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THE ADOPTION OF OPEN INNOVATION PRACTICES IN GLOBAL FIRMS

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Declaration of originality

The work referred to in the thesis has not been submitted in support of an application for another degree or qualification of this or any other University or other institute of learning.
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INTRODUCTION

Innovation can be considered as the main mechanism for companies to grow and to create a sustainable competitive advantage (Teece et al., 1997; Verona & Ravasi, 2003; Wang & Ahmed, 2007). Therefore, firms are constantly searching for ways to transform and advance their innovation strategies in order to generate and maintain superior firm performance.

Traditionally, firms operated predominantly according to a closed innovation model, which emphasizes internal focus and control of the innovation process. Closed innovation refers to the notion that firms rely mostly on their internal Research and Development (R&D) function for launching new research projects and that they employ their own product and process development facilities to bring new innovations to the market (Chesbrough et al., 2006).

However, the globalization, volatility and velocity of markets and technological developments have recently called for a transformation of the traditional model of closed innovation. In this context resources for innovation are becoming increasingly distributed and are changing more frequently (Gassmann & Enkel, 2004), R&D costs are accelerating while at the same time product life cycles are becoming shorter (Chesbrough, 2007; Drechsler & Natter, 2012), and improved market institutions such as intellectual property rights, venture capital and technology standards enable organizations to trade their knowledge and ideas (Dahlander & Gann, 2010). Such economic and technological changes and trends suggest that single firms cannot anymore innovate in isolation (Davis & Eisenhardt, 2011). Therefore, an alternative approach to managing innovation proposes that firms respond to these developments by opening up their boundaries (Chesbrough, 2003; Chesbrough et al., 2006), combining internally and externally developed knowledge in their innovation processes, and bringing in-house inventions to markets via external paths (Dahlander & Gann, 2010). In that context, Open Innovation (OI) can be defined as *"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively"* (Chesbrough, 2003; Chesbrough et al., 2006).

Given these developments, the fundamental assumption of this dissertation is that firms increasingly transform from a closed to an Open Innovation model. More specifically this work investigates how global firms adopt Open Innovation to benefit from external knowledge sources and to improve their competitiveness.

This dissertation is structured as follows.

In the first chapter, which serves as a theoretical foundation, I shortly outline the emerging literature on Open Innovation. By using a firm's process perspective, two types of knowledge flows across the firm's boundary can be differentiated: outside-in (or inbound) and inside-out (or outbound) (Gassmann & Enkel, 2004). The adoption of Open Innovation practices forces firms to reformulate their business models, or to create completely new ones. These business models may lead to better financial performance by reducing costs and time of innovation (Vanhaverbeke & Chesbrough, 2014; Chesbrough, 2007). In such a context innovation can be regarded as resulting from distributed inter-organizational networks, involving different types of partners.

The second chapter explores how Open Innovation is implemented in global firms through the opening up of their business model and the adoption of a network structure. Previous studies show that building relationships with multiple partners has a positive impact on innovation performance (Von Hippel, 1988). Collaboration with partners is the core of OI and it has been widely used as a measurement of OI since the publication of Laursen and Salter's 2006 paper mainly utilizing two dimensions: the breadth and the depth of interaction with partners. Jointly, breadth and depth can be characterized as a firm's degree of openness and both are likely to have an effect on the performance of the firm's overall OI strategy. Literature shows that openness towards different actors, such as customers, suppliers, and universities, has a significant positive impact on innovation (Drechsler & Natter, 2012; Lee et al., 2010). Innovation search, however, can be time consuming and expensive. Laursen and Salter (2006) find that 'over-search' may indeed hinder innovation performance, identifying tipping points after which openness, in terms of breadth and depth, can negatively affect innovative performance. Besides the ability to identify and source external knowledge, firms need to be capable of developing and deploying external knowledge resources internally in a rent-generating manner (Dyer & Singh, 1998).

Following the argument of Cohen & Levinthal (1990), external search strategies remain ineffective without the ability of the firm to integrate external knowledge flows. Hence, knowledge integration rather than access to knowledge resources themselves is critical. This integrative capablity determines how efficiently a firm can manage knowledge across boundaries and how productively new knowledge resources are utlized (Grant, 1996; Carlile, 2004). In the context of Open Innovation, the applicability of integrative capability with regard to networks becomes increasingly relevant, as firms become more permeable with respect to external sources of knowledge. The ability to integrate external knowledge resources can be considered a dynamic capability as it aims at upgrading the firm's knowledge-based resources in order to advance and accelerate the firm's innovation process, and driving superior innovative performance (Amit & Schoemaker, 1993). The degree of openness and integrative capability, however, cannot be treated in isolation. The external environment and the organizational culture have an important impact on Open Innovation success. The contingency perspective suggests that relationships between strategies and performance differ across environmental conditions (Arora & Nandkumar, 2012). This means that it is also crucial to examine the influence of environmental conditions on the value creation potential of Open Innovation strategies. In the OI literature two external and one internal aspects have been highlighted: the degree of turbulence in a firm's technological environment (Christensen, 2006; Huizingh, 2011); the level of competition (Chesbrough, 2007; Dahlander & Gann, 2010); the organizational culture, as an important factor to implement Open Innovation successfully (Gassmann et al., 2010; Huizingh, 2011; Lichtenthaler, 2011; Van de Vrande at al., 2010).

Finally, the third chapter provides an example of the shift from a closed to an Open Innovation model in a global firm: Panasonic Corporation. I shortly introduce the main characteristics about technological innovation in Japanese firms. Then I analyze the transformation of the organizational structure and R&D processes of Panasonic in response to fundamental changes in the external environment. The case of Panasonic is especially striking for its dynamic interaction between the changes of its corporate group structure and the shifts in its R&D organization, showing the challenges a global firm face to adopt the Open Innovation paradigm.

1. THE FUZZY FRONT END OF OPEN INNOVATION

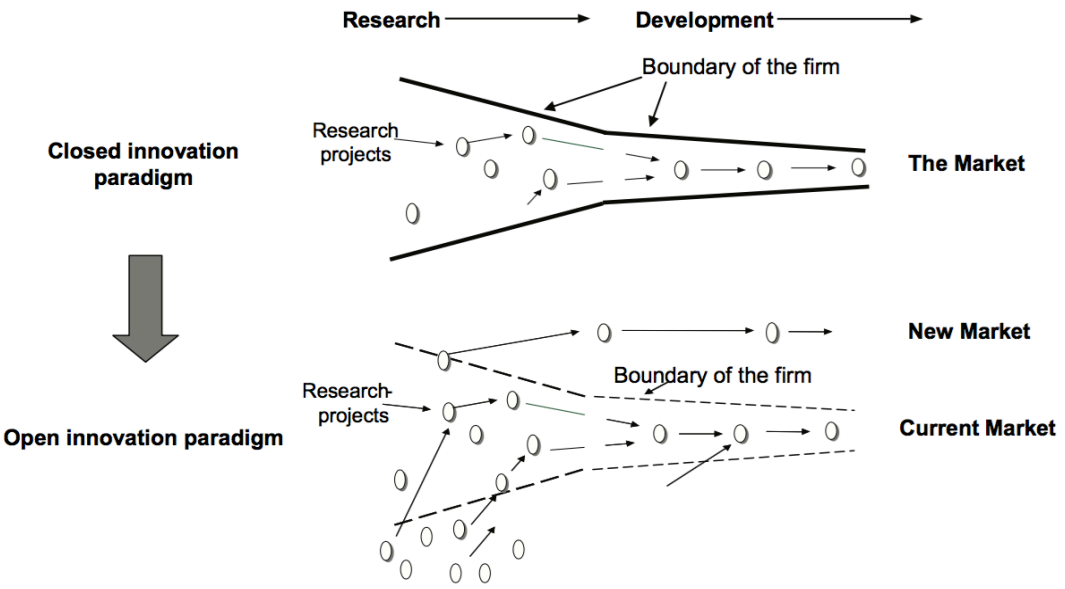
This dissertation is motivated by the observation that firms respond to increased technological complexity, rising R&D costs, shortened product life cycles and improved market institutions by opening up their boundaries and leveraging inflows and outflows of knowledge and technology. Given these developments, the fundamental assumption of this dissertation is that firms increasingly transform from a closed to an open innovation model. While prior work has developed a first understanding of antecedents and outcomes of Open Innovation (OI), it has, so far, been less clear how firms create and capture value from OI and why they differ in the extent to which they are successful in doing so. In that sense this work investigates how global firms adopt Open Innovation pardigm to benefit from external knowledge sources and to improve their competitiveness.
In the following I will outline the Open Innovation paradigm, which serves as a theoretical foundation of this dissertation.

1.1 Dynamic Competitive Environment and Innovation

Innovation can be considered as the main mechanism for companies to grow and to create a sustainable competitive advantage (Schumpeter, 1934; Teece et al., 1997; Verona & Ravasi, 2003; Wang & Ahmed, 2007). Therefore, firms are constantly searching for ways to transform and advance their innovation strategies in order to generate and maintain superior firm performance.
Traditionally, firms operated predominantly according to a closed innovation model, which emphasizes internal focus and control of the innovation process. Closed innovation refers to the notion that firms rely mostly on their internal Research and Development (R&D) function for launching new research projects and that they employ their own product and process development facilities to bring new innovations to the market (Chesbrough et al., 2006). This implies that the corporate R&D laboratory constitutes the locus of innovation in which firms explore and exploit their internal technology base (Mowery, 1983).

