

# Connecting absorptive capacity and open innovation

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## 1. Introduction

Open innovation and absorptive capacity are two popular concepts in contemporary innovation management literature. To our knowledge, they never have been connected to each other in a systematic way although it is straightforward that firms' absorptive capacity, as it has been defined by Cohen and Levinthal (1990), determines their ability to in-source externally developed technology or ideas. In this paper, we tie these two concepts to each other and demonstrate how the recent insights about technology markets (Arora et al., 2001) and open innovation can advance our understanding of absorptive capacity.

The burgeoning management literature on open innovation has revitalized the interest of companies to tap into external sources of knowledge. Chesbrough et al. (2006, p.1) define open innovation as "... the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively." External technology sourcing is becoming more important for a number of reasons: Shortening technology life cycles, emerging technologies with the potential to disrupt market leaders' positions, sharing costs and risks associated with science based technology such as nano-electronics, globalization of the R&D activities as a response of companies to the greater dissemination of knowledge throughout the world, increased rivalry between firms in their product markets, the growing importance of seed and venture capital to finance excellent business ideas, etc...

These inter-organizational knowledge flows do not materialize automatically and firms have to develop skills to tap into external sources of technology. Cohen and Levinthal (1990) coined the term absorptive capacity and defined it as the ability of innovating firms to assimilate and replicate new knowledge gained from external sources. The ability to recognize, value and exploit external sources of knowledge in general and technology in particular is crucial in explaining organizations' innovative capabilities (Cohen and Levinthal 1990, Leonard-Barton 1992, Dyer and Singh 1998). Firms differ in their ability to exploit these external technology sources since absorptive capacity can be understood as a firm-specific dynamic capability which is

build over time (path-dependency) based on organizational routines (Teece et al. 1997; Winter, 2003).

Furthermore, absorptive capacity is crucial in explaining why some companies are much better than others in creating and capturing value from in-sourcing externally developed technology and technological collaboration with innovation partners. Hence, absorptive capacity and the outside-in dimension of open innovation<sup>1</sup> are necessarily linked to each other. The purpose of this paper is to analyze how absorptive capacity and the outside-in dimension of open innovation can be linked to each other<sup>2</sup>. We claim that recent insights from open innovation practices in companies entail several clues to enrich the concept of absorptive capacity and to improve our understanding how management decisions can strengthen a firm's ability to learn from its external environment.

In the past decade we have witnessed a strong emphasis on the question how firms can learn from knowledge and resources outside their organizational boundaries. Both the literature about absorptive capacity (Lenox and King, 2004, Arora and Gambardella, 1990; Ireland, Hitt & Vaidyanath, 2002) and the one about open innovation (Chesbrough, 2003, 2006; Chesbrough et al. 2006; Christensen et al., 2005) have been focused on how innovating companies can benefit from external sources of technology through corporate venturing, alliances, licensing, etc... However, the attention towards external knowledge sources does not diminish our need to understand how companies can generate and manage *internal knowledge* (Gambardella and Giarratana, 2006). Internal knowledge or technological capabilities remain crucial in determining firms' innovative capabilities and financial performance even when firms divert their attention more and more towards external knowledge. Open innovation scholars have been arguing in the same way; In line which Cohen and Levinthal (1990) Chesbrough (2003, 2006) and Gassmann and Enkel (2006) stressed the need to balance the ability to profit from external knowledge sources and the ability to develop and exploit internal knowledge.

Moreover, the presence of valuable external sources of knowledge does not imply that the inflow of new ideas into the organization is an automatic or easy process. External knowledge can only be recognized, accessed and assimilated when firms develop new routines and change their organizational structure and culture to facilitate open innovation processes (Dalander and Gann, 2007). A thorough understanding of open innovation requires a better understanding of these insourcing mechanisms, routines and structures. Hence, it is necessary to explore how open innovation forces firms to develop new organizational routines to tap into external knowledge. In other words, the developing and improving the absorptive capacity of innovating firms is at the heart of open innovation. Consequently, the combination of research about open innovation on the one hand and absorptive capacity on other hand has the potential to strengthen our understanding of absorptive capacity.

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<sup>1</sup> Gassmann and Enkel (2006) define the outside-in process as follows: Enriching a company's own knowledge base through the integration of suppliers, customers and external knowledge sourcing can increase a company's innovativeness.

<sup>2</sup> We could also include the inside-out dimension of open innovation, but we expect that this would divert our attention away from the original idea of Cohen and Levinthal (1990) who emphasized how companies could benefit from outside sources of technology.

The paper is structured as follows. First, we focus on the question how complementarity between internal and external technology plays a role in open innovation and absorptive capacity of innovating firms. Next, we analyze how the outside-in dimension of open innovation can be decomposed into four constituent dimensions and how it can, in this way, be related to different literature streams; the business model (strategy), transactions / networks (TCE, network view), capabilities or competencies (RBV), and uncertainty (real options). We claim that we can enrich our understanding of the absorptive capacity concept by combining these four dimensions. Next, we illustrate how absorptive capacity can be built by best practices in open innovation. Finally, we provide the preliminary conclusions and some indications for further research.

