

# **“Determinants of ‘Openness’ in R&D Collaboration: The Roles of Absorptive Capacity and Appropriability”**

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## Abstract

A growing number of knowledge intensive firms are involved in inter-firm R&D collaboration. Yet a number of factors determine the possibility of using external sources of knowledge, and a thorough understanding of these determinants will provide a foundation for defining the optimal level of openness for a given firm. Identifying and analysing these determinants and their affect on the level of openness is the ambition of this paper.

## 1. Introduction

An increasing number of knowledge intensive firms rely on knowledge produced in an inter-firm setting as a means to improving innovativeness and thereby competitive advantage (Teece 1992, Caloghirou, Kastelli and Tsakanikas 2004). Whether the relations take the shape of one-off research relations or long time strategic alliances they bear witness of how firms are opening up to external sources of knowledge (von Hippel 1988, Chesbrough 2003). R&D collaborating across organizational borders seems to satisfy both the need for new leading edge knowledge (Powel, Koput & Smith-Doerr 1996) and the demands of the bottom line (Skakibara 2003). However, using external knowledge sources in the innovation process is a complex matter as a number of different factors determine the optimal degree of openness, (i.e. the share of R&D projects being done in collaboration with external partners). The aim of this paper is to identify and analyse the main determinants of 'openness' in the R&D process, and thereby contribute to a more complete understanding a firms ability to engage in R&D collaborations.

The main objective of this paper is to position my work theoretically before studying the field empirically through four different case studies. Representatives from the four firms which are going to be studied are participating in a 'knowledge club' affiliated to this research project. These four companies are all facing the challenges that inter-firm R&D collaboration brings about.

A single distinct theme emerges from the discussions and interviews with the representatives from the four companies. It has to do with the peril of being caught on the horns of a dilemma: Relying on an open innovation strategy while at the same time wanting to protect the knowledge produced. In other words, R&D firms are faced with the dual challenge of accessing external knowledge by collaborating across boarders and simultaneously creating and protecting knowledge internally in order to gain competitive advantage. Even though the dilemma has attracted scholarly attention during the last decades (Teece 1992, Heiman and Nickerson 2004, Laursen and Salter 2005a), a thorough understanding of the different factors that determine the possibility of opening up to external sources of knowledge in the R&D process is needed.

The paper is organized as follows: on the basis of a theoretical overview of central themes relating to R&D collaboration I will discuss the main motivational factors as well as determinants of openness in the R&D process. To this end I will rely on both theoretical work and empirical findings from

my preliminary studies. Following this, propositions will be put forward forming the end discussion and giving rise to a model outlining the possible determinants of openness in the R&D process.

## **2. Theoretical Background**

### **2.1 R&D collaboration**

It is widely believed that the profitability and growth of a firm depends upon the development and deployment of knowledge assets (Blackler 1993, Kogut & Zander 1996). The subsequent focus on innovative firms and their use of knowledge has brought many insights into the character of knowledge and the different knowledge processes in an organisation (Amin and Cohendet 2004). To achieve and sustain competitive advantage a firm's capacity to adapt, integrate and reconfigure both external and internal skills, resources and functional competences is of particular importance (Teece, Pisano and Shuen 1997: 515). Moreover, it is recently discovered that the required knowledge is not necessarily produced inside the organization, but is likely to originate externally (Chesbrough 2003, Duysters et al 1999).

In line with this, a number of empirical studies reveal that in an attempt to manoeuvre in an increasingly competitive environment a growing number of firms turn to external partners for innovative ideas and new knowledge. This is the case even when it comes to activities relating to the strategically important R&D processes. Corporate interest in participating in inter-firm networks is certainly on the rise (Hagedoorn 2002). Besides, recent research has identified an increase not only in the number of firm-external relations, but also in the percentage of revenues that derive from these strategic alliances (Heimeriks 2004).

These strategic relations can be variously shaped, ranging from licensing agreements to joint ventures (Contractor and Lorange 2004), and the reasons for engaging in inter-firm networks are as numerous and diverse as the types of relations themselves. However, fierce competition in knowledge intensive fields, the speed of technological change, and the need for diversity in knowledge production processes, and intense globalization, are among the most frequently mentioned reasons for firms to expand their organizational borders and engage in knowledge networks.

R&D collaborations are based on a variety of motives and they can change over time (Hagedoorn 2002). The reason for entering into a knowledge network is not necessarily the same for all partners in the network. Small

research departments or companies may see collaboration with a larger company as an opportunity to gain faster access to markets, while the same relation might be an opportunity for the larger company to get access to complementary competences or new knowledge production processes.