However, the globalization, volatility and velocity of markets and technological developments have recently called for a transformation of the traditional model of closed innovation. As for competition, the focus has shifted from the concept of competitive environment to competitive landscape, whose two main characteristics are the absence of boundaries (intrinsic characteristic of environment) and the dynamic dimension that distinguishes the landscape, always changing, from the environment which is rather static and stable (Brondoni, 2003). In this context resources for innovation are becoming increasingly distributed and are changing more frequently (Gassmann & Enkel, 2004), R&D costs are accelerating while at the same time product life cycles are becoming shorter (Chesbrough, 2007; Drechsler & Natter, 2012), and improved market institutions such as intellectual property rights, venture capital and technology standards enable organizations to trade their knowledge and ideas (Dahlander & Gann, 2010). Such economic and technological changes and trends suggest that single firms cannot anymore innovate in isolation (Davis & Eisenhardt, 2011). Therefore, an alternative approach to managing innovation proposes that firms respond to these developments by opening up their boundaries (Chesbrough, 2003; Chesbrough et al., 2006), combining internally and externally developed knowledge in their innovation processes, and bringing in-house inventions to markets via external paths (Dahlander & Gann, 2010). In that context, Open Innovation can be defined as *"the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively"* (Figure 1) (Chesbrough, 2003; Chesbrough et al., 2006). Hence, by definition, the concept of Open Innovation includes both outside-in processes to source external knowledge, as well as inside-out processes to leverage external paths to markets.

Figure 1 The Open Innovation Funnel



Source: Chesbrough (2003)

Since Chesbrough (2003), many studies have contributed to a further clarification of the concept. Table 1 provides an overview of definitions of Open Innovation.

Table 1 Definitions of Open Innovation

Study	Definition of Open Innovation
Chesbrough (2006)	*"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively*. [This paradigm] *assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."*
Gassmann and Enkel (2004)	*"Open innovation means that the company needs to open up its solid boundaries to let valuable knowledge flow in from the outside in order to create opportunities for cooperative innovation processes with partners, customers and/or suppliers. It also includes the exploitation of ideas and IP in order to bring them to market faster than competitors can."*

Dittrich and Duysters (2007)	*"The system is referred to as open because the boundaries of the product development funnel are permeable. Some ideas from innovation projects are initiated by other parties before entering the internal funnel; other projects leave the funnel and are further developed by other parties."*
Perkmann and Walsh (2007)	*"This means that innovation can be regarded as resulting from distributed inter-organizational networks, rather than from single firms."*
West and Gallagher (2006)	*"We define open innovation as systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels."*

Source: Adapted from Gianodis et al. (2010)

The idea that firms include external sources of knowledge into their innovation process is, of course, not entirely new. Instead, the concept of innovation can be considered as a continuum between closed forms and more open forms of innovation. Along this continuum of innovation, prior studies can be related to different degrees of openness. For instance, previous literature has studied firms' use of strategic alliances (Mowery et al., 1996; Powell et al., 1996), the co-creation processes between firms and users (Bogers et al., 2010), or the rise of intermediate markets (Arora et al., 2001). While prior theorizing suggests that firms use some forms of accessing external knowledge, the Open Innovation model proposes that the role of this external knowledge has shifted from being supplemental to obtaining a more equal role in a firm's innovation process (Chesbrough et al., 2006). This support the notion that, instead of speaking of a dichotomy of closed versus Open Innovation, the idea of Open Innovation needs to be placed on a continuum, ranging from closed to open, covering different degrees of openness (Dahlander & Gann, 2010).

While the traditional model of innovation is based on the logic of internal focus and control and can, therefore, be found at the lower end of continuum, companies that

are adopting an Open Innovation model embrace a mentality of outside-in and inside-out thinking that builds extensively on external sources of innovation and commercialization (Chesbrough, 2003, Gassmann & Enkel, 2004; Chesbrough et al., 2006). The core idea is the involvement of diverse actors (customers, suppliers, universities, competitors, individual, inventors, start-up firms, etc.) in various flexible ways (collaborative agreements, crowdsourcing, co-creation, external corporate venturing, out-licensing, technology sales) that transcend beyond the traditional notion of innovation alliances and contract research (Keupp & Gassmann, 2009). Technical and scientific knowledge and competences that were traditionally developed internally are now accessed from a broad set of external parties, which are flexibly chosen and recombined over time (Almirall & Casadesus-Masanell, 2010; Chiaroni et al., 2011). Likewise, internal knowledge and technology are increasingly commercialized via external paths to markets (Gassmann & Enkel, 2004; Bianchi et al., 2011). Therefore, firms have relocated to the upper end of the continuum between being closed and open. As a result, the locus of innovation has shifted, since open forms of innovation increasingly crowd out more traditional intra-firm innovation.

According to Milan-Bicocca School of Management, Open Innovation paradigm targets R&D at both innovation and imitation processes, because companies tend to refer primarily to their competitors when they define and organize their R&D strategies; in such a context firms adopt an outside-in approach, oriented to combine internal skills and knowledge coming from network relationships with different types of partners and even competitors (Brondoni, 2009, 2012, 2015). In that sense, in the current state of market globalization (competitive globalization) the boundaries between imitation and innovation are increasingly blurred (Brondoni, 2012). Companies therefore acquire innovation sources from outside, developing them internally to implement innovations and imitations that are competitive. These innovations and imitations are thus the result of corporate policies focused on competition (market-driven management) (Lambin & Brondoni, 2000), with the common goal of improving performances in the very short term (Brondoni, 2012).

Table 2 shows the main differences between the closed and the open innovation approach, related to differences in beliefs and attitudes towards innovation.

Table 2 Closed Innovation Vs Open Innovation

Closed Innovation	Open Innovation
The smart people in our field work for us.	Not all smart people work for us. We need to work with smart people inside and outside the company.
To profit from R&D we must discover it, develop it and ship it ourselves.	External R&D can create significant value, internal R&D is needed to claim some portion of that value.
If we discover it ourselves, we will get it to market first.	We don't have to originate the research to profit from it.
The company that gets innovation to the market first will win.	Building a better business model is more important than getting to the market first.
If we create the most and the best ideas we will win.	If we make the best use of internal and external ideas we will win
We should control our IP so that our competitors cannot profit from it.	We should profit from other's use of our IP (license out) and we should license other's IP whenever it advances our business model.

Source: Chesbrough (2003)

By now there is a fair body of research addressing a range of factors deemed crucial in opening up the firm's innovation process. For example, some studies have investigated factors that operate as antecedents of open innovation, such as scarcity of internal resources or characteristics of the firm's product markets (Gassmann & Enkel, 2004; Keupp & Gassmann, 2009; Drechsler & Natter, 2012). Furthermore, there is a small number of empirical studies researching the extent to which openness leads to increased R&D and innovation outcomes (Laursen & Salter, 2006; Garriga et al., 2013). Nevertheless, open innovation is still a relatively new phenomenon and, so far, lacks theoretical foundations. Constructs and relationships that help to explain such antecedents and outcomes of open innovation are not yet clearly established. In particular, while a first understanding of antecedents and outcome of open innovation has been developed, it is less clear how firms create and capture value from open innovation and why they differ in the extent to which they are successful in doing so. Hence, explanatory factors of open innovation are, so far, missing.

This begs the question of how firms develop strategies that enable them to benefit from open innovation approaches, what mechanism are implemented and how

resources are being deployed to support these mechanism. One approach particularly useful for developing a better understanding of the phenomenon of open innovation and its outcomes is to adopt a capability perspective. Such a perspective deals with the organizational capabilities and processes firms need to develop and deploy in order to create innovations. The capabilities required to recombine resources from outside and inside the firm are likely to be different from those found in traditional R&D settings (Dahlander & Gann, 2010). These firm-level capabilities may help to explain how and why firms differ in the extent to which they implement open innovation and translate it into positive outcomes. Hence, it is of interest how firms adopt open innovation strategies to benefit from external knowledge sources and paths to market and what kinds of capabilities support these strategies. A crucial question refers to how such capabilities create a competitive advantage in innovation in a world in which sources of innovation are increasingly distributed and cannot anymore be kept secret and protected within the firm's boundaries.

While acknowledging the relevance of purposive inside-out flows, I mostly focus on open innovation in terms of the embracement of external ideas, knowledge, and technologies to accelerate internal innovation processes (Chesbrough, 2003; Almirall & Casadesus-Masanell, 2010). In the following I clarify the open innovation paradigm by using a firm's process perspective (Gassmann & Enkel, 2004), and outline the emerging literature stream on open innovation with a particular focus on outside-in aspects. The discussion of prior open innovation research will reveal some of the gaps in the existing literature, especially with regard to the organizational challenges required to become effective at leveraging external sources of innovation.