## **2. Internal and external innovation as complements**

During the last two decades firms have focused increasingly on external sources of innovation to improve their innovative and financial performance (Hagedoorn and Schakenraad, 1994). Even large organizations no longer rely solely on their internal innovation capabilities. They tap into external sources of technology through licensing, R&D outsourcing, corporate venturing, spin-ins and acquisitions in addition to their development of internal technological capabilities. However, the role of cooperative agreements should be analyzed in the broader context of the firm's innovation strategy. Firms that decide to be innovation active need to understand the complementarities that exist between own R&D programs, cooperative agreements in R&D, and external technology acquisition in order to take advantage of publicly available information within the innovation process, and, to better appropriate the results of successful outcomes of the innovation process.

Internal and external sources of knowledge are complements (Cassiman and Veugelers, 2002). They have to be combined to improve the innovative performance of companies. On the one hand, companies require internal R&D capabilities to recognize and monitor interesting technologies that are developed elsewhere. On the other hand, internal research capabilities are indispensable to effectively exploit external know-how (Arora and Gambardella, 1994; Rosenberg, 1990; Cohen and Levinthal, 1989). This is also echoed in the open innovation literature; internal R&D spurs a more effective monitoring and use of external knowledge resources and networks (Zook and Rigby, 2002; Chesbrough, 2003;2006). Cassiman and Veugelers (2002; 2006) and Veugelers (1997) found that innovating firms are performing better when they combining internal innovation activities with external technology sourcing. External acquisition and internal R&D are considered to be *complements*, not substitutes. This implies that managers have to integrate tightly the internal and external knowledge to capture the positive effects each type of innovation has on the marginal return of the other. Internal and external innovation activities are not only complementary, but the reliance of firms on external technology implies also that it has to change its internal innovation activities compared to a closed innovation.

Cohen and Levinthal (1990) argue that the ability to tap into external technology sources may be created as a byproduct of a its prior R&D investment, or firms can invest directly in absorptive capacity when for instance personnel participates in advanced technical training. Todorova and Durisin (2007) have refined the concept of

absorptive capacity<sup>3</sup>: Following Jansen, Van den Bosch, and Volberda (2006) they conclude that acquisition, assimilation, transformation and exploitation of external knowledge are four distinct dimensions of absorptive capacity. Absorptive capacity is furthermore moderated by two factors: on the one hand organizational routines and processes that make internal skills and resources work together (Amit & Shoemaker, 1993; Grant, 1991, 1996; Prahalad and Hamel, 1990) and on the other hand power relationships both inside the firm and those with customers and others external stakeholders (Pfeffer, 1981). As a result, absorptive capacity can only be fully understood when we also analyze the internal structures and processes of a company. Similarly, to understand the outside-in dimension of open innovation, we have to look at the organization structure and the routines innovating firms establish to optimally tap into external sources of knowledge.

In the next section we explore open innovation from several theoretical angles in order to understand absorptive capacity in a different but complementary way than the current literature that focuses directly or exclusively on absorptive capacity. We claim that an analysis of open innovation practices based on different theoretical perspectives can enrich or understanding of the absorptive capability of innovating firms. In the next section we have a look at business models, network theory and transaction cost economics, resource based view and real option theory as interesting avenues to embed open innovation in the existing literature and to combine it in that way with the insights about absorptive capacity.

### **3. Open innovation, absorptive capacity and underlying management theories**

Open innovation stems from practice oriented research. Chesbrough (2003, 2006) developed his view on open innovation by observing and analyzing the recent (r)evolution of different innovation practices in large companies. Since open innovation is closely related to managerial practice it has the advantage of providing an integrative approach to innovation management; Corporate and business strategy, business modeling, collaborative agreements with innovation partners, IP-policy, etc... are integrated with each other in a model that has proven to be valuable in practice. At the same time, this practice based approach has the disadvantage that thus far open innovation has only been loosely connected to the existing innovation management literature and its underlying management theories<sup>4</sup>. In this section, we first search for management theories that are compatible with open innovation. Next, we analyze whether or not open innovation and absorptive capacity share the same theoretical underpinnings.

Chesbrough's (2003) open innovation model can be decomposed into 4 constituent dimensions; value creation and capturing via the business model, transactions / networks with innovation partners, capabilities or competencies, and coping with technological and market uncertainty which is embedded in the funnel concept. These dimensions indicate that *open innovation can only be understood by combining*

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<sup>3</sup> Their analysis is at the same time a critique on the model of Zahra and George (2002).

<sup>4</sup> To our knowledge Laursen and Salter (2006), Christensen et al. (2005), Chesbrough et al. (2006) and Gassmann and Enkel (2006) are the only exceptions. However, no scholar attempted so far to clarify the theoretical assumptions that are implicitly present in open innovation.

*different management theories.* As a result, the challenge of analyzing open innovation in terms of its underlying theoretical assumption is the necessity to combine different streams of literature that have been developed in isolation from each other. Different management theories offer only a partial explanation of the phenomenon of open innovation. Combining these theories to some extent is required to understand open innovation from a scholarly point of view. More specifically, we will look at value creation and sharing in cooperative settings (Brandenburger and Nalebuff (1996) ), transaction cost view (Williamson, 1975, 1985), the resource based view (i.e. Wernerfelt, 1984; Barney, 1986, 1991), the relational view (Dyer and Singh, 1998; Dyer, 1999), organizational learning theory (March and Olsen, 1975; Levinthal and March, 1993) and real option theory (Folta, 1998).

