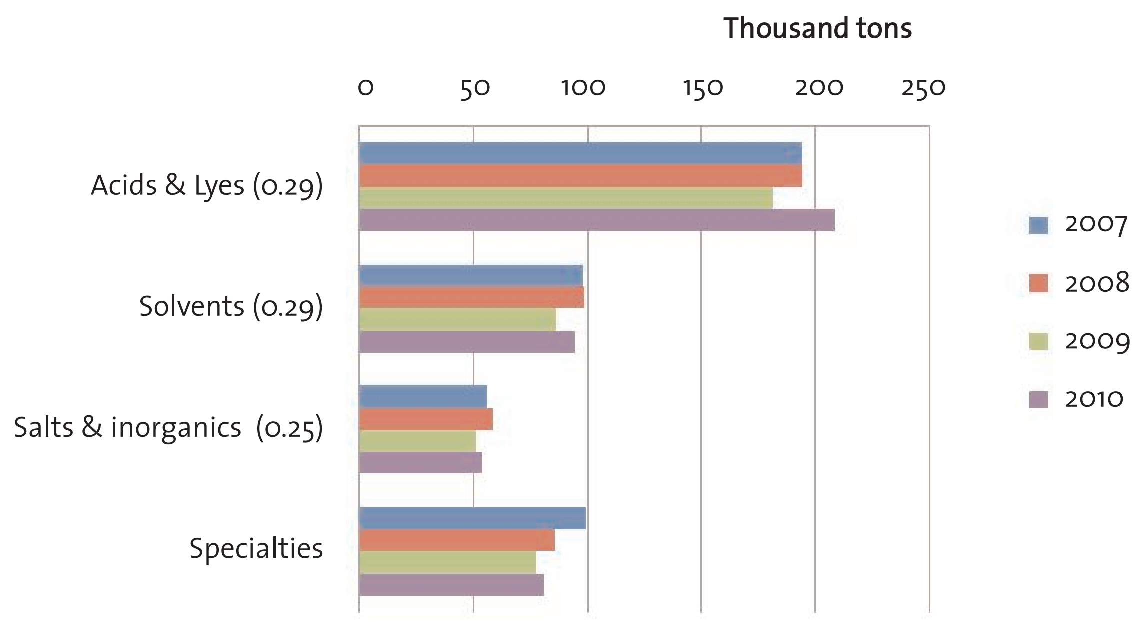
The economic decline in 2009 significantly impacted European chemical distribution. The German market turnover and investment volume dropped by 22% and 50% respectively (VCH, 2010). This market is considered to some extent a benchmark for the whole of Europe (ICIS Chemical Business, May 2010). At European level, turnover and traded volumes dropped on average by 15 – 20% and 10 – 15% respectively (Districonsult, March 2010). This implies that prices fell, on average. However the European sector recovered strongly in the first half of 2010 due to a general recovery in industrial activity and due to customers replenishing stocks after having minimized stocks during 2009 (ICIS Chemical Business, October 2010). The purpose of this section is to represent the Belgian sector in figures and to assess how this geographic market has been impacted in 2009. For the assessment of turnover, added value, investment volume and employment we distinguish between all-round distributors (active in both commodities and specialties) and pure specialty distributors to account for the commercial differences between both product types.

4.1 Traded volumes

Figure 2 shows evolutions in the volumes sold on the Belgian market by the eight distributors considered in this study. The data represent only sales on the basis of durable distribution contracts. In 2009 total volumes dropped by 6.4, 12.9, 12.3 and 9.2% respectively, corresponding to the order in Figure 2. In 2010 total volumes recovered, however the individual companies performed very differently.

Commodity distribution is for at least 98% in the hands of Brenntag, Caldic, Univar and Quaron. As an indication of concentration in commodity markets the sum of squared market shares[1] for these four firms (volume-based) is given between brackets. In all three markets the concentration indicator remained unchanged over the period considered. However in 2010

Figure 2 Volumes sold through durable contracts



1) The indicator corresponds to the Herfindahl-Hirschman Index (Bishop, Walker, 2010). It is assumed here that the commodities market consists of only the four mentioned companies, firstly because their joint market share approaches 100% and secondly because our purpose is to position the leading distributors relative to one another.

Quaron was acquired by competitor Univar, reducing the number of firms in commodity markets from four to three starting from 2011.