1.2 Clarifying the Open Innovation Paradigm

At the most fundamental level, Open Innovation is embedded in the notion that the sources of knowledge for innovation are widely distributed in the economy. When Chesbrough (2003) inaugurated the popular use of the term open innovation, it described a phenomenon of companies making greater use of external ideas and technologies in their own business, and letting unused internal ideas and technologies go outside for others to use in their business. The book proposes erosion factors that

undercut the logic of the earlier closed innovation model of R&D and developed the logic of an open innovation model. These factors are:

- The growing mobility of skilled professionals; meaning staffs are no more attached to a single company in a long term relationship and the labor market is becoming much more dynamic with employees changing location and roles more often (Chesbrough, 2003; Gassman & Enkel, 2004). This makes it difficult for a firm to maintain its core-competencies, as the staffs leaving will take the knowledge with them. As a result, large amount of knowledge now exists outside the boundaries of the firm. This fact encourages firms to open to the outside, tapping into the pool of external resources to maintain competencies and acquire new ones.
- The rise of venture capital funding: it is incentivizing the creation and development of new firms and startups. It also triggers consequences like restructuration of industries, increases in competition, shifts in the market share, etc. (Chesbrough, 2003). Specifically, these new entrants play an important role in what comes to innovation, as they often enter the market using highly innovative, disruptive products (Christensen, 1997).
- Faster cycles of product development, as products themselves become obsolete much more quickly than earlier.
- Globalization of the markets, with the consequent hardening of the competition, as firms competes in a given industry at a global scale (Brondoni, 2012).
- Increase of specialization is more and more necessary (Gassman et al., 2010). As the complexity of technologies grows, firms need to focus in a narrow area to master their competencies. This implies that other competencies should be dropped if the firm wants to keep focus and efficiency.
- The increasing capability of external suppliers (Gassman & Enkel, 2004) and the threat of competition from them.
- The rise of the Internet (and the related rise of social media), which has brought the knowledge access and sharing capabilities of previously firm-specific internal ICT networks to the World Wide Web (Chesbrough & Bogers, 2014).

Open Innovation refers to an innovation model that emphasizes purposive inflows and outflows of knowledge across the boundary of a firm in order to leverage external sources of knowledge and commercialization paths, respectively. The definition of *"purposive inflows and outflows of knowledge"* hearkens back to a vibrant economic literature on spillovers that arise from the firm's investment in research and development. Because firms cannot fully specify the outcomes of this investment in advance, R&D inevitably produces outcomes that were not expected *ex ante*. These outcomes spill over beyond the ability of the investing firm to benefit from them, hence the term "spillovers" (Griliches, 1992). Prior research points out the presence of spillovers, and the benefits of being able to utilize them when they exist in one's surrounding environment (Arrow, 1962; Cohen & Levinthal, 1990; Griliches, 1992). Throughout this literature, however, spillovers are considered a cost for the focal firm, and are judged to be essentially unmanageable. In the open innovation framework, spillovers are transformed into inflows and outflows of knowledge "*that can be purposively managed"*. Specific mechanisms can be designed to direct these inflows and outflows of knowledge. Firms generate a process to inhale inflow ideas and to exhale outflow ones to purposely utilize knowledge spillovers in the surrounding environment. Thus, what was unspecified and unmanageable before can now be specified and managed in the open innovation model (Chesbrough & Bogers, 2014).

These elements then give a basis to refine the definition of open innovation. Also following the original and more recent conceptualizations (Chesbrough, 2003, 2006; Gassmann & Enkel, 2004; Dahlander & Gann, 2010; West & Bogers, 2014), open innovation is defined as *"a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model"* (Chesbrough & Bogers, 2014). These flows of knowledge may involve knowledge inflows to the focal organization (leveraging external knowledge sources through internal processes), knowledge outflows from a focal organization (leveraging internal knowledge through external commercialization processes). In this definition, innovation refers to the development and commercialization of new or improved products, processes, or services, while the openness aspect is represented by the

knowledge flows across the permeable organizational boundary.
In order to pursue open innovation the role of the business model is emphasized, as it describes not only how value is created within the value network but also how it is captured by the involved organizations (Chesbrough & Rosenbloom, 2002; Chesbrough, 2006).

1.2.1 The two sides of Open Innovation

There are many ways to categorize theoretical developments in the field of open innovation, such as schools of thought (Gassmann, 2006), actors, or processes (Chesbrough et al., 2007; Gassmann & Enkel, 2004). By using a firm's process perspective, two types of knowledge flows across the firm's boundary can be differentiated: outside-in (or inbound) and inside-out (or outbound).
These two labels help researchers to categorize various OI activities (formal and informal) which companies set up. It has been generally acknowledged (Bianchi et al., 2011; Enkel et al., 2009) that inbound processes are favored, in particular by large companies, and researchers have attempted to measure the impact of these processes on performance. For example, in a review of 165 open innovation articles, West and Bogers (2014) find 118 addressing outside-in open innovation, in contrast to 50 articles addressing the inside-out process.
The outside-in process enriches the company's own knowledge base through the integration of suppliers, customers, and external knowledge sourcing. This process can increase a company's innovativeness (Laursen & Salter, 2006). It reflects companies' experience that the locus of knowledge creation does not necessarily equal the locus of innovation. Within this process, we can see an increasing awareness of the importance of innovation networks (Dittrich & Duysters, 2007; Enkel, 2010), in - licensing IP, university research programs, new forms of customer integration, such as crowdsourcing, mass customization, and customer community integration (Piller & Fredberg, 2009), as well as the use of innovation intermediaries (Piller, 2009). The company's business model, in turn, determines which external inputs and contributions will be taken forward into the market.

The Inside-Out process requires organizations to allow unused and under-utilized ideas and assets to go outside the organization for others to use in their businesses and business models (Arora et al., 2001). Companies that establish the inside-out process as key, focus on externalizing their knowledge and innovation in order to bring ideas to market faster than they could through internal development. The decision to shift the locus of exploitation outside the company's boundaries means generating profits by out-licensing IP and technology, spin-outs, corporate venture capital, corporate incubators, joint ventures and alliances (Chesbrough & Bogers, 2014). The firm no longer restricts itself to the markets it serves directly. Instead, it participates in other segments using licensing fees, joint ventures, spin- offs, etc. The business model for the idea often will differ from that of the company from which it came, and often the business model must be discovered in order to take the idea to market.

Following Dahlander and Gann (2010), these two processes can be further divided in pecuniary versus non-pecuniary. They propose two different types of outside-in innovation—Acquiring and Sourcing, as well as two forms of inside-out—Selling and Revealing (Table 3).

Table 3 Different forms of openness

	Outside-in	Inside-out
Pecuniary	Acquiring	Selling
Non-pecuniary	Sourcing	Revealing

Source: Dahlander & Gann (2010)

Revealing refers to how internal resources are revealed to the external environment without immediate financial rewards, seeking indirect benefits. The premise is that openness, caused by voluntarily or unintentionally divulging information to outsiders, does not always reduce the probability of being successful (von Hippel, 1988, 2005; Henkel, 2006). Henkel (2006), for instance, suggests that firms adopt strategies to selectively reveal some of their technologies to the public in order to elicit collaboration, but without any contractual guarantees of obtaining it.

An obvious disadvantage of revealing internal resources to pace the general technological advance is the difficulty in capturing benefits that accrue (Helfat,

2006). Competitors can be better positioned with complementary assets and production facilities to make use of the technological advance. Choosing what internal resources to reveal to the external environment is not an easy task. Some large companies have different committees that make decisions whether to file patents or disclose. Smaller companies, in contrast, typically lack the resources to structure this process.

Selling refers to how firms commercialize their inventions and technologies through selling or licensing out resources developed in other organizations. By selling or out-licensing, firms can more fully leverage their investments in R&D, partnering with actors adept at bringing inventions to the market (Chesbrough, 2003, 2006). Research suggests that licensing out inventions and technologies is becoming more common (Gassmann & Enkel, 2006). Some firms have even made it a strategic priority to out-license technologies and inventions. However there are some obstacles that prevent firms from selling or licensing-out technologies. One of this obstacles is the so-called Arrow's 'disclosure paradox' (1962). When an inventor decides to license its information to a potential licensee, it is necessary to reveal some information to the potential customer. This implies that the potential licensee receives the information without paying for it and could act opportunistically and steal the idea. Arrow argued that such problems cause market failures because they make inventors reluctant to reveal their technology or knowledge. To overcome this paradox, firms often require that inventors have formal intellectual property rights in place before they work together. Understanding this problem calls attention to the means of appropriability in open innovation, and how firms attempt to be open yet are able to appropriate commercial returns from their innovative efforts.

Sourcing is a type of openness that refers to how firms can use external sources of innovation. Chesbrough et al. (2006) claim that firms scan the external environment prior to initiating internal R&D process. By definition R&D laboratories are vehicles for absorbing external ideas and mechanisms to assess, internalize and make them fit with internal processes. Laursen and Salter (2004) define openness as *"the number of different sources of external knowledge that each firm draws upon in its innovative activities"*. Their logic is that the larger the number of external sources of innovation, the more open will be the firm's search strategy. This is highlighted in

much other open innovation literature, which underlines that innovation is often about leveraging the discoveries of others. Available resources become larger than a single firm can manage; they enable innovative ways to market, or the creation of standards in emerging markets. Such synergies can be created by relying on the external environment, and by taking an active part in external developments (Dahlander & Gann, 2010).

Some organizations over-search by spending too much time looking for external sources of innovation with negative effects on the innovation performance. Laursen and Salter (2006) show that wide and deep search for sources of innovation have a curvilinear relationship with innovative performance. In other words, while there may be an initial positive effect on openness, firms can over-search or come to rely too heavily on external sources of innovation.

Acquiring refers to acquiring input to the innovation process through the market place. Following this reasoning, openness can be understood as how firms license-in and acquire expertise from outside (Dahlander & Gann, 2010). Acquiring valuable resources to an innovation process requires expertise. While acknowledging the importance of openness in terms of external sources of innovation, von Zedtwitz and Gassmann (2002) state that in order to invest when openness is high, firms need some degree of control over a number of the elements in their networks. Although there are many benefits from being able to buy or in-source external ideas to the organization, expertise is required to search for and evaluate them. A further point relates to the similarity of knowledge bases and how they facilitate the integration of ideas from distant realms, because shared languages, common norms and cognitive configurations enable communication (Cohen & Levinthal, 1990). However incorporating knowledge bases too close to what the firm already knows may prevent from the positive effect of assimilating external sources, and too distant inputs are harder to align with existing practices (Sapienza et al., 2004). In other words, the effectiveness of openness is contingent upon the resource endowments of the partnering organization.