## **2.2 'The Open Innovation Paradigm'**

The focus on sources of external knowledge used in the innovation processes is captured by the idea of "the Open Innovation Paradigm" (Chesbrough 2003). As Chesbrough declares, "Open Innovation is a paradigm that assumes that firms can and should use external as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology" (Chesbrough 2003:xxiv). The Open Innovation Paradigm differs from an earlier view of the innovation process, according to which successful innovation requires internal control, i.e., that a firm must generate their own ideas and fully control the subsequent processes of developing, marketing, distributing and financing these ideas (Chesbrough 2003: xxvi). The Open Innovation paradigm in contrast calls for a more sensitive relation to external knowledge (Chesbrough 2003). But being open to external sources of knowledge, raises a number of challenges. A central challenge has to do with the need to protect the knowledge acquired through these external sources. When innovation requires openness and the ability to capture the returns of the innovation requires appropriability, two conflicting strategies meet, giving rise to a situation labelled 'the Paradox of Openness' (Laurson and Salter 2005a).

All things considered, the Open Innovation Paradigm raises a number of questions regarding the costs and benefits of relying on external knowledge in the innovation process. It becomes very important to examine the factors that affect the possible level of openness and thereby influence a firm's decision on whether or not to collaborate with external partners.

## **3. The Determinants of the Level of Openness**

### **3.1. Factors affecting the decision to collaborate**

In general, a number of factors motivate a firm to do R&D in collaboration with others. The question of whether to collaborate with an external partner for the purpose of accessing the assets needed or to integrate the activities can be set up as chain of questions guiding the innovator through to the end decision of whether or not to collaborate (Teece 1986). Each 'step' can be viewed as a trade-off between using internally produced knowledge

(internalising the knowledge) and of sourcing externally the knowledge needed (collaborating with R&D partners) in the innovation processes. According to Teece (1986) a firm has to go through six different levels when deciding whether to collaborate or not. First, the decision relies on whether complementary assets are necessary for commercial success, secondly it has to be determined whether the assets needed are specialized, and thirdly the character of the appropriability regime is important. A fourth issue to determine is whether specialized assets are critical, and to prove the status of the cash position. Finally the position of the competitors will have to be considered (Teece 1986: 636). These different decisions all affect the number of R&D projects done in collaboration with external partners.

As illustrated the factors motivating a firm to engage in collaboration are many. These motivators can be categorized into three main groups: motivational factors related to the need for complementary knowledge (1), motives connected to the need for sharing the risk and the cost related to the R&D projects (2), and finally motives which are specific to the focal company (3). These three groups of motives will be presented in the following.

### *3.1.1 Access to Complementary Knowledge*

The fundamental factor in the R&D process is the creation and use of knowledge. When firms choose to open up to external sources of knowledge in their R&D process it often, as mentioned, serves the purpose of accessing complementary knowledge, i.e. knowledge that add to and match the knowledge already at hand.

A firm's exposure to knowledge within its environment will influence the development of future capabilities (McGrath, MacMillian and Venkataraman 1995), yet this knowledge needs to complement the knowledge already at hand to ensure learning, defined as the extent to which knowledge is related to and at the same time different from the knowledge in their networks (Lofstrom 2000). From a resource-based point of view, access to external complementary knowledge is a dominant motive for participating in knowledge networks. As knowledge creation and innovation are becoming increasingly multidisciplinary, a combination of scientific skills and intellectual capabilities that normally exceed the capabilities of a single firm is often needed to generate research breakthroughs (Powel, Koput & Smith-Doerr 1996). This motivates firms to exceed their organizational borders when new knowledge is asked for.

### 3.1.2. *Cost and risk sharing*

Another group of motivators relates to different types of possible resource constraints in the firm. As often pointed to nearly no firm has the financial resources needed to undertake the R&D projects they want to do by themselves. Seen from an economic angle the reasons for engaging in knowledge networks are therefore often related to cost sharing among the participants, leveraging economies of scale in R&D, and avoiding the duplication of already achieved results (Sakakibara 2003).

The transaction cost economic (TCE) perspective is often used to understand more fully the forms; functions and effectiveness of inter-organizational strategies (see Zajac and Olsen 1993). A central understanding in the transaction cost view is that a firm collaborates when the payoff for collaborating exceeds that of proceeding alone (Williamson 1991, Eisenhardt and Schoonhoven 1996). Even though scholars point to some shortcomings of this perspective (e.g. that the TCE perspective is focusing on the benefits of the hierarchy for mitigating contracting problems) (Heiman and Nickerson 2004), the insights from TCE are suitable for the study of a part of the knowledge-sharing/knowledge-exploitation dilemma (Heiman and Nickerson 2004).