Each of these management theories will be related to open innovation and absorptive capacity to some detail. The comparison should indicate in which way the analysis of outside-in knowledge flows as part of open innovation can further improve our understanding of absorptive capacity.

### **3.1 Value creation and value capturing and networks**

#### *Short intro*

Innovation based value creation for a targeted customer group is at the center of open innovation. Rosenbloom and Chesbrough (2002) have demonstrated in detail that value creation and capturing processes are determined by the business model, which is a central idea in open innovation. Similarly, value creation and capturing are also at the center of strategy analysis (Bowman and Ambrosini, 2000; Hawawini et al. 2004) suggesting that there is a strong, although yet fairly unexplored link between open innovation and strategy making processes.

Let's take 'value creating systems' as an example to compare open innovation with the classical strategy analysis framework. Porter (1985, 1990, 1996) has argued in length that value is created by a "value creating system" – a vertical chain extending from suppliers in upstream industries to buyers of products or services: "Gaining and sustaining competitive advantage depends on understanding not only a firm's value chain but how the firm fits in the overall value system" (Porter, 1985, p. 34). However, there is a major difference between value creation within the open innovation context and within a classical "value system". In the classical value system every company occupies a particular position within the value system and adds value to the inputs before passing them to the next actor in the chain. Relationships between firms (suppliers, distribution channels, substitutes, etc...) are described bilaterally as simple exchange relations and are mainly dealt with by means of arm-length transactions. Managing and organizing requirements are restricted to activities within the firms<sup>5</sup>. There is a clear distinction between firms and markets; outside the firm boundaries only markets exist. On the contrary, in open innovation a firm collaborates with technology providers, suppliers and/or customers (Von Hippel, 1988, 2005) to improve its internal innovation capabilities or to expand the markets for the external use of internal innovations (Chesbrough, 2003). In an open innovation context, firms

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<sup>5</sup> The traditional value system approach has already been challenged in the past by several authors (Brandenburger and Stuart, 1996; Stabell and Fjeldstad, 1998; Ramirez, 1999, Ramirez and Wallin, 2000).

*jointly* create value through a number of non arm-length transactions in so-called value networks.

Accordingly, open innovation should be linked to the concept of co-opetition (Brandenburger and Stuart 1996). In co-opetition collaborating actors create value because they combine different skills, competencies. But the value that is jointly created has also to be divided. This is the fundamental duality in co-opetition and in open innovation: "whereas value creation is an inherently cooperative process, value capturing is inherently competitive" (Brandenburger and Nalebuff 1996, p. vii). The joint value creation in open innovation depends on the strength of the ties among the partners. Hence, the quality of the relations between an innovation firm and its partners determines the size of the pie. The share each participant gets is determined by two factors: the first factor is the bargaining position of each company (Porter, 1985). In traditional competitive strategies value creation can be considered separately from the value capturing process since it is framed as a zero-sum game (which is typical for price-negotiations in commodity markets). Second, in value networks capturing value has to be considered jointly with value creating strategies because the quality of the cooperation among players determines the value a participant can claim. Hence, firms have always to consider a trade-off: being too greedy in claiming its part of the pie, might reduce the size of the pie because it might endanger the trust among the firms and the quality of their cooperative agreements<sup>6</sup>.

At first sight, business models and strategy making processes are not relevant for absorptive capacity, since it is defined the capability to absorb external knowledge. However, innovating firms have to determine at *the corporate level* which technologies are important enough to acquire from external partners (Vanhaverbeke and Peters, 2005). At *the business level*, they have to figure out how externally sourced technology can be leveraged to generate value for a customer group and how the company can capture part of that value that it has generated together with its partners. Business models also determine which type of innovations it will develop as products and which it will out-license or divest as a spin-off. In this way, they determine also which external technologies an innovating firm has to in-source in order to minimize "false positives".

### ***3.2 Interorganizational transactions***

Open innovation could be seen as the result of a steady increase of interfirm specialization of innovation activities. The emergence of new, science based technologies, the increasing innovation costs, and the increasing technological complexity of products and services (Grandstrand et al. 1992; Prencipe and Brusoni) has led to the fast growth of specialized technology suppliers and intermediary organizations that engage in a narrow range of activities which they exchange with other organizations in the value chain. R&D labs in big companies may still benefit from scale and scope advantages in R&D, but have to be weighted against the advantages of an open innovation model in which innovating firms profit from externally developed technology and ideas. Tapping into external innovations has

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<sup>6</sup> Interestingly enough Porter (1996) also elaborates on "activity systems" of companies which have a lot of similarities with the "value network"-concept and activity systems of companies, but the focus remains on the individual firms not the value net representing all firms involved.

disadvantages as well, which are related to the problems to trade technology (Gambardella, 2002) and transactions costs (Williamson, 1975, 1985). Because of the transaction costs and the sticky nature of the knowledge involved in most innovations, transactions between technology partners will be non arm-length transactions.

Transaction cost theory (Williamson 1975, 1985) emphasizes that companies choose for their economic exchange arm-length transactions, hierarchical control or intermediate governance modes (i.e., alliances, JV, etc...) in order to minimize the costs of economic transactions and to cope with the threat of opportunistic behavior. Opportunistic behavior is in its turn related to the transaction-specific-investments. When one party has made a large transaction-specific investment, i.e. an investment that should be considered as a sunk cost as it has no (little) value outside the specific transactional context, other parties has an incentive to behave opportunistically. Market transactions are usually highly efficient as transaction governance mode, but when opportunistic behavior is likely to occur, companies can mitigate the threat of opportunism by choosing for a hierarchical governance mode (e.g. acquiring the economic exchange partner) or alliances.