1.3 The Outside-in Dimension: Obtaining Innovations from External Sources

Obtaining innovations from external sources requires two steps: firms must first find external sources of innovation and then integrate them into the firm. In terms of empirical context, studies on obtaining innovations from external sources originally focused on large firms in high-tech industries, although there has since been some research on firms in low-tech industries (Chesbrough & Crowther, 2006; Spithoven et al., 2010) and an increasing body of research on small and medium enterprises (Lee et al., 2010; van de Vrande et al., 2009). Firms may source actual innovations, technical inventions or knowledge, components, or other useful information to support firm innovation efforts (Bogers & West, 2012).

1.3.1 Searching for External Sources of Innovation

The first step for obtaining innovations from external sources is the process of identifying and sourcing these innovations. Researchers have studied the general role of external sources of innovation as a means to add to or complement the firm's internal knowledge base (Laursen & Salter, 2006; Witzeman et al., 2006). West and Bogers (2014) identify three main topics in external knowledge search:

- *Sourcing from external stakeholders;*
- *Facilitating external searches;*
- *Limits to search*.

Sourcing from external stakeholders. Firms can identify or search for external sources of innovation by collaborating with different external stakeholders or seeking out specialists with useful knowledge; firms may also passively obtain innovation that is pushed by external stakeholders (Spaeth et al., 2010). Researchers have identified specific sources of external knowledge including suppliers, customers, competitors, or universities (West & Bogers, 2014). Factors that influence the use of external sources of innovation include not only the characteristics of the external source, but also internal factors such as R&D capabilities and complementary assets (Ceccagnoli et al., 2010).

Facilitating external searches. While many studies assume innovations are sourced via a direct and costless process (Dahlander & Gann, 2010), some research has identified specific ways a firm can search for innovation from external sources, such as technology scouts or intermediaries (Lee et al., 2010).

Various factors have increased the potential and decreased the costs of searching for innovation from external sources. One of the most important factors has been the growing availability of information and communication technologies, which Dodgson et al. (2006) call 'innovation technologies'. More specifically, the rise of the Internet has played an important role in enabling searches for external sources of innovation, by facilitating technology intelligence, online communities, crowdsourcing, and Internet platforms such as blogs and virtual worlds.

Limits to search. Despite the benefits of obtaining external innovations, there can be significant costs involved as well. Laursen and Salter (2006) find that beyond an optimal level, firms that rely on an increasing variety of external sources of innovation have decreasing returns in terms of innovation performance. Thus even though broad search may be beneficial, there may be limits to search effectiveness. Moreover, Stuermer et al. (2009) show that when a firm relies on external sources of innovation, it may face costs related to communication and control. Another possible trap is that overly positive attitudes toward external sources of innovation may hamper search effectiveness. Then organizations face a trade-off between the benefits and costs of obtaining innovation from external sources by aligning search breadth and depth, which potentially allows them to overcome some of the impediments of relying on external sources of innovation (Keupp & Gassmann, 2009).

1.3.2 Enabling, Filtering and Integrating Innovation from External Sources

Firms seeking to increase the external supply of innovations can use third party actors (such as innovation intermediaries) to enable and facilitate such innovations (Lee et al., 2010; Spithoven et al., 2010).

Researchers have identified two key mechanisms that encourage innovation creation outside of the boundaries of the firm. The first is encouraging external innovators by providing effective incentives, whether monetary incentives such as awards and innovation contests or nonmonetary incentives/intrinsic motivation as often found in open-source software (West & Gallagher, 2006). A second mechanism is building formal tools and processes that provide a platform for external stakeholders to produce and possibly share innovations. While such a platform accelerates the innovation process, this might be combined with the provision of incentives, as with innovation toolkits that include awards distributed based on the quality of the submission (Piller & Walcher, 2006).

A major challenge for firms relying on external sources of innovations is how to effectively identify the most valuable innovations. This identification might take place inside the firm, by an external intermediary, or even by the community of external contributors. For firms that rely on employees for filtering, the role of the gatekeeper is increasingly shared and distributed within the organization (West & Bogers, 2014)

Identifying and acquiring innovations from external sources is only the first step. In order for firms to profit from the external sources of innovation, the innovations must be fully integrated into the firm's R&D activities. This requires a compatible culture in the R&D organization to overcome tendencies toward the 'not invented here' syndrome (Chesbrough 2003, 2006), as well as the capabilities to assimilate innovations obtained from external sources.

Organizational culture plays an important role in the willingness and ability of an organization to successfully profit from external sources of innovation. The earliest mention of cultural impediments to the success of using external sources of innovation is the potential 'not invented here' attitude of many successful R&D organizations (Laursen & Salter, 2006; West & Gallagher, 2006). Cultural changes are often needed to successfully use innovation from external sources and collaborate with external partners, particularly for organizations with a high level of internal innovation (Dodgson et al., 2006). Such changes can be used to shift the focus from 'not invented here' to an outlook that views the external environment as the firm's technology base.

1.3.3 Implications for Capabilities

Externally sourcing innovations could change the R&D competencies of the firm, both directly and indirectly. On the one hand, resources allocated to sourcing innovations from external sources could directly reduce the resources made available for internal innovation. On the other hand, external sourcing can improve internal capabilities (Ceccagnoli et al., 2010).

Indirectly, a decision to pursue an external innovation sourcing strategy would normally cause firms to seek the competencies necessary to make such a strategy effective. Christensen (2006) predicts that in an open innovation context, deep technological capabilities will play less of a role in firm success, but instead firms will need integrative capabilities necessary to integrate externally sourced innovation and to manage relationships with different partners.

Following Cohen and Levinthal (1990), they look at the effect that internal R&D capabilities have upon the ability to utilize external knowledge. Most research using this conception have hypothesized that higher internal absorptive capacity helps firms capitalize on external sources of innovations. These hypotheses fall into two categories: firms with high absorptive capacity will be more likely to use innovations from external sources, or that firms will be more successful in such use.

Researchers have conflicting predictions about the effect of absorptive capacity on collaboration: some suggest that absorptive capacity reduces the need for collaborations (Barge-Gil, 2010), while others argue that it increases the likelihood that firms will do so. The results of absorptive capacity on performance are more consistent. Absorptive capacity amplifies the benefits of external innovation sourcing both on innovativeness and on financial performance. It speeds the assimilation of external knowledge and commercialization of such knowledge (Lichtenthaler & Lichtenthaler, 2009).

1.4 The Business Model: Connecting Internal and External Innovation

Literature shows that rising cost of innovation and shorter product life cycles push incumbent firms to pursue open innovation. In order to do so, the role of the business model was emphasized.

A business model is a framework to link ideas and technologies to valuable economic outcomes. At its heart, a business model performs two key functions: 1) it creates value, and 2) it captures a portion of that value (Teece, 2010). Organizations can create value by defining a range of activities that will yield a new product or service valued by a (target) customer group (Vanhaverbeke & Chesbrough 2014). Organizations also capture value by establishing a unique resource, asset or position within that series of activities where the firm enjoys a competitive advantage. More specifically the business model also refers to the linkages between the organizational units that perform key activities as well as with external stakeholders in the firm's attempt to create, deliver, and capture this value (Zott et al., 2011).

Business models are dynamic and morph as changing markets, technologies and legal structures (Teece, 2010). Beyond these exogenous factors, there are also endogenous factors that make business models change. Among them, attention has been given to the adoption of the Open Innovation. On global markets where competition is particularly fierce, the leading companies reveal the crucial importance of open innovation (Brondoni 2012). This paradigm forces companies to think about at the reformulation of their business models, or the creation of completely new ones. The permeability of the company's boundaries (Chesbrough, 2003), in fact, is a business model choice (Baden-Fuller & Haefliger, 2013). New actors may be involved in the value chain linkages as well as in the monetization or revenue model dimension, and in particular, in the customer engagement. Even if the business model concept is not included in the definition of open innovation it is tightly related to it. Chesbrough (2003) claims: *"Open innovation combines internal and external ideas into architecture and systems whose requirements are defined by a business model. The business model utilizes both external and internal ideas to create value, while defining internal mechanisms to claim some portion of that value."* There is no way to conceive open innovation without business models: the

value of an idea or technology depends upon the business model. There is no inherent value in technology per se, the value is determined instead by the business model used to bring it to market. The same technology taken to market through two different business models will yield a different return. As Chesbrough (2003) notes, a mediocre technology pursued within a great business model may be more valuable than a great technology in a mediocre business model. To improve or renew the existing business model, a firm needs to go through extensive business model experimentations (Chesbrough, 2010; West & Gallagher, 2006). Furthermore, successful business model innovation calls for organizational leadership necessary for overcoming organizational barriers to changes which a firm faces during the process of business model experimentation (Chesbrough, 2007; Chesbrough, 2010; Amit & Zott, 2012).

Researchers from different domains (namely e-business and information technology, strategy, and innovation and technology management) have independently used and developed the concept in silos (Zott et al., 2011). Some researchers in the field explicitly consider boundary-spanning activities (Shafer et al., 2005; Zott & Amit, 2007, 2010; Zott et al., 2011) or collaboration with partners (Osterwalder et al., 2005; Teece, 2010) an integral part of business models.