### 3.1.3. *Company related factors*

A last group of motivation factors can be composed under the label, 'company related factors'. These can be internal as well as external in nature, but they all relate to the state of the focal firm. Often a firm will have firm specific reasons (e.g. due to strategic considerations) to collaborate.

*The need for complementary assets.* A primary determinative for the level of openness in the R&D process is the need for complementary assets (Teece 1986). If complementary assets (e.g. marketing, competitive manufacturing or after sale support) are necessary for the successful commercialization of the innovation, but are not specialized (i.e. unilateral dependent to the innovation at stake), they ought to be accessed through an external partner (Teece 1986:296). Furthermore the importance of these specialized assets to the commercialization of the innovation should affect the decision to collaborate or not; e.g. if the specialized assets are not critical they can be sourced externally. The need for complementary assets to secure commercial success is of course more common in a small firm with limited access to assets inside the company. Yet, due to rapid technological change both small and large firms may possibly experience that technologies advance so rapidly that it is unlikely that a single company will have a full range of expertise needed to

bring advanced products to market in a timely and cost effective fashion (Teece 1986).

*Timing.* Timing is potentially a very important determinant for the decision to collaborate. One main characteristic of R&D opportunities is that they are often temporary which means that an innovator needs to exploit the opportunity quickly before the information leaks to competitors, or before the opportunity is replaced with a technologically more advanced alternative, i.e. before the window of opportunity closes (Katila and Mang 2003). A situation where the innovator due to competition does not have sufficient time to build the knowledge or complementary assets needed, the time issue can force the firm to collaborate to access the required assets. This is particularly true when imitation is easy (Teece 1986:634). In fact prior research has shown that discoverers of technological opportunities can access resources for exploitation most effectively through collaboration (Mitchel and Singh 1996).

### **3.2 The Main Determinants**

In addition to the different motives for wanting to engage in R&D collaboration some determinants affect the level of openness in a given firm. Two central determinants will be discussed here, that is the 'absorptive capacity' of the firm and the 'appropriability of knowledge'. Individually they represent the two poles of the dilemma presented in the beginning of the paper; namely that R&D firms are faced with the dual challenge of accessing external knowledge by collaborating across borders (touched upon in the part about the absorptive capacity of the firm) *and* simultaneously creating and protecting knowledge internally in order to gain competitive advantage (related to in the part about the appropriation of knowledge).

#### *Absorptive Capacity*

The first factor affecting the level of openness is related to the ability of a firm to digest and use the knowledge produced in an inter-firm setting. In the knowledge society, a number of features make it easy for organizations to find and relate to external knowledge resources, but access to existing knowledge is not enough to enhance competitiveness. Whether firms succeed in their network activities is a question both of finding the right partners and of being able to incorporate and make use of the new knowledge involved. The latter issue concerns the absorptive capacity of the firm (Cohen & Levinthal 1990). Absorptive capacity is the three-pronged capability of recognizing the value of new, external information, assimilating it and applying it to commercial ends in the firm. A number of sub-issues proceed from the issue of absorptive capacity. It is, for example, important to understand the differences between individual

and organisational absorptive capacity as well as the differences between absorption of internal knowledge versus absorption of external knowledge.

The construct of absorptive capacity has been widely used by scholars analysing diverse, significant and complex organizational phenomena. One reason for this popularity could be that the notion directs attention to the mechanisms that lie between external knowledge and firm-level innovation performance (Foss, Laursen and Pedersen 2005). Pointing out that it is still very ambiguous and diverse in its definitions, components, antecedents, and outcomes, researchers have been calling for clarification and operationalization of the construct (Matusik and Heeley 2001, 2005). To meet this quest for clarification Zahra and George (2002) suggests that a firm's absorptive capacity can be seen as consisting of two subsets namely potential and realized absorptive capacity. Potential capacity comprises knowledge acquisition and assimilation capabilities, while realized capacity centres on knowledge transformation and exploitation (Zahra and George 2002). When studies show a positive relationship between absorptive capacity and a firm's competitive advantage (i.e. improvement of the innovative output) it is often related to the realized absorptive capacity. Still, the (less exploited) potential absorptive capacity provides a firm with strategic flexibility and the degrees of freedom to adapt and evolve in changing environments and thereby allows the firm to sustain a competitive advantage even in a dynamic industry context (Zahra and George 2002).