In line with several authors (Dyer, 1997; Madhok, 1997; Ring and van de Ven, 1992; Zajac and Olson, 1993) we argue that open innovation can be better understood by focusing on transaction value than on transaction costs. We argue that firms engaged in open innovation *maximize the transaction value* rather than minimizing transaction costs. The transaction value approach is an interesting framework to understand open innovation. Open innovation focuses on business models wherein the innovating firms turns technological inventions and ideas into new profitable products and businesses. Business models in an open innovation context describe how a firm can create value jointly with its partners and how it can capture part of that value.

We argue that companies involved in open innovation are primarily interacted in joint value maximalization – completely in line with the transaction value perspective. The threat of opportunistic behavior is of course always present, but it is suppressed by the fact that companies are continuously establishing non arm-length transactions with their technology partners. The inclination to act opportunistically is dominated "...by the firm's estimate of the negative impact that the opportunistic behavior will have on the value of the future exchange with its partner" (Zajac & Olson 1993, p. 137). The transaction itself is a value-bearing asset in and of itself.

Furthermore, Kogut (1988) argued in summarizing the literature about joint ventures that the value of cooperation among firms is based on strategic, learning and transaction cost objectives. Firms involved in open innovation can increase the strategic and learning gains from their cooperation with their partners, while simultaneously increasing transaction costs. Partners in open innovation are not interested in transaction cost minimization, but in the pursuit of transactional value they will choose cooperative modes with higher transaction costs, as long as "...the expected joint gains outweigh transaction cost considerations" (Zajac and Olson, 1993, p. 138). Dyer (1997) analyzes how partners invest in transaction specific assets (formal safeguards) and build strong relations based on goodwill trust or embeddedness and reputation (informal safeguards) (Gulati, 1995; Uzzi, 1997) to reach the full potential of the interorganizational collaboration. Transaction specific

expenditures are not considered as costs but as an investment in future value (Madhok and Tallman, 1998).

Open innovation has another characteristic in common with the transaction value analysis. They both concentrate on the *process* of value creation and distribution, there is an interesting match between both approaches. Transaction cost theory (Williamson, 1985) put emphasis on the governance structure of the transaction. The transaction value approach, on the contrary, emphasizes the process of governance how value is created and distributed over time (Zajac and Olsen, 1993; Madhok and Tallman, 1998). Value networks that are set up to develop and commercialize radically new products are not successful only because they are structured in a way that combines strategic resources of different partners, but also because the partners have developed over time the organizational mechanisms to realize benefits from these different strategic resources. The compatibility of systems, processes and culture among the partners is crucial in realizing the potential of a value network (see Doz (1996) for similar arguments on alliances).

Arora et. al (2001) have analyzed in detail how technology markets merged and prospered during the last fifteen years. Transaction cost still play an important role in the exchange of technology between (potential) partners, but new, specialized players in the market have developed business models that help breaking down transaction costs and facilitating open innovation interactions between different actors in the innovation chain. Nice examples of these specialized companies or technical services companies in the chemical industry (Arora et al, 2001); different types of innovation intermediaries – innomediaries – like Innocentive, Ninesigma, YourEncore, yet2.com, Ocean Tomo (Chesbrough, 2006); but also specialized organizations that enable companies to overcome minimum efficient scale in technology activities such as Sematech or IMEC<sup>7</sup> in nano-electronics. Hence, overcoming transaction cost or creating joint transaction value is not necessarily determined by the industry context: the emergence of organizations that facilitate technology transactions may foster open innovations practices.

Transaction specific costs and the emergence of technology markets influence how companies can build absorptive capacity. Building absorptive capacity is not only determined by the internal organization of the firm (prior R&D investments, innovation strategy, etc...) but also by the changes in the external / industry conditions and the breakthrough of organizations that facilitate technology trade and co-creation. The rapidly developing and changing markets for technologies, spurred by a broad set of specialized players, changes the odds for technological collaboration and. As a result, it also increases the role of absorptive capacity and requires that firms continuously adapt there internal routines to tap in an optimal way into external technologies. They have to do so because specialized players in the markets offer new opportunities for technology in-sourcing companies that were new unattainable or even unthinkable before. In short, we have to rethink absorptive capacity a dynamic capability (Teece et al. 1997; Eisenhardt and Martin, 2000) that has to co-evolve with changing markets for technology.

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<sup>7</sup> For more information see [www.imec.be](http://www.imec.be).