4.2 Turnover and added value

Figures 3 and 4 show, for all-round and pure specialty distributors respectively, evolutions in turnover and added value. Turnover makes a good indicator of the business climate, however chemical distributors focus on added value growth as they strive to offer customers a complete solution rather than just a product. In 2009 the Belgian sector turnover and added value dropped by 18.5 and 4.2% respectively. Although individual performances were very different, the limited decline in added value confirms the view that 2009 was also a year of opportunity as both suppliers and customers were looking for cost efficiencies. For example many customers from the food, cosmetics and paints industries were looking for new formulations with less expensive ingredients, creating opportunities for distributors to promote their product expertise. Moreover, a number of commodities users that were previously serviced directly by suppliers had switched to lower purchasing volumes for which they were referred to the distributors.

In 2010 Belgian chemical distribution achieved a turnover and added value of 597 and 92 million euros respectively, compared to 638 and 82 million euros in 2008. The key conclusion is that when in 2010 demand for products went up again, distributors benefited from the increased customer awareness and creativity in

Figure 3 All-round distributors Turnover (left) and Added Value (right)

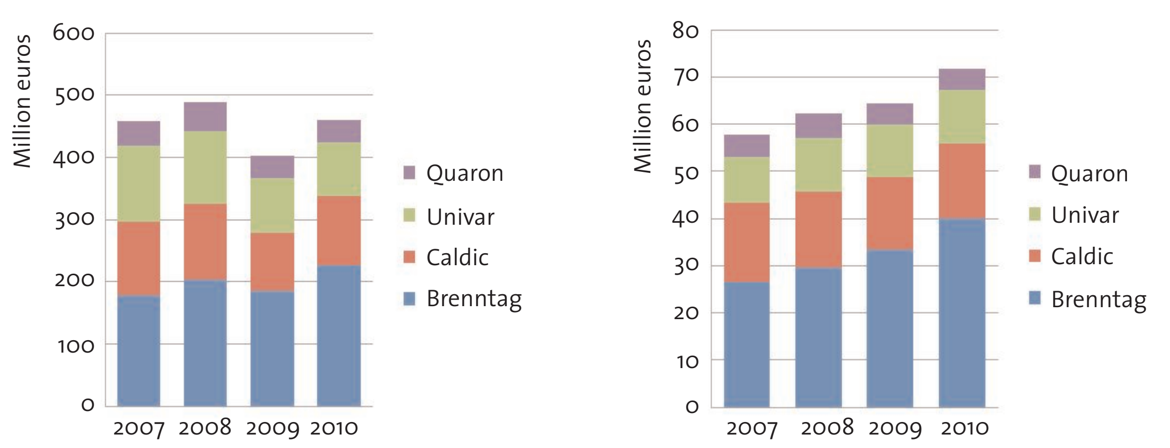
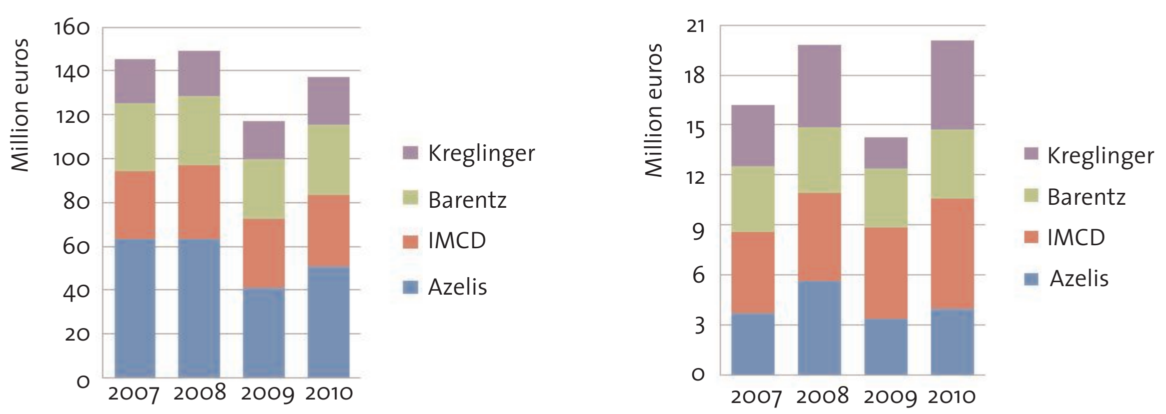


Figure 4 Pure specialty distributors Turnover (left) and Added Value (right)



service development put forth the year before.

Figure 5 indicates the share of a range of industries in the sector turnover. The food, paints and chemical industries consistently represent 54% of the Belgian sector turnover. Nearly all industries were severely impacted in 2009. In seven out of the ten industries shown, turnover dropped by more than 15%. The recovery in 2010 is obvious, however only turnover in cosmetics, pharma and chemical industries recovered to the 2008 levels.