One stream in literature (Chesbrough & Schwartz, 2007; Chesbrough, 2006; Davey et al., 2011; Smith et al., 2010) closely links the open business model to openness with regard to a firm's research and development (R&D) activities, as postulated by the open innovation paradigm (Chesbrough, 2003). Open innovation captures phenomena such as IP commercialization, user and customer integration, and collaborative R&D processes (Gassmann et al., 2010). Chesbrough (2007) argues that *"To get the most out of this new system of innovation, companies must open their business models by actively searching for and exploiting outside ideas and by allowing unused internal technologies to flow to the outside, where other firms can unlock their latent economic potential"*. According to this stream, with its focus on technology, innovation, and ideas, the open business model is tied to openness with regards to a firm's research and development (R&D) activities. In this view of the concept, the open business model is built around R&D openness and ensures value creation and capture from the focal firm's open innovation activities.

In global markets new flexible organizational forms emerge, postulating a global division of the structures in terms of space, time and the functions performed (Brondoni, 2014). In particular in explaining open business models, Chesbrough (2006) starts with the current trend towards the 'division of innovation labor'. The division of labor is a new and powerful way to speed up innovation and improve R&D productivity. An open business model uses the division of labor to create greater value by leveraging more ideas (external ideas) and to capture greater value by using key assets, resources, or positions not only in the company's own business but also in other companies' businesses.

An open business model is thus a powerful organizational model of innovation. Open business models may lead to better financial performance by reducing the costs and time of innovation on the one hand and generating extra revenues on the other hand by monetizing technologies through licensing agreements and spin-off activities when the technology cannot be adopted profitably in the product markets of the company (Vanhaverbeke & Chesbrough, 2014). In this way, open business models are still tightly linked to innovation activities of a firm or its external innovation partners, enhancing internal and external knowledge flows and enabling organizations to be more effective in creating as well as capturing value (Chesbrough, 2007).

1.4.1 The Antecedents of Open Business Models

Research on open business models has analyzed antecedents that influence the change of a business model design toward an open model (Zott & Amit, 2013; Frankenberger et al., 2014). Antecedents are intended as influencing factors for changing or adapting a business model. These can refer to internal factors, such as organizational structure or leadership, or to external factors, such as regulatory or environmental changes (Demil & Lecocq, 2010). Prior research has identified new technologies as an important trigger of business model innovation (Calia et al., 2007; Chesbrough & Rosenbloom, 2002). Zott and Amit (2013) identify goals to create and capture value, templates of incumbents, stakeholder activities, and environmental constraints as antecedents for business model design in new ventures. Others argue

that external pressure and regulations foster business model innovation and that new entrants can cause market leaders to change their business model (Casadesus-Masanell & Tarziján, 2012; Casadesus-Masanell & Zhu, 2013). Internal factors, such as changes in the cost and revenue structure (Demil & Lecocq, 2010) or organizational and managerial factors, have been identified as key antecedents for business model change as well (Hartmann et al., 2013).

In the related field of open innovation, antecedents mark an important research direction which advances the phenomenon's understanding and practical relevance (Lichtenthaler, 2011). Scholars have identified external antecedents as diverse as industry characteristics (Chesbrough & Crowther, 2006; Lichtenthaler & Ernst, 2006) or firm size (Henkel, 2006; van der Meer, 2007), generally finding smaller firms in fast-moving industries more prone to adopt open innovation principles. Internal antecedents are often related to technology characteristics (Dodgson et al., 2006; Henkel 2006) or very diverse organizational capabilities (Witzeman et al. 2006; Leih et al., 2014), such as certain technology sourcing practices. In open innovation, research on its antecedents contributed to a better understanding of the phenomenon itself and its implementation in managerial practice.

Frankenberger et al. (2014), drawing on case evidence and literature, identified four main antecedents that lead firms to open up their business models in an open innovation context:

- Need to create and capture new value;
- Experience with collaboration;
- Open business model patterns;
- Industry convergence;

The first two antecedents could be classified as internal, whereas the latter two are clearly external in nature.

Need to create and capture new value

The first identified antecedent of open business models is the need to create and capture new value. Firms are increasingly under pressure to sustain their performance and competitive advantage. Increased competition, falling prices,

commoditization, and higher costs are only a few reasons why firms need to open up their business model (Amit & Zott, 2012). This, in turn, leads to a new value creation and capture logic which is needed to stay competitive. Opening up the business model is a key move in order to grow rapidly with limited resources and to produce permanently a stream of innovative products or services (Frankenberger et al., 2014). For new ventures, Zott and Amit (2013) argue that the goal to create and capture new value is a major antecedent of business model design. Other business model scholars have found that incumbent firms are more likely to innovate their business model if their old model does not work anymore (Chesbrough, 2007, 2010; Demil & Lecocq, 2010). It is widely assumed among managers that opening up the business model is one way to achieve superior value creation and capture (Chesbrough & Crowther, 2006; IBM Global Business Services, 2012). One effect is that external partners can speed up the innovation process. More importantly, however, openness brings in new ideas and knowledge, which allow the focal firm to overcome its dominant logic, a major barrier to business model innovation (Chesbrough, 2010; Frankenberger et al., 2013; Sandulli & Chesbrough, 2009).

Experience with collaboration

The second antecedent identified is previous experience with collaborations. Firms that are skilled in working together with other firms have developed collaboration capabilities and are more likely to open up further their business model and vice versa. Therefore cases with a high level of experience through existing relationships with partners show that the involvement of partners can become natural to the organization (Frankenberger et al., 2014).

It is a known fact that firms learn and build up the capabilities required to collaborate over time (Chesbrough & Schwartz, 2007; Möller & Svahn, 2003). Scholars have argued that prior collaboration experience leads to effective collaborations and improves collaboration outcomes (Anand & Khanna, 2000), as experienced firms are better able to identify potential collaborators, negotiate and manage agreements and know when to terminate collaborations. Also, scholars have argued that firms with collaboration experience are more likely to go for new partnerships (Powell et al.,

1996). This is in line with the finding that prior collaboration experience triggers the further opening of the business model.

Open Business model patterns

According to Frankenberger et al.'s study (2014), an other trigger to open up further the business model is other successful open business models. Companies observe elsewhere, even in other industries, that opening up a business model leads to superior value creation and therefore imitate such an approach. In the case of Procter&Gamble, for example, the transfer of the 'open business model pattern' (Osterwalder & Pigneur, 2010) occurred from the pharmaceutical and IT industry, where Eli Lily and IBM had successfully pioneered openness of their R&D activities (Frankenberger et al., 2014).

Various scholars have highlighted the possibility of 'adopting', 'imitating' or 'replicating' a business that has proven to work before in order to achieve business model innovation (Baden-Fuller & Morgan, 2010; Casadesus-Masanell & Zhu, 2013; Teece, 2010; Zott & Amit, 2013). Teece (2010), for example, argues that successful business models can be transferred from one context to another and trigger a successful business model there. Baden-Fuller and Morgan (2010) argue that business models may also serve as recipes, which by themselves are open for variation and innovation. Finally, Casadesus-Masanell and Zhu (2013) show that incumbents need to decide whether they stay with their own business model or imitate the business model of entrants in order to remain in the market. Hence, business model patterns and especially open business model patterns seem to be an important trigger for opening up the business model further.

Industry convergence

The last antecedent identified is industry convergence, which is defined as *"the blurring of boundaries between industries"* (Bröring et al., 2006). Industry convergence triggers open business models in two ways: through technology

convergence, affecting mainly R&D, and through the power of new market entrants, requiring broader business model adjustments.

Scholars have widely recognized that industry convergence redefines the structure and the competitive forces in an industry (Bröring et al., 2006; Hacklin et al., 2013; Lei, 2000). Technological developments trigger the creation of new revolutionary firms which, in turn, challenge industry boundaries and the value propositions of industry leaders (Lei, 2000). As a consequence, firms need to acquire the competences necessary to create value for a broader market (Lei, 2000). Put differently, they need to rethink their logic of value creation, value delivery and value capture to respond to the new situation - hence they need to adjust their business model (Hacklin et al., 2013). The fast pace of industry convergence in many industries, however, makes it difficult for the firms to acquire and develop the competences on their own. Opening up the business model in form of strategic alliances and partnerships significantly facilitates the learning of new competences (Bröring et al., 2006; Lei, 2000).

Also, sheer size is a key issue in such converging industries (Hacklin et al., 2010; Levitt, 1983). Smaller firms need to cooperate or even acquire firms to compete against the newly entering giants or alliances, which have both economies of scale and scope on their side (Hacklin et al., 2010). Hence, industry convergence encourages firms to open up further their business model to acquire skills and technologies and to grow in size and power.

1.5 Challenges in Open Innovation Research

After introducing the main concepts about the OI paradigm, in the following I elucidate the challenges in the OI research. The emerging conceptual and empirical literature on open innovation can be sketched in terms of different themes or topics. A first set of studies provides some empirical evidence of firms opening up their boundaries to capture outward and inward knowledge flows. A second topic refers to the conceptualization of openness in terms of firms breadth and depth in external knowledge search. A similar set of studies discusses to what extent these degrees of openness lead to different performance and innovation outcomes. Finally, a small

collection of prior work deals with organizational and managerial challenges that arise due to increasing permeability and openness in the firm's boundaries (opening up the business model). Despite these emerging themes and topics and increasing empirical studies, the relatively young literature on open innovation leaves questions and gaps yet unaddressed.