### ***3.3 Inter-organizational combination of resources, competencies and knowledge***

#### **The resource-based view, the knowledge-based view and organizational learning theory**

The third dimension of the open innovation model, resources, competencies and knowledge, is clearly embedded in the resource-based view, the knowledge-based view and the organizational learning theory of the firm. The resource-based view of the firm finds its origins in the work of Wernerfelt (1984) and Penrose (1959). A core feature of this management theory, is that value is created when the firm consists of a unique collection of difficult-to-imitate resources, competencies and capabilities (Barney, 1986, 1991; Grant, 1996; Wernerfelt, 1984). To create a competitive advantage and capture above-normal rate of returns (i.e. rents) these resources must, by definition, be scarce, valuable and reasonable durable (Barney, 1991). Work that is closely related to the resource-based view is the study of Grant (1996) who is one of the founders of the knowledge-based view. The knowledge-based view is an outgrowth of the resource-based view to the extent that it focuses upon knowledge as the strategically most important resource of the firm (Conner and Prahalad, 1996; Grant, 1996; Nonaka, 1991; Spender, 1989). Knowledge is also a central issue in several other research traditions that stress the importance of both organizational learning and the transfer and diffusion of innovative capabilities within the firm (e.g. Boisot, 1995; Grant, 1996; Huber, 1991; Levitt and March, 1988).

The resource-based view and the knowledge-based view argue that firms can create and capture value according to the unique bundle of resources they possess and the differences between these resources are held responsible for the differences in performance between firms (Bierly and Chakrabarti, 1996). In other words, proponents of the resource-based view or the knowledge-based view emphasize the fact that a sustainable competitive advantage is based on those resources (knowledge) and capabilities that are owned and controlled within the boundaries of a single firm (Dyer and Singh, 1998).

An important question that we have to ask ourselves in that respect is: "What is the value of this introspective viewpoint centered on the firm itself, in relation to open innovation?". Although the resource based view emphasizes that a firm's competitive advantage results from difficult-to-imitate bundles of resources within the boundaries of the firm, we argue that from the perspective of open innovation these resources should not be closed off within one single firm. Rather scarce, valuable and reasonably durable resources of different (previously independent) companies should be brought together in order to offer value for the targeted customers. Consequently, a firm's critical resources should extend beyond its boundaries and enable resource flows (knowledge flows) with external firms.

Subsequently, whereas the resource-based view and the knowledge-based view stresses such issues as independence and the crucial role of competition between autonomous companies based on the unique set of resources and capabilities they possess, open innovation emphasizes the interdependence of complementary resources of firms to introduce an innovative product in the market. This implies that we are in need of an extension of the resource-based view and the knowledge-based view with respect to the main theoretical premise underlying open innovation. Part of

this job has been done in the area of technology alliances (Kale and Singh 1998, Kale et al. 2002, Grant and Baden-Fuller, 2004, Gulati & Sytch, 2007) but more work is required to understand open innovation practices in terms of the resource or knowledge access and acquisition.

One of these extensions is the relational view of Dyer and Singh (1998), who were among the first to recognize that a firm's resources may span firm boundaries and interfirm linkages can be an important source of competitive advantage. They provide us with a theory through which we are able to explore value-creating linkages between previously independent organizations. Along with a growing interest for the relational view has come a consensus about the central argumentation underlying the relational perspective, i.e. that value-creating linkages between previously independent firms (at the dyad level, sub-group level or network level) can result in a sustained competitive advantage. More specifically, it proposes that: "relationships between firms are an increasingly important unit of analysis for explaining super-normal profit returns" (Dyer and Singh, 1998, p.676).

Although previous research shows that the percentage of revenues coming from inter-firm linkages has grown (Margulis and Pekar, 2001) and that successful value creating linkages outperform industry averages in terms of return on investment (Harbison and Pekar, 1998) we are particularly interested in those value-creating linkages that can be expected to have an influence on innovative firm performance (Shan, Walker and Kogut, 1994; Stuart, 2000). Scholars in the strategy field are progressively concerned with the differential effect of value-creating linkages on innovative firm performance (Hagedoorn and Schakenraad, 1994; Shan et al., 1994; Powell et al., 1996; Mitchell and Singh, 1996; Stuart, 2000).

Nowadays, especially high-tech sectors are characterized by rapid scientific and technological developments where knowledge is so broadly distributed that no single firm possesses internally all relevant information for successful innovation (Hagedoorn, 1993; Powell, Koput, and Smith-Doerr, 1996). This shortcoming of the resource based view (Dyer and Singh, 1998) has led to an emphasis on inter-firm linkages that facilitate learning, innovation, and the creation of new knowledge within companies (Kogut and Zander, 1992; Tsai, 2000). The choice for a specific form of inter-firm linkages depends on the goal an innovating company wants to realize: it can develop relations with universities and research institutions, establish dyadic relationships with other firms, create networks or acquire technology-based start-ups.

### **Reasons to combine resources (and especially knowledge)**

From a resource point of view, there are three important reasons why firms set up inter-firm linkages. First, companies team up with other companies to monitor and stay in touch with the latest technological developments (Vanhaverbeke, 2006). Second, collaboration enables the transfer and absorption of external knowledge and in that respect acts as an important supplement to the internal innovative activities of organizations (Ahuja, 2000; Deeds and Rothaermel, 2003; Eisenhardt and Schoonhoven, 1996; Grandstrand et al., 1997; Hagedoorn, 2002). Finally, companies are no longer able to exploit and commercialize innovative products on their own (Chesbrough, 2003; Grandstrand et al., 1996). So, inter-firm linkages help firms to obtain access to complementary resources that are needed to commercialize new products (Teece, 1986; Hagedoorn, 1993).