Figure 5 Market turnover by industry

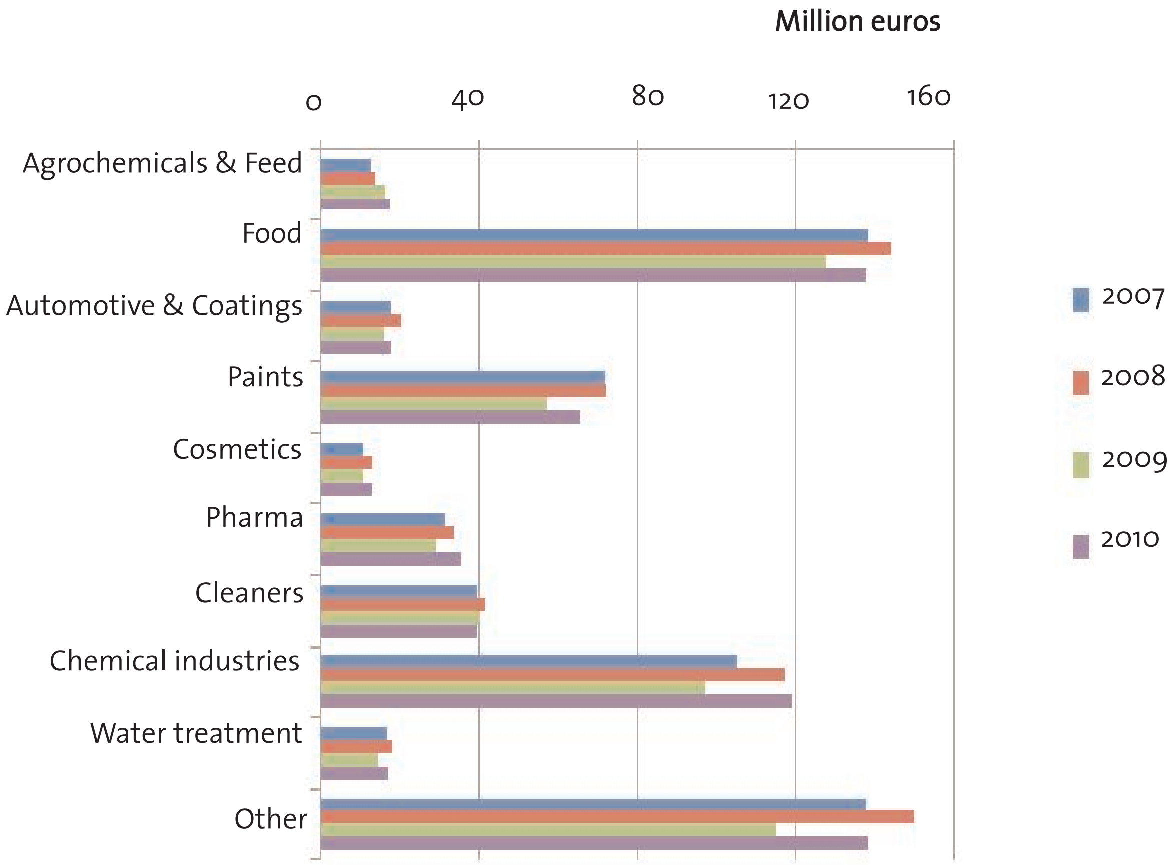
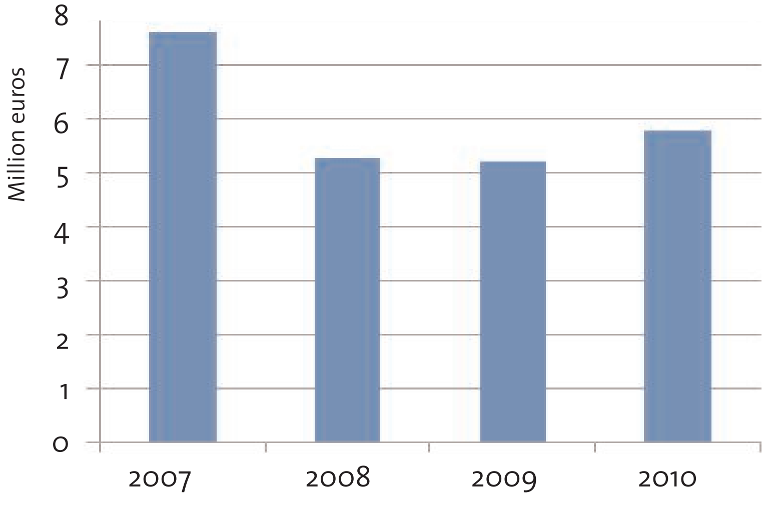