Through development of a model that connects the antecedents, moderators and outcomes of absorptive capacity Zahra and Gorge (2002) suggests that both external knowledge sources and a firm's past experience significantly influence the potential absorptive capacity of a firm. Zahra and George propose that the greater a firm's exposure to diverse and complementary external sources of knowledge the greater the opportunity is for the firm to develop potential absorptive capacity.

Being exposed to external knowledge will not in and of it self lead the firm to gain from this external knowledge. A number of activation triggers can moderate the impact of external knowledge sources and past experience of the firm's potential absorptive capacity (Zahra and George 2002). These triggers can be events that encourage or compel a firm to respond to specific internal or external stimuli (Winter 2000). Internal triggers could be crisis occurring inside the company, while externals triggers are events that may influence the future of the industry in which the firm operate (Bower and Christensen 1995). Adding the concept of activation triggers to the model of absorptive capacity, draws attention to the different events, which can influence a firm's ability to

internalize new knowledge. Addressing and analyzing the activation triggers (i.e. technological shift, new market opportunities, or need for new knowledge inside the firm) contributes to a better understanding of how the firm must organize the process of acquiring and assimilating new knowledge and how they need to invest in and improve their absorptive capacity. It is even shown that it is possible to identify events (or 'occasions'), that have a potential effect on the structure of the industry network a given firm is a part of. Some events are structure reinforcing (i.e., the existing distribution of network power is strengthened) and some are structure loosening (i.e. the existing distribution of network power is weakened), yet as both types of events are possible to identify in advance these they can be used as clear signals to managers and guide them in initiating strategic moves (Madhavan, Koka and Prescott 1998).

#### *Appropriability of Knowledge*

Firms undertaking R&D must be able to appropriate returns sufficient to make the investment worthwhile (Levin et al. 1987). The question of appropriability is essentially about the possibility of capturing parts of the rent stream from a given innovation. As defined by Teece et al (1997): "Appropriability is a function both of the ease of replication and the efficiency of intellectual property rights as barriers to imitations" (1997: 526). If the knowledge or technology involved is hard to imitate and can be protected by, say, a patent, then appropriability is defined as strong. Appropriability is weak when knowledge is easily imitated (usually because it is codified) and cannot be legally protected (Teece et al 1997). The scope in which knowledge and innovation can be protected from imitators thus depends on features of the firm's core knowledge (i.e. tacit/codified knowledge) and the effectiveness of legal protection (Teece et al 1997).

Patenting is of course one very popular way of appropriating returns from research and development investments. Yet studies have shown that both acquiring lead time and exploiting learning curve advantages can be more important methods of appropriating returns (Levin et al 1987). Thus, in addition to legal protection, more informal mechanisms can be used to secure gains from innovation (Cohen, Nelson and Walsh 2000). Indeed, firms use a wide variety of appropriation mechanisms and studies have shown that firms that use a legal appropriation strategy also tend to use first mover appropriability strategy (Laursen and Salter 2005b). Informal protection can take the form of creating a corporate culture that signals a more prudent relation to competitors or future partners.

Yet other factors are dominating a firm's attitude towards external sources of knowledge as well. Tidd and Trewhella (1997) examine the factors affecting

38 firm's decision on acquiring external technology, and find that the factors can be grouped into two categories; *Organizational factors*, comprising 'corporate strategy', 'fit with competencies', and 'company culture' and *Technology factors*, comprising 'competitive impact', 'complexity', 'codifiability' and 'credible potential' (Tidd and Trewhella 1997).

Some factors might not be directly affecting the decision to collaborate, but are taking the shape of mediators when a company is engaged in R&D collaboration. These factors are Managerial Competences and Collaboration Skills.

*Managerial Competences.* A central issue in this discussion is the capability of the managers (R&D managers in particular) to orchestrate the process of R&D collaboration. The management team members are often the conceptualizers of collaboration strategy and the key sources of leads to potential alliance partners. Further the top managers usually serve as the principal negotiators of the alliance agreement, and the strategic alliance formation can be seen as a complex phenomenon involving both strategic and social factors (Eisenhardt and Schoonhoven 1996).