The three reasons mentioned above can be recognized as different stages in the open innovation funnel and each has important connections with the concept of absorptive capacity. The first dimension of absorptive capacity relates to the know-what of the company and is associated with the ability of the firm to recognize and value new external knowledge (Cohen and Levinthal, 1990). This ability is especially important when firms want to monitor and stay in touch with the latest technological developments, as mentioned above. The second dimension includes the know-how of firms and refers to the ability to assimilate new external knowledge. Even if a firm has the ability to recognize the value of new knowledge, the question remains whether it is able to absorb this valuable knowledge. The last dimension of absorptive capacity is related to the know-why aspect and involves the commercialization of external knowledge in order to achieve organizational objectives (Cohen and Levinthal, 1990). So, to understand a firm's absorptive capacity, one should focus not only on the boundary-crossing relationship between the firm and its partners but also on the internal organization of the innovation process, that determines the diffusion and exploitation of technological knowledge within the organization (Nooteboom et al., 2007; Levinthal and March, 1993; Argyres and Silverman, 2004).

Although there are differences between the three dimensions of absorptive capacity, they cannot be studied in isolation of each other. Consider for example the positive interrelationship when discussing the transfer of knowledge between firms. Transfer of knowledge involves both transmission and receipt (Grant, 1996). Receipt can be analyzed in terms of a firm's absorptive capacity, which plays a dual role in improving innovative performance (Cohen and Levinthal, 1989, 1990). When a firm increases its internal knowledge base by bringing in knowledge from an outside source, it can use this knowledge to generate new product and process innovations. In addition, the expansion of the internal knowledge base also increases the firm's ability to recognize the value of other external information, to transmit and assimilate this information and to further exploit this new knowledge for commercial ends (Cohen and Levinthal, 1989).

Besides positive interrelationships between the dimensions of absorptive capacity there are also negative interrelationships. For example, constantly recognizing and valuating the external supply of available new knowledge consumes managerial time, energy and resources of the firm that cannot be devoted to the absorption or integration process. Furthermore, a sole focus on searching and monitoring may result in a random drift in continuously different and unrelated technology landscapes (Fleming and Sorenson, 2001; Ahuja and Katila, 2004). The absorption of these unrelated technologies often requires a radical change in the way of organizing research (Kogut and Zander, 1992) and requires additional resources to be devoted to integration activities, leaving fewer resources for the actual innovative endeavor (Ahuja and Katila, 2001; Dosi, 1988). This can be explained by the fact that Cohen and Levinthal view absorptive capacity as an ability, which the firm develops cumulatively over time by accumulating a relevant knowledge base (Lane and Lubatkin, 1998). In other words, a firm's absorptive capacity depends to a large degree on its existing level of knowledge in a specific field and consequently is path dependent (Cohen and Levinthal, 1990; Dodgson, 1993; Duysters and Hagedoorn, 2000; Mowery et al., 1996). This implies that if the knowledge base of the firm is not

sufficiently adapted to the newly acquired knowledge, the absorption process becomes very difficult (Duysters and Hagedoorn, 2000).

### **Insights from open innovation and absorptive capacity**

From the above it becomes clear that absorptive capacity on the one hand creates opportunities for - and on the other hand also determines the limitations of interorganizational combinations of resources (knowledge) within an open innovation model. Firms operating within a closed innovation model may not be able to recognize and value the significance of novelty, simply because more distant knowledge falls outside the scope of their absorption capability (Ahuja and Lampert, 2001). When these firms begin to open up their innovation process and expand their internal knowledge base, they are able to increase their absorptive capacity significantly. However, during this process they will notice that there are limitations to a firm's ability to acquire unfamiliar new knowledge with the goal of increasing innovativeness. In acquiring new external knowledge, the firm tends to be constrained by its own existing knowledge base and past routines (Nelson and Winter, 1982). This means that it is advantageous to the firm to obtain unfamiliar knowledge in areas that are still somewhat closely related to its existing activities (Dosi, 1988; Teece, 1986). The advantage of this relatedness in technological knowledge is found in the rather smooth absorption process of the acquired knowledge base while changes in the organization of research will be incremental (Kogut and Zander, 1992). This implies that, in order to increase their innovative performance, companies have to target other firms with moderately related knowledge bases.

According to Nooteboom et al. (2007), this optimal overlap in knowledge is not fixed but depends on the firm's past investments in building up its technological knowledge base. Given the fact that this is a dynamic and continuous process, they argue that there may be increasing returns in absorptive capacity. Over time, the firm will enlarge its ability to understand more and more issues from a different perspective and quickly recognize the value of novel external knowledge, which can help the acquirer to develop an even richer knowledge base (Ahuja and Katila, 2001; Bierly and Chakrabarti, 1996; Levinthal and March, 1993; Vermeulen and Barkema, 2001). So in time, firms with a large knowledge base should have fewer problems in dealing with large differences in external knowledge.

In short, open innovation is focuses on how to combine different competences, or technological capabilities that reside in different (specialized) firms. RBV emphasizes that a sustainable competitive advantage is based on those resources (knowledge) and capabilities that are owned and controlled within the boundaries of a single firm (Dyer and Singh, 1998). Therefore, resource-based view is largely introspective and centered on the firm itself. *In contrast, open innovation focuses on the combination of resources / competencies in different firms.* Consequently, absorptive capacity has to be understood as a combination and integration of competencies (or knowledge) between organizations. Partnering firms always have different (technological) capabilities, and are confronted with the 'technological distance' between them. Companies with strong open innovation practices and increased absorptive capability can span larger technological distances. As a result they are better equipped to explore new technological areas that are not directly related to their core technology (Nooteboom et al., 2007; Wuyts et al. , 2005).