Recently, empirical evidence and in-depth case studies on the phenomenon of open innovation have started to accumulate. A first, more practice-oriented literature stream reveals that firms across industries are increasingly opening up their innovation processes (Chesbrough & Crowther, 2006; Dodgson et al., 2006). Internal and external conditions (contingency factors), such as internal impediments to innovation (Keupp & Gassmann, 2009) and product and industry characteristics (Gassmann & Enkel, 2004) were found to influence a firm's decision to open up its boundaries. A recent study on Open Innovation in large firms shows that this paradigm is most widely adopted in high-tech manufacturing sectors and wholesale, trade and retail. Low-tech manufacturing sectors and financial services show the lowest rate of adoption (Chesbrough & Brunswicker, 2013). Most important, scarcity of internal resources and constraints in the application of these resources shape the firm's need to search more broadly for knowledge in the external environment (Keupp & Gassmann, 2009; Drechsler & Natter, 2012). These antecedents to open innovation suggest that firms differ in the extent to which they open up their boundaries to become more permeable for inflows and outflows of knowledge and technology (Dahlander & Gann, 2010).

Differences in firms' degrees of openness indicate that they face strategic choices regarding the extent to which they open up their business model and adopt different open innovation practices (Drechsler & Natter, 2012). Prior work suggests that degree of a firm's openness is determined by two aspects. First, the breadth of openness specifies to what extent firms access different external knowledge sources, including customers, suppliers, competitors, universities, start-up companies, innovation intermediaries and other firms (Laursen & Salter, 2006). Second, the depth of openness refers to how deeply or intensively firms draw from these different external knowledge sources (Laursen & Salter, 2006; Drechsler & Natter, 2012). Hence, depth refers to the importance of external knowledge sources for the focal

firm's innovative activities. These two dimensions describe a firm's effort to search beyond its organizational boundaries for external knowledge required to innovate (Garriga et al., 2013). Jointly, breadth and depth can be characterized as a firm's degree of openness and both are likely to have an effect on the extent to which the firm's overall open innovation strategy leads to positive innovation outcomes.

A few studies have addressed performance implications of open innovation and yielded interesting findings. For instance, while it was shown that large networks of flexible partnerships can be highly beneficial for the firm (Almirall & Casadesus-Masanell, 2010) and that collaboration constitutes a crucial determinant of high innovation performance (Herstad et al., 2008), empirical studies also indicate that the breadth and depth of a firm's external search strategies are not linearly related to innovative performance (Laursen & Salter, 2006). Furthermore, numerous management-oriented case studies have discussed firms that excel at implementing open innovation and firms that are less successful in capitalizing on open innovation strategies (Chesbrough, 2003). These differential performance outcomes are striking and raise questions regarding where these differences stem from.

One root cause of these differences lies in the challenges that firms, relying on external sources of innovation, experience when they try to identify the most valuable innovations in the external environment (West & Bogers, 2014). Firms need to put effort into finding appropriate external knowledge sources and broadening the scope of partners (Chiaroni et al., 2011). They differ in their abilities to identify, screen, and evaluate external inputs and outputs of the innovation process, as they face substantial barriers in their search process. On the one hand, search and decision processes are likely to become subject to consistent partners of collaboration over time due to socialization (Dahlander & Gann, 2010). On the other hand firms may engage in 'over-search', managing too many external relations that are not anymore relevant for the organizational context (Laursen & Salter, 2006). Hence, search strategies and the identification and recognition of relevant and valuable external knowledge sources represent a significant organizational challenge in the open innovation process.

In addition the identification and acquisition of external resources does not necessarily mean that firms can integrate them into their existing innovation

processes. As a result, a further challenge in open innovation context refers to the actual integration of external knowledge or technology. Firms need to be able to absorb the knowledge contained in external sources and integrate it into their own internal innovation processes (Lichtenthaler & Lichtenthaler, 2009; Zahra & George, 2002). To achieve this, firms need to overcome implementation stickiness, which refers to difficulties experienced between the decision to source external knowledge and the start of actual use. External elements may be documented in a way that makes them inappropriate for internal use or difficult to harmonize and align with internal knowledge sources. Furthermore, negative behavioral responses to external elements may need to be overcome, which is referred to as the 'not invented here' syndrome (Chesbrough, 2003; Chesbrough & Crowther, 2006; West & Gallagher, 2006). In sum, organizational challenges of open innovation are particularly related to the identification and integration of external knowledge sources.

Despite the importance of these organizational challenges, only few studies discuss how firms can tackle the demanding tasks of implementing open innovation and managing collaborative innovation efforts. For instance, Davis and Eisenhardt (2011) study the processes by which some technology collaborations generate innovations while others do not. However, this study adopts the partnership as the unit of analysis and, therefore, has little implications for how an individual firm can benefit from increasing collaborative innovation processes. At the firm level Foss et al. (2011) examine internal organizational practices that support firms in leveraging user and customer knowledge in the context of open innovation. They find that delegation of decision rights increases the likelihood that external knowledge is brought into the firm, while communication and incentive systems help to ensure that this knowledge is disseminated and utilized inside the firm. Yet this study focuses exclusively on user and customer knowledge and does not investigate a firm's broader open innovation strategy that incorporates a much more diverse set of external knowledge sources. In general prior work in related literature streams typically studies capabilities and practices for isolated collaborative innovation activities, such as alliances and acquisitions, but does not consider a broad portfolio of activities that characterize an open innovation strategy. Finally, Petroni et al. (2011) provide some anecdotal evidence that the adoption of open innovation influences the organizational

structures of R&D and the ways firms manage their R&D personnel. In particular they find that networked business models, as well as central personnel that are able to select and integrate external knowledge and expertise, are becoming increasingly important in an open innovation context.

Despite these important insights, these studies shed only little light on the organizational challenges of the identification and integration of external knowledge in an open innovation context. An explanation of how and why firms differ in overcoming these challenges and becoming effective at open innovation is still lacking. There is a gap in understanding how firms can identify valuable opportunities for open innovation and how they translate the open innovation concept into positive innovation outcomes. In particular it is unclear how these opportunities and outcomes can be achieved by means of organizational capabilities. Little is known about the capabilities and processes that enable external resources to flow into and out of the organization's business model and facilitate the effective utilization of these resources across the firm's boundaries. Furthermore as resources are externally available and transferable in an open innovation context, it remains questionable how open innovators, leveraging such external resources, can create an innovation-based competitive advantage. If resources are widely accessible, how can a firm differentiate its innovative performance from relevant competitors? What kinds of resources and capabilities determine the effectiveness of open business models and lead to competitive advantage? A key role is played by the underlying capabilities that firms develop in order to effectively tap into diverse external knowledge sources and leverage them to create a competitive advantage in innovation. As open innovation deals with the transfer of resources and the acceleration of innovation capabilities, the dynamic capabilities view can help to explain how such resource transfer and change in capabilities can be achieved. The dynamic capabilities view focuses on the capacity of the organizations to address rapidly changing environments and to create, integrate and reconfigure resources and capabilities (Teece et al., 1997; Eisenhardt & Martin, 2000; Helfat et al., 2007; Teece, 2007). Therefore, in dynamic markets in which companies may be forced to open up their boundaries, developing Open Innovation Networks, the dynamic capabilities by which firms access, transfer, combine, and integrate external

resources, become the main source of open innovation performance. These dynamic capabilities are driven by organizational processes that are firm specific and can, therefore, contribute to an explanation of how firms obtain an innovation-based competitive advantage in a more open environment where resources are widely available and transferable. In the following, I will shortly outline the dynamic capabilities literature as a theoretical foundation to study open innovation.

1.6 The Dynamic Capabilities Perspective

The Dynamic Capabilities (DCs) perspective builds on the Resource-based view (RBV) and the Knowledge-based view (KBV) of the firm, and represents a recent extension to address the constant pursuit of adding, shedding, renewing and reconfiguring resources and capabilities in rapidly changing environments (Teece et al., 1997; Helfat et al., 2007; Teece, 2007). According to the RBV, firms can be conceptualized as bundles of resources and operational capabilities (Barney, 1991). Resources are any firm-specific assets that are owned or controlled, while operational capabilities are used by the firm to deploy these resources on a day-to-day basis (Amit & Schoemaker, 1993). According to the KBV the firm can be conceptualized as an institution for developing and integrating knowledge resources (Kogut & Zander, 1992; Grant, 1996). Knowledge has been considered the most important strategic resource of the firm, and therefore, the KBV can be seen as the most essential subset of the RBV. Considering the strategic relevance of knowledge resources in the innovation process, external knowledge integration can also be considered as the essence of OI.

More recently, the concept of dynamic capabilities was introduced to address the static nature of the RBV, analyzing how competitive capabilities can be built in the context of turbulent and dynamic environments (Teece et al., 1997). While the RBV and KBV fail to explain how firms can adapt to and remain competitive in changing environments, dynamic capabilities deal with the continuous upgrading of the firm's knowledge-based assets and other resources. They refer to *"the capacity of an organization to purposefully create, extend, or modify its resource base"*(Helfat et al., 2007). Thereby, they aim at integrating building and reconfiguring internal and

external resources and competencies in order to adapt to changing environments and to remain competitive in the long term.

Dynamic capabilities are enabled by path dependent processes that are built and embedded in firms to change the existing resource base. While dynamic capabilities have certain commonalties (Eisenhardt & Martin, 2000; Wang & Ahmed, 2007) they are still heterogeneously distributed across firms and their complex and intangible nature makes them difficult to transfer or imitate (Pitelis & Teece, 2010). Hence, dynamic capabilities can be assumed to constitute a source of competitive advantage, if they adequately change the resource base, particularly in turbulent and high velocity environments (Zollo & Winter, 2002; Helfat et al., 2007).