Figure 6 All-round distributors investment volume



4.3 Investment

Total investment volume is almost exclusively attributable to the all-round distributors due to their commodity business. Figure 6 shows the evolution of all-round distributors investment volume. The decline in 2008 was almost completely attributable to one company. The recovery in 2010 was largely attributable to two companies who made exceptional investments in the security of material assets on their sites. Over 2007 – 2010 the ratio of investment volume to added value steadily declined from 13 to 8%. For pure specialty distributors the ratio is consistently lower than 2.5% and represents mostly investments in operational efficiency. For example, distributors increasingly rely on software for management of customer relations and inventory, for reasons to be discussed in Section 5.

4.4 Employment, labor productivity and labor costs

Evolutions in number of employees are shown in Figure 7. Over 2007 – 2010 total employment in the sector declined slightly from 688 to 677 employees.Different individual evolutions can be seen, however most companies provided a positive outlook for high-skilled labor. Pure specialty distributors typically have a sales force of 35 - 40 employees.

Figure 8 combines the data on added value and employment into an indication of labor productivity and labor intensity in the sector. Significant variability is observed in both labor productivity and labor intensity, which corresponds to the heterogeneity of firms and to the differences in commercial performance over 2007 - 2010. The larger variability is between the all-round distributors because the differences in commercial performance were strongest in this group. Both indicators show a considerable gap between Brenntag and Caldic on the one hand and Univar and Quaron on the other hand. Moreover, over 2007 – 2010 Brenntag significantly outperformed the others with regard to added value growth.

5 Trends in chemical distribution

In this Section, some remarkable trends within chemical distribution in Belgium are discussed. Chemical distribution is a young sector in development and an overview of its progress during the period 2007-2010 is given.

5.1 Working capital and inventory management

Private equity has since 2005 been very active in chemical distribution and has initiated a trend of rationalization of working capital. Economical

Figure 7 Employment by all-round distributors (left) and pure specialty distributors (right)

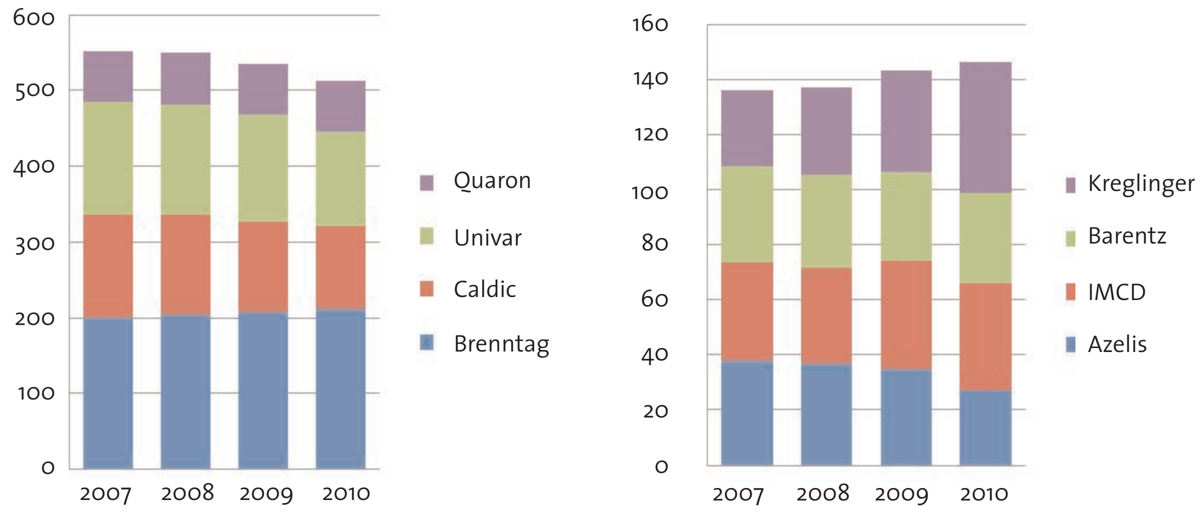


Figure 8 Labor productivity and labor intensity. All-round distributors (top) and pure specialty distributors (bottom)

	AVERAGE				STANDARD DEVIATION			
	2007	2008	2009	2010	2007	2008	2009	2010
Added value employee (euro)	98.697	105.040	108.818	123.418	34.519	33.879	44.339	54,485
Share of labor costs in added value (%)	63,2	61,9	63,7	58,1	23,3	16,8	22,5	25,1