### ***3.4 Uncertainty and real options***

Open innovation and the creation of new businesses inherently involve a high level of uncertainty, especially in the earlier stages of new business development. One way for firms to cope with the technological and market uncertainty associated with new business development is by making small investments in multiple options on technology. The small, initial investments can be regarded as a real option. A real option is ‘the right, but not the obligation, to take an action in the future’ (Amram and Kulatilaka, 1999, p. 5), and typically consists of two distinct actions: option creation and option exercise. Option creation is the initial investment, which creates an option for the future. At some point in time, this option can be exercised through a follow-on investment. In the management literature, real options reasoning is often referred to as a tool for uncertainty reduction – making a small, initial investment under high levels of uncertainty allows one to create an option while waiting until the uncertainty about the opportunity has decreased. When the uncertainty has decreased, the investing firm can decide whether to make a follow-on investment or whether to abort the project (Adner and Levinthal, 2004; McGrath and Nerkar, 2004).

The real options approach has been discussed frequently in the literature as a tool to reduce the uncertainty of innovation projects and new business development (e.g. Bowman and Hurry, 1993; Huchzermeier and Loch, 2001; Miller and Arikan, 2004; Teisberg, 1994). Due to its explicit nature to cope with uncertainty, real options reasoning may also provide us a better understanding how innovating firms evaluate sequential investment decisions concerning the external sourcing of technologies. In particular, this is applicable at the fuzzy front-end of the innovation funnel where R&D cooperation with upstream technology providers and corporate venturing play a crucial role in reducing the uncertainty inherently present in early phases of technology ventures.

#### **Real options and open innovation**

Real options reasoning may provide several advantages with regard to open innovation practices<sup>8</sup>. First, innovating firms *benefit from early involvement*. Open innovation allows innovating companies to sense developments in a wide range of externally developed inventions by buying minority stakes in (high-tech) start-ups, participating in VCFs, providing educational investments in promising project at universities or research labs. This is an option creating process in order to get more information and learn about projects or technologies with uncertain payoffs. The advantage of this strategy is that companies learn early on about new technologies: at that stage investments are small and reversible when investing companies exit. Moreover, tapping into externally developed technologies also *enhances the upward-potential of the real option* because the company can scan a broad range of interesting ideas and projects. A company that is experienced in external technology scanning will select on average more interesting ideas than what the company itself can develop internally. Nokia, for instance, is continuously identifying opportunity identification in its on ventures organization; it systematically scans emerging trends and

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<sup>8</sup> We follow the typology provided by Janney, J.J. and Dess, G.G., 2004. Can real-options analysis improve decision-making? Promises and pitfalls. *Academy of Management Executive*, 18(4), pp. 60-75.

disruptions from the perspectives of technology, business, and users. The knowledge gained from these multiple perspectives identifies potential indicators of change or disruption.

Second, innovating firms also benefit *from delayed entry or delayed financial commitment*. The staged process in which new technologies are developed and commercialized into new business opportunities can be analyzed as a compound option. In closed innovation, firms can only start with an internally developed idea / invention and pull it through the funnel. Open innovation practices offer firms more flexibility to start the innovation process: A company can start exploring the commercial possibilities of a technology early on, but it is also possible to license-in or purchase technologies, make direct investments in ventures, etc... The delayed entry or delayed financial commitment offers firms a second chance to develop growth opportunities from a technology. This flexibility also creates the possibility to differentiate innovation strategies: some firms have developed the ability to scan technologies and ideas early on, other firms prefer to invest in technologies in a later stage when the level of uncertainty has decreased to a level where the future market potential of the new venture becomes more predictable.

Third, open innovation offers firms the *advantage of an early exit*. Open innovation is characterized by the possibility that innovating firms always can out license or sell technologies or spin-off ventures that are not promising enough or/and does not fit with their business model or core competencies. This implies that the *potential downward losses* of earlier investments *are much smaller* than in the case of closed innovation. Two caveats: First, firms have to trade part of their IPR. Second, quick exit is more interesting in the early stages funnel because application specific investments in the commercialization phase may be sunk costs (depending on the contestability of the market).

Fourth, firms benefit from *delayed exit*. The creation of corporate ventures that reside outside the organization allows firms to monitor its developments while delaying the exit decision. While the venture further matures, the corporation can decide whether to spin-in the venture or whether to sell it externally or through an IPO, depending on the strategic fit and the success of the venture. The open innovation paradigm is particularly suitable for firms to maintain flexible while keeping their different options open.

### **Implications for the conceptualization of absorptive capacity**

In the previous section we have shown that real options reasoning is an important tool to manage open innovation. In addition, real options reasoning has also major implications for the absorptive capacity of innovating firms. As mentioned before, absorptive capacity consists of three dimensions: identification, assimilation and exploitation of external knowledge. Real options reasoning has important implications for each of these three dimensions. First of all, the making of small investments allows firms to tap into different technologies at the same time. These small, initial investments allow them to learn about the different technological opportunities ahead. In this way, the investing firm builds up absorptive capacity in a number of technologies simultaneously. Real options reasoning also indicates that absorptive capacity is not a byproduct of a firm's own R&D-investments. It is not a process in which innovating firms automatically can profit from knowledge spillovers of other

firms as it has been described in the literature in the wake of the seminal publication of Cohen and Levinthal (1990); Firms identify and assimilate new technologies through purposively investing in interesting external technology sources in order to learn from them. R&D-expenditures alone cannot explain the large variability in absorptive capacity among innovating firms.