One central tension in the R&D process is the dilemma that can be framed as the knowledge-sharing/knowledge-expropriation dilemma (Heiman and Nickerson 2004). It deals with the situation occurring when collaborators have to adopt a variety of practices to facilitate the transfer of knowledge, but in doing so may increase the likelihood that knowledge which is beyond the scope of the collaboration, and difficult to legally protect, is expropriated (Heiman and Nickerson 2004:401). To handle this dilemma Heiman and Nickerson (2004) predict that managers adopt knowledge management practices such as 1) communication channels that are high in bandwidth and 2) communication codes that are increasingly co-specialized (not generic), as the degree of tacit knowledge and problem solving complexity increases (Heiman and Nickerson 2004). However when tacit knowledge and problem solving complexity are not present in the collaboration, costly knowledge practices and governance can and should be avoided. By using both the framework of the Knowledge-Based View and the Transaction Cost Economics Heiman and Nickerson propose a chain of relationship between these two frameworks that clarify the need for managerial awareness of different elements of the knowledge-sharing/knowledge-exploitation dilemma (e.g. the effect the different knowledge attributes can have on the transfer cost) (Heiman and Nickerson 2004).

*Collaboration Skills.* When looking at factors that influence how a firm absorbs external knowledge, the nature of the relation between the companies involved has to be considered. Lane and Lubatkin (1998) show, that the ability to learn from another firm is jointly determined by the relative characteristics of the firms (Lane and Lubatkin 1998). In doing so, they re-conceptualize the construct of absorptive capacity, resulting in a concept of relative absorptive capacity. In a setting where they describe the one firm as a teaching firm and the other as the student firm they state that three characteristics determine the absorptive capacity of a firm; a) the specific type of new knowledge offered by the teacher firm, b) the similarity between the student and the teacher firm's compensation practices, i.e. the similarity of two firms' compensation policies serves as one proxy for the similarity of their knowledge-processing systems and norms (Lane and Lubatkin 1998:465) and organizational structures (structures are important to how firms processes knowledge because organizational members interact not only as individuals, but also as actors performing organizational roles (Lane and Lubatkin 1998:465); and c) the student firm's familiarity with the teacher firm's set of organizational problems (i.e. the way a firm deals with organizational problems is a function of the dominant logic of that firm, or the common thread running through all the objectives of a firm (Lane and Lubatkin 1998:466).

As Lane and Lubatkin conclude: "Even if the students understands the know-what (scientific knowledge) and the know-how that shaped it (the knowledge processing systems) its ability to commercially apply the new knowledge will largely depend on the degree to which its know-why (dominant logic) overlaps with the teacher's... the more familiar the student is with the types of problems or projects that the teacher prefers, the more readily it will be able to commercially apply new knowledge from that teacher" (1998: 466).

#### **4. Methodology - and Case study presentation**

As the objective of this paper is mainly to position my work theoretically my empirical work will not be presented in detail. Yet as many of the themes discussed in this paper are as well inspired by preliminary discussion with representatives from the four cases I am going to study, as well as defined through expert interview in two of the four cases, I find it important to mention, briefly, how I am going to go forward with the case studies in my project.

The empirical part of this project will be conducted as a *collective case study* (Stake 2003). By this is meant that the overall study will consist of four

*instrumental case studies* (Stake 2003)<sup>1</sup>, which will be carried out not as much to learn about this single company as to provide insight into the core theme, namely the use of external sources of knowledge, and to redraw a generalization about the issue at stake. Although the four cases defined seem to be four very interesting and illustrating examples of how companies can deal with and benefits from engagement in knowledge networks, the cases are not as such of primary interest; they are chosen because they, each in there own way, facilitates the understanding of the main issue. It might even be that a better understanding of these four cases will lead to a better theorizing, about a still larger collection of cases (Stake 2003).

The case study is a research strategy which focuses on understanding the dynamics presented within single settings (Eisenhardt 1989). To get a firm understanding of how a given variable can be said to affect, *in general*, the optimal level of openness towards external sources of knowledge, it is essential to study if or how it affects the openness in *the specific* case.

Using a strategy that can be labelled “stacking comparable cases” (Miles and Huberman 1994), I will be writing up the four cases, using a standard set of variables (whit leeway for studying uniqueness as it emerges). For each case will be used interviews, expert interview, and data material from the firms studied. After working through each case I will ‘stack’ the case-level displays in a matrix which will be condensed in a way that permits systematic comparison (Miles and Huberman 1994: 176, Eisenhardt 1989). The main purpose of the cases studies will be to get a thorough understanding of the main determinants of the level of openness.