Existing literature offers different definitions, classifications and conceptualizations for dynamic capabilities. Eisenhardt and Martin (2000) suggest that dynamic capabilities (1) acquire and shed resources, (2) integrate, and (3) recombine them. Similarly, Verona and Ravasi (2003) differentiate between knowledge creation/absorption, knowledge integration, and knowledge reconfiguration as underlying mechanisms of dynamic capabilities. Wang and Ahmed (2007) define three components of dynamic capabilities, including adaptive, absorptive and innovative capability. Similarly to the components approach, Barreto (2010) proposes different dimensions of dynamic capabilities that entail sensing opportunities and threats, making timely and market-oriented decisions and changing the resource base. Finally, Teece (2007) conceptualized three classes of dynamic capabilities at the most aggregate and comprehensive level. Firms exhibiting dynamic capabilities effectively sense and shape opportunities, address these opportunities by seizing them and continuously reconfigure themselves as markets and technologies change (Teece, 2007). While this disaggregation, classes and components demonstrate fine-grained differences in the definition and conceptualization of dynamic capabilities, they can be summarized in terms of Teece's terminology as the abilities to (1) sense and shape opportunities, (2) to seize these opportunities, and (3) to maintain competitiveness through enhancing combining and reconfiguring intangible and tangible assets. This classification will be used as a definition of dynamic capabilities throughout this dissertation.

First, sensing dynamic capability refers to the mobilization of requisite resources and organizational infrastructure to generate opportunities for creating, acquiring, or shedding resources (Teece, 2007). Second, seizing dynamic capability refers to how firms capture value from these opportunities by means of appropriate integration and absorption. Finally, reconfiguring dynamic capability describes how resources are continuously recombined as markets and technology change. Recent research suggests that firms can sense, seize and reconfigure opportunities for resources alterations internally or externally (Di Stefano et al., 2010). Internally, new resources or capabilities can be created or built by means of entrepreneurial efforts (Helfat & Peteraf, 2003; Helfat et al., 2007) or existing resources can be leveraged and recombined for new applications or product categories (Danneels, 2010). Externally, resources can be accessed by sensing opportunities in the outside environment (Zahra & George, 2002; Teece, 2007), acquiring and integrating external resources, and absorbing external information (Wang & Ahmed, 2007).

1.6.1 Sensing, Seizing and Reconfiguring for Open Innovation

Recent literature in the field of open innovation (Chesbrough, 2003, 2006; Laursen & Salter, 2006; Arrigo, 2012; Brondoni, 2012, 2015) show that in today globalized markets it is no more sufficient to rely on internal sources to stay competitive. Resources and operational capabilities that were traditionally developed internally are now increasingly being accessed outside the firm's boundaries. This transition towards open innovation business models enhances the importance of external dynamic capabilities.

Adopting an external perspective, dynamic capabilities can be applied to the context of open innovation and explain how firms sense, seize and reconfigure external sources of innovation and commercialization to create a competitive advantage in innovation (Table 4).

The first class (sensing and shaping opportunities and threats) deals with the sensing of both technological and commercialization opportunities. In an OI context, sources of innovation are increasingly distributed and the identification of relevant external knowledge and technology becomes more difficult (Pitelis & Teece, 2010).

Furthermore, technological and competitive uncertainties make it difficult to determine which external resources are most likely to support innovative products that fit the firm's strategic orientation and are relevant for existing or emerging markets (Teece et al., 1997; Grant, 1996). Hence, firms require external sensing DC for recognizing valuable sources of external resource renewal. To identify and shape these opportunities Teece (2007) argues that companies must overcome a narrow search horizon by combining internal and external knowledge that originates in the core as well as the periphery of their business ecosystem. This is closely related to the outside-in approach of open innovation. To start, firms can develop strong knowledge bases internally by investing heavily in R&D activities. These R&D activities will enable the firm to develop its own core capabilities in new technological fields that form the basis of possible 'first mover advantages'. However, building up an internal knowledge base is a long and costly process and it is also very difficult to change the profile of technological foundations over time (Breschi & Malerba, 2005). Therefore, relying on internal capabilities only is likely to lead to 'core rigidities' or the so-called familiarity trap (Ahuja & Lampert, 2001) reducing the chance that companies can benefit from new technological opportunities. By tapping into external knowledge a firm can overcome the limits of internal learning (Capron & Mitchell, 2000; Karim & Mitchell, 2000). This reliance on external knowledge is closely related to the imperative of open innovation, where external knowledge is equally important to internal knowledge.

The second class of capability (seizing opportunities) deals with the choices one has to make after the opportunity is sensed. Once external knowledge sources have been identified as valuable opportunities for exchange, these opportunities need to be 'seized' in order to optimize their outcomes (Teece, 2007). Firms need to be able to integrate the external knowledge into their internal innovative processes (Wang & Ahmed, 2007). Hence, external seizing DC refers to the capacity to address opportunities for external renewal and integrate these resources within the organization. These capabilities are particularly related to making the right decisions regarding the investments in development and commercialization activities, as multiple investment paths are possible. In that sense the selection or creation of the proper business model is fundamental as it defines a firm's commercialization

strategy and investment priorities (Teece, 2007). Consequently, the creation, adjustment, or replacement of business models is a very important microfoundation of the second class of dynamic capabilities (Teece, 2007). However, business models can create strong inertial forces, once they have become well established (Chesbrough & Rosenbloom, 2002), making it difficult to adjust or replace them. As mentioned above, the business model also plays a central role in open innovation (Chesbrough, 2006). However, Teece is focusing on internal paths to market while open innovation is also emphasizing external paths to market.

The third dynamic capability class is focused on the reconfiguration of assets and organizational structures as a result of changing technologies and customer needs. This change is needed to escape from unfavorable path dependencies and to maintain evolutionary fitness (Teece, 2007; Helfat et al., 2007). In this context, external reconfiguring DC can be described as a combinative capability (Kogut & Zander, 1992) that refers to the novel synthesis of external and internal resources into new innovations. As such, external reconfiguring DC refers to the capacity to flexibly employ and combine resources across external and internal sources (Ridder, 2013). One of the important microfoundations underlying this dynamic capability class is the achievement of decentralization and near decomposability. On the one hand, growing enterprises must decentralize to remain flexible and be able to respond to changing technological and customer needs. On the other hand, organizations should be able to achieve integration as well to benefit from potential economies of scale and scope. Obtaining this subtle balance is called 'near decomposability' (Teece, 2007). Teece (2007) explicitly links the concepts of decentralization and near decomposability to open innovation as they rely on a distributed model of innovation to access and integrate external knowledge.

In sum, dynamic capabilities explicitly address some of the important elements of open innovation. Especially, the balance between internal and external knowledge, the important role of the business model and embracing open innovation as a way to access and integrate external technology, play a role in Teece's in-depth analysis of dynamic capabilities. Both open innovation and dynamic capabilities concern strategic responses to rapidly changing environments and a transformation of resources and capabilities. Their interface lies in their focus on the acquisition of

external resources in order to alter and transform the firm's internal resources and be at the forefront of innovation. Both approaches emphasize the significance of knowledge resources and discuss inter-organizational knowledge transactions as an important means to extend a firm's internal knowledge base.

However, we can also observe some differences between the dynamic capabilities theory and open innovation. Most importantly, the inside-out approach of the open innovation model is not addressed in the former. According to Teece (2007), the sensing and seizing of opportunities as well as reconfiguration are all closely related to an outside-in approach of the open innovation model, where the company integrates internal and external knowledge to create new products or services that are commercialized via internal paths to markets.

Table 4 Dynamic Capabilities for Open Innovation

DCs for Open Innovation	
Sensing	• Monitor and recognize new and emerging markets and technologies • Choose appropriately between different resource alteration paths according to strategic and competence-based fit
Seizing	• Manage a context that stimulates the use of externally generated resources, • Organize, diffuse and maintain externally generated resources.
Reconfiguring	• Actively monitor the internal resource base to identify opportunities for novel configurations. • Flexibly employ and combine resources across external and internal sources.

Source: Adapted from Ridder (2013)

2. HOW FIRMS BENEFIT FROM OPEN INNOVATION

In the following I will elucidate how OI is implemented in global firms through the opening up of their business model and the adoption of a network structure. Previous studies show that building relationships with different partners, customers, competitors or suppliers has a positive impact on innovation performance (Von Hippel 1988). This supports my research, finding in networked business model a source of competitive advantage in innovation. Furthermore I find that, external technological sources are not enough to innovation success, increasing attention must be paid to a company's ability to interact with its environment and to integrate external knowledge. In that sense OI success is closely related to dynamic capabilities (to integrate sources and manage inter-organizational relationships with partners who possess these critical resources) and environmental contingencies (organizational culture, technological turbulence, dynamics of competition).