Moreover, the stage-gate process of real option reasoning leads to a gradual improvement of a firm's absorptive capacity. Firms learn about new technologies and opportunities by making small learning steps. This accumulation of absorptive capacity over time is an important precondition for the selection of options. By gradually improving its absorptive capacity, firms gain knowledge about the future potential of the projects. When a follow-on investment decision has to be made, this knowledge is necessary to select the best options ahead.

Hence, real options reasoning is a dynamic approach that helps firms to improve their ability to identify, assimilate and exploit the external knowledge. As such, real options reasoning has important implications for the way in which firms build up absorptive capacity. Real options allow firms to build up their absorptive capacity in a broad range of technologies, by making small steps at a time and bringing down uncertainty in that way. The larger the portfolio of options, the stronger the absorptive capacity skills a firm will be able to build. In an open innovation paradigm, this is particularly important. Firms are constantly being confronted with the decisions whether to (further) develop a particular technology in-house, or whether to source it externally. The lack of absorptive capacity that may exist in the early stages of technology development can be gradually enhanced through the use of real options, in addition to the internal R&D activities. When uncertainty decreases, and the value of the opportunity becomes apparent, the increased absorptive capacity of the firm will help to make the right decision.

In short, some of the benefits of open innovation can be explained through the real options reasoning.

Hence, open innovation has not yet been linked explicitly *to real option reasoning*. Real options may provide us a better understanding of how innovating firms evaluate sequential investment decisions in sourcing external technologies. In particular, this is applicable at the fuzzy front-end of the innovation funnel where R&D cooperation with upstream technology providers and corporate venturing play a crucial role. In a similar way, the creation of real options in the context of insourcing external technologies also increases the absorptive capacity of investing firms. Linking absorptive capacity to real options reasoning has according to us a major potential to refine our understanding of the former. Absorption capacity of firms in relation to radically new ideas in an early research phase is quite different from absorption capacity related to proven technology that can readily be translated into new products or markets (Leifer et al. 2000). Hence, we have to differentiate absorptive capacity along the 'innovation funnel'. It is different for technological exploration compared to exploitation and it has quite different strategic and organizational consequences. Combining both requires that companies become ambidextrous (Tushman and O'Reilly, 1996; O'Reilly and Tushman, 2004)

#### 4. Conclusions and discussion

In this paper we intend to analyze how absorptive capacity and the outside-in dimension of open innovation can be linked to each other. We suggest that insights from best practices in open innovation allow us to enrich the concept of absorptive capacity and to improve our understanding how management decisions can strengthen a firm's ability to learn from its external environment.

What are the main conclusions from this paper. First, both open innovation and absorptive capacity focus on the sourcing of externally developed knowledge. Both concepts have to be linked to each other since they are focusing on the same managerial practices. So far, they have not been connected to each other: open innovation stems from practice oriented research and has not been embedded into the mainstream management literature, while absorptive capacity has been a central concept in the literature but is too abstract to play a decisive role in the decision making of managers. In this paper, we attempt to combine both concepts, showing on the one hand that open innovation is not possible without absorptive capacity as an internal capability of innovating companies, and that our understanding of absorptive capacity can be enriched by linking it to open innovation.

Second, in order to understand "absorptive capacity" we have to combine the resource based view (capability building) and the relational view of the firm, as part of the absorptive capacity of a firm is determined by its ability to establish and manage inter-organizational ties. A theoretical underpinning of open innovation should start from the same theoretical angles. But open innovation adds other two dimensions: the strategic perspective (value creation and capturing via the business model) and the real options perspective (the 'innovation funnel'-concept). These two last theoretical perspectives can improve our understanding of absorptive capacity.

Third, open innovation is much more explicit about the different organizational practices to improve external sourcing. The organization and management of different ways to source external innovations (e.g. scouting, corporate venturing, alliance management, incubators, use of intermediaries, etc...) plays a crucial role in explaining successful cases of open innovation. Relating absorptive capacity to open innovation open up new avenues to reconceptualize absorptive capacity into a concept that is also valuable for managerial practice.

Combining open innovation and absorptive capacity can also be realized in different ways. The approach in this paper is only one way to enrich our understanding of absorptive capacity. In our opinion, another fruitful approach is to focus on particular management challenges in open innovation. Detailed case studies could illustrate how companies cope with the considerable management challenges in implementing open innovation. Companies get involved in open innovation for different reasons and there is a wide range of management practices to implement open innovation successfully (e.g. scouting, corporate venturing, alliance management, incubators, use of intermediaries, etc.). Analyzing best practices in external corporate venturing for instance could result in a richer idea of what absorptive capacity entails. It could also transform it from a fairly abstract, academic concept to a concept that makes sense for managers. Another example is the analysis of how firms can benefit from specific types of technology intermediaries (Chesbrough 2006, Nambisan and Sawhney,

2007). These examples should open new perspectives to change absorptive capacity into a concept that is embedded in managerial practices.

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