## **5. The model and the future research**

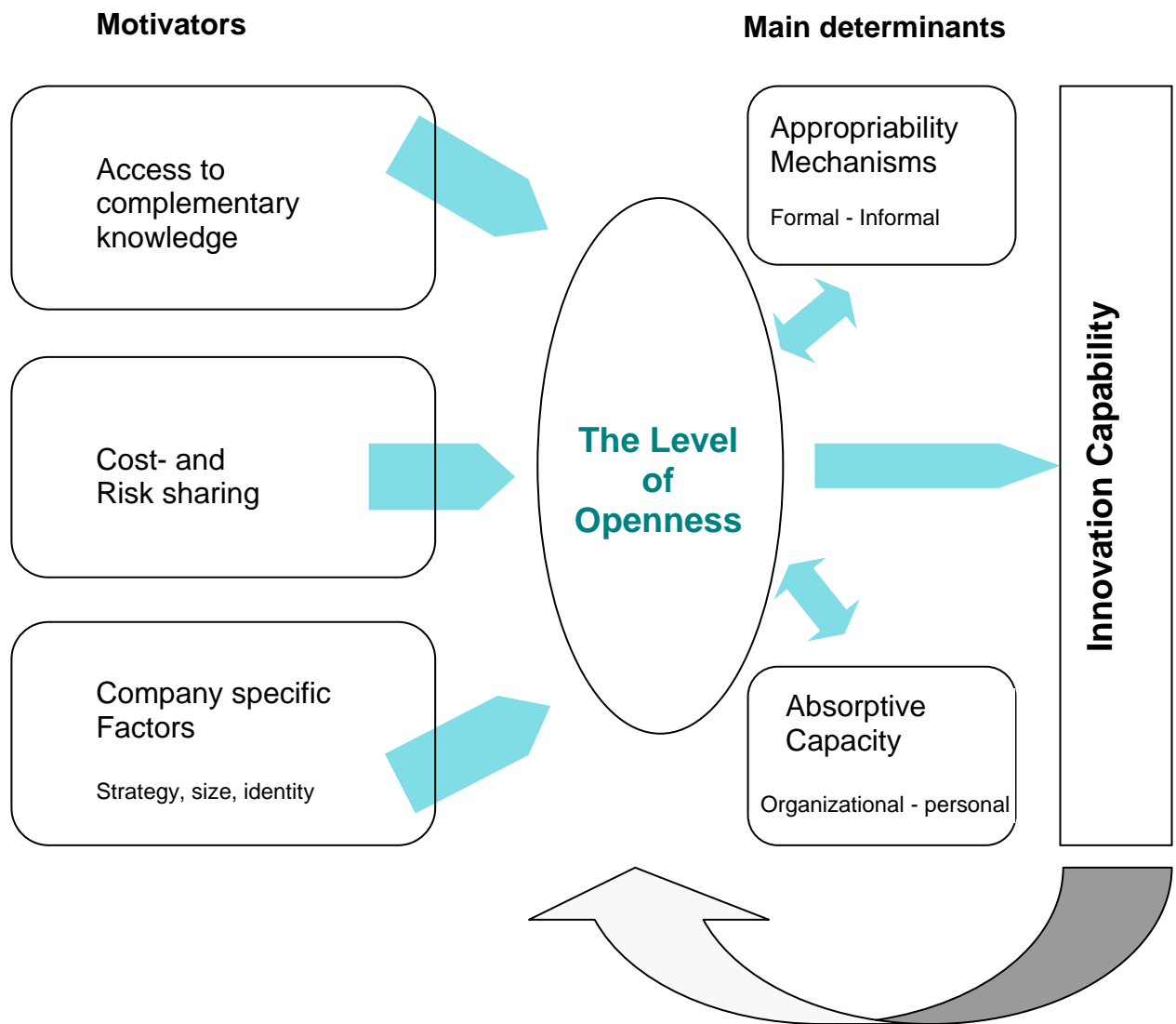
A model is developed comprising the different factors, motivators as well as determinants put forward in the preceding chapters. The relation between the dimensions, the level of openness and the innovation capability is illustrated below. Every motivational factor contains a number of elements (not yet illustrated), and some of them are likely to be subordinated to others. Others might affect innovation capability directly, and take the shape of moderating variables. The further study will reveal the relations and the character of the determinants presented in this paper.

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<sup>1</sup> An *instrumental* case study contrast with an *intrinsic* case study. The later is undertaken because a better understanding of this particular case is wanted; the case itself is of interest (stake 2003:136).

Model 1:

The Main Determinants of “Openness” in R&D Collaboration



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