2.1 Open Innovation and the Relational View

In prior work, the unit of analysis with open innovation has been at the firm level. The business models focus on the value creation and capturing activities of a single firm (Amit & Zott, 2001; Chesbrough et al., 2006). Chesbrough et al. (2006) suggest that the research scope of open innovation should be expanded to the inter-organizational level where the focal firms jointly create values with their collaborators. In that sense the relational view provides a valuable theoretical foundation for the study of open innovation, especially because prior work on this issue has been criticized for its lack of theoretical grounding (Lichtenthaler, 2011).
In open innovation, firms rely for their new products/services on both internal and external resources, and internal resources can be deployed using inside as well as outside paths to market (Chesbrough, 2003). Companies get access to external knowledge and integrate it into the development of their new offerings. Resources and capabilities of different organizations are brought together in an effort to offer value to the targeted customers. Firms, even the largest ones, cannot develop the required resources internally and have to cooperate with innovation partners enabling

resource flows between firms. Such an increase in permeability of firms' boundaries will enhance the match between market opportunities and capabilities as well as a more efficient use of resources (Arora et al., 2001, 2010).

In contrast to the traditional RBV whose proprietary assumption (a firm should protect its resources from imitation) appears to somewhat contradict the idea of opening up the innovation process, the relational view specifically addresses the sources of collaborative rent generation (Duschek, 2004; Lavie, 2006). The relational view emphasizes that critical resources can and should also be found outside the firm's boundaries (Dyer & Singh, 1998). Collaborating firms that combine resources in unique ways may realize a competitive advantage over others that compete on the basis of a stand-alone strategy. To do so, firms have to combine resources with partners in unique ways and be willing to make relationship-specific investments. These relationship-specific investments generate relational rents that are a property of the dyad or network and cannot be enjoyed by a firm in isolation (Dyer & Singh, 1998). The relational view identifies complementary resources or capabilities of firms as a potential source of inter-organizational competitive advantage: this is in line with a major premise of open innovation to consider the sourcing of knowledge from external partners a source of competitive advantage. In particular, the relational view of the firm considers the dyad/network as the unit of analysis and, as a consequence, the complementary resources that create the relational rents are essentially beyond the control of the individual firm (Dyer & Singh, 1998). Literature on networks proves that companies with technology-oriented external relationships are more innovative than companies without such relations. Especially in technology intensive industries such as biotechnology or electronics, network approach and alliances have usually been a more important instrument to guarantee knowledge or complementary resources (Powell et al., 1996; Mowery et al., 1996).

According to this theoretical framework, firms will be more likely to realize the potential benefits of their collaborative innovation activities when they possess (1) partner-specific *absorptive capacity* and (2) complementary *resource endowments* and (3) when they employ effective *governance mechanisms* (Dyer & Singh, 1998; Lavie, 2006).

First, extending Cohen and Levinthal's (1990) widely recognized absorptive capacity concept, according to which the focal firm's ability to harness external knowledge is a function of its prior related knowledge generated through internal R&D, Dyer & Singh (1998) introduce the idea of partner-specific absorptive capacity. They argue that the focal firm's ability to generate value from its innovation collaborations is not only dependent upon its general absorptive capacity, as shown by previous studies in the context of open innovation (Salge et al., 2012), but may be particularly affected by its ability to absorb valuable knowledge from a specific collaboration partner. Second, complementary resource endowments are another important dimension of collaboration success (Duschek, 2004; Dyer & Singh, 1998), which has been extensively discussed in the innovation literature (Teece, 1986). Product innovation often requires that the focal firm's resources (technologies) are used in combination with a collaboration partner's idiosyncratic resources (local market knowledge, distribution channels). By selecting collaboration partners with specific resources, the focal firm can leverage the value of its own resources. This effect is exemplified by start-up firms that enhance their reputation through collaborating with prestigious partners (Lavie, 2006). Finally, proponents of the relational view argue that the selection of collaboration partners also influences to what extent there is an alignment of incentives that encourages the partners to be transparent, exchange knowledge, and not act opportunistically (Duschek, 2004; Dyer & Singh, 1998). To ensure interfirm knowledge transfer, motivate collaboration partners to invest in relation-specific assets, and protect against the hazards of opportunism, firms can employ various governance modes, or what is also referred to as safeguards (Dyer, 1997). In essence, the literature distinguishes between formal governance mechanisms such as contracts that specify the rights as well as obligations of collaboration partners and rely on third-party enforcement (state authorities) and informal, self-enforcing mechanisms such as trust (Carson et al., 2006; Dyer & Singh, 1998; Poppo & Zenger, 2002). Although research suggests that informal agreements based on trust are generally more effective and involve lower transaction costs than formal safeguards, the choice of optimal governance modes nevertheless appears to be highly context dependent (Poppo & Zenger, 2002).

2.1.1 Partner type and Governance mode

The relational view aids in identifying theoretically meaningful contingencies that affect the effectiveness of the focal firm's open innovation activities. By merging the arguments advanced above with previous research on open innovation, the partner type (market- versus science-focused innovation partners) and governance mode (informal versus formal) of innovation collaborations can be derived as salient factors in this respect.

The first dimension recognizes the specific characteristics of different types of collaboration partners (customers, suppliers, universities, and research institutes) in terms of their value-creating potential and value- appropriation hazards (Bercovitz & Feldman, 2007; Faems et al., 2005). In particular, following the relational view, these partners may not only vary in their incentives to act opportunistically, but also in their contribution to the focal firm's innovation processes given differences in the complementarity and transferability of their idiosyncratic resources (Dyer & Singh, 1998; Lavie, 2006).

The literature suggests that collaboration partners can be broadly categorized into *market-* and *science-focused* innovation partners, depending on the kind of knowledge (market versus technological knowledge) they bring into the partnership (Bogers et al., 2010). On the one hand, market-focused innovation partners such as suppliers and customers (business customers or consumers) are widely expected to contribute to NPD success by providing the focal firm with a better understanding of potential applications of its technologies, market opportunities, and how to serve markets (marketing strategies). Interacting with customers, for example, can enhance the market fit of new products or services through gaining an understanding of customers' needs and preferences ('need information') (von Hippel & Katz, 2002). On the other hand, collaborations with science- focused innovation partners such as universities and research institutes are particularly valuable for assessing unique technological knowledge ('solution information') that is distinct from the focal firm's knowledge base. As these institutions typically not only engage in applied but also basic research, science-based collaborations hold promise for generating

technological breakthroughs that offer long-term commercial potential (Bercovitz & Feldman, 2007; Faems et al., 2005).

Second, the issue of governance is at the heart of the relational view as the choice of a particular governance mode is likely to influence not only the transaction costs of collaborative arrangements, but also the behavior of collaboration partners including their willingness to share knowledge or their inclination to opportunistic behavior (Duschek, 2004; Dyer, 1997). Accordingly, an effective governance mode is one that minimizes transaction costs while maximizing value-creation incentives (Dyer & Singh, 1998). Drawing on transaction costs economics (Williamson, 1985), two main approaches to safe- guard against opportunistic behaviors of collaboration partners such as shirking, failing to fulfill obligations, and withholding valuable information are discussed, namely, a relation-based approach that emphasizes trust and the contract-based approach that emphasizes control (Carson et al., 2006). Informal innovation collaboration reflects the former approach. Instead of using complex contracts that specify the roles and responsibilities to be performed as well as benefits and obligations of the focal firm and its collaboration partner, informal collaboration relies on self-enforcing mechanisms, most notably trust and reciprocity (Dyer, 1997; Poppo & Zenger, 2002). As mentioned above, under most conditions, this form of governance is viewed as more effective and less costly than formal collaboration based on contracts because of, for example, lower contracting and monitoring costs (Dyer & Singh, 1998).

2.2 Networks and Innovation

Definitions of *network* vary, but they are usually seen as patterns of organizing involving multiple connections. These involve collections of nodes, which could be individuals, teams, or organizaions, linked by a relationship. Where such relationships abound amongst groups of firms and public-sector institutions, they are sometimes described as ‘innovation networks’ (Freeman, 1991). The role networks play in innovation is not new. During the industrialization of Britain in the late 1700s there were strong linkages between the individuals developing the first generation of

steam engines. Professional communities often met to share ideas about technology and markets (Dodgson et al., 2008).

Today the role of networks, communities, and linkages has come to the fore in investigations of innovative performance. The development of network structures is a response to the challenges of globalization: due to the gradual decrease in the importance of geographical, administrative, political, currency, tax, legislative, linguistic and other barriers networks allowed companies to access broader and more open markets, with a large number of end customers but also with large numbers of companies operating at all levels of the supply chain (Corniani, 2013). The early Schumpeterian model of the lone entrepreneur bringing innovations to markets has been superseded by a rich picture of different actors working together in iterative processes of trial and error to bring about the successful commercial exploitation of a new idea (von Hippel, 1988; Tidd & Trewhella, 1997). These newer models of innovation have highlighted the interactive character of the innovation process, suggesting that innovators rely heavily on their interaction with lead users, suppliers, and with a range of institutions inside the innovation system (von Hippel, 1988). In this respect, innovators rarely innovate alone. They tend to band together in teams and coalitions based on 'swift trust,' nested in communities of practice and embedded in a dense network of interactions.

Research on network theory in multiple studies shows that a network of relationships produces a number of positive outcomes, including increased access to novel and diverse information (Burt, 1992; Granovetter, 1985; Hansen, 1999), increased access to resources (Gnyawali & Madhavan, 2001), more efficient knowledge transfer (Reagans & McEvily 2003; Uzzi 1997), heightened power and control, increased legitimacy and understanding for the products, increased innovation (Capaldo 2007), and increased performance (Lechner et al. 2010; Powell et al. 1996). But scholars also argue that networks have negative effects, such as costs of maintaining additional ties, reduced information benefits, or information overload (Burt 1992; Uzzi 1997).

A major reason for firms belonging to networks is that as technology becomes more complicated and complex, it is necessary to combine and integrate knowledge, components, and systems from many different domains. A modern car is not simply

an extraordinary