Brenntag, Caldic, Univar, Quaron

	AVERAGE				STANDARD DEVIATION			
	2007	2008	2009	2010	2007	2008	2009	2010
Added value employee (euro)	120.696	144.070	98.276	141.677	18.246	17.047	35.347	23.724
Share of labor costs in added value (%)	57,2	55,7	57,6	61,5	10,1	11,8	19,5	14,6

IMCD, Azelis, Barentz, Kreglinger

use of working capital automatically leads to a focus on inventory management. Forecasting has become an important concept for chemical distributors and more experts are appointed within companies to deal with purchase planning issues. Stocks have decreased and there were less unsold products destructions. In 2010, trade volumes have reached the levels of before the crisis, but a large number of customers are now responsible for smaller, but more frequent orders. Stocks have decreased throughout the chemical supply chain, having a profound impact on the chemical distribution business as distributors are expected to absorb changes in demanded volumes. Hence, inventory management has become an essential part of chemical distribution with respect to competitiveness.

5.2 Impact of REACH

The task of distributors within the REACH regulations is to pass on information between customers and suppliers, for example for the possible application of a product. As a result, the first two phases of REACH, completed in December 2010, increased the number of staff within chemical distributor companies, having to maintain the necessary contacts.

In specialty markets, characterized by small trade volumes, REACH led to some suppliers stepping out of business due to REACH registration costs being too high compared with profitability. The next phases of REACH focus on the smaller chemicals volumes and the supplier effect will therefore become even larger, leading to the risk of monopoly-formation of suppliers (those able and willing to pay the registration costs) for some chemicals.

5.3 2009: year of crisis and opportunities

Belgian chemical distributors indicate that 2009 was a year of crisis as well as of opportunities. Customers and suppliers were in search for increasing their cost efficiencies, leading to the opportunity of distributors to promote new services. Falling prices meant less working capital requirements, hence resources became available to invest in these new opportunities. In 2009, distributors have worked hard to differentiate from their competitors, leading to important positive results in 2010.

The 2009 crisis also pushed towards more economical use of working capital, besides the private equity push on this matter. In 2010, when the market recovered from the economic decline in 2009, the inventory and resources management changes from 2009 were still fully standing, making the chemical distributors to have a strong economic position.

On the one hand, some suppliers did serve themselves certain important customers in 2009, thus bypassing the distributor in the supply chain, and on the other hand, certain customers switched to smaller purchase volumes, and therefore became customer of distributors. In 2009, specialty distributors were mainly confronted with a decreasing demand from the cosmetics industry, and to a much lesser extent a decreasing demand from the food and pharmaceutical industries.

5.4 Consolidation of the industry

As a result of legislation and regulations becoming ever more demanding and complex in Europe and in Belgium, a clear trend in consolidation of chemical distributors in Belgium, being private equity - driven, started in 2005. Mergers and Acquisitions led to eight main players in 2010, with focus on efficiency through inventory management and outsourcing of logistics, and on growth by acquisition. In 2009, external growth strategies for the Belgian market were clearly put on hold, however general consensus is that consolidation will continue, proof of which are acquisitions done by Univar and Azelis in 2010.

On the long term two limitations exist on consolidation in specialty distribution. Firstly, because suppliers require exclusivity, the number of brands existing for a product largely determines the number of distributors in the market. Thus competition in specialties distribution is a direct consequence of competition at the supply side. A second limitation is suggested by the product lifecycle view on chemical distribution: as suppliers carefully select a distributor based on the maturity of their product, they would in many cases refuse to accept consolidation across the lifecycle phases. For example, the acquisition of Kreglinger or Barentz by a firm like Brenntag would urge many principals of the acquired firm to terminate the relationship, because the acquiring firm has a completely different way of interacting with its suppliers (refer to Section 3). Hence the acquisition would actually destroy value. This implication of the product lifecycle view was confirmed by the smaller firms (the potential targets of an acquisition) and they even indicated that their independence is a core condition in their agreements with principals.

6. Conclusions

Based on chemicals trade volumes, the Belgian market is largely dominated by eight major international distributors. Starting from 2010, the market for commodity chemicals is effectively dominated by three firms. For the purpose of describing chemical distribution, the product lifecycle model was found to be a useful tool as many characteristics of firms relate to the phases in the model. Moreover, the product lifecycle view is useful for predicting future consolidation in specialty distribution. In 2009, the year of worldwide economic crisis, distributors were urged to creativity and they developed new business opportunities for their customers and suppliers, leading to a full recovery of the industrial sector in 2010. The European REACH legislation, and the accompanying registration costs, has led to suppliers stepping out of the market for certain chemicals. Chemical distributors fear the possibility of supplier monopoly-formation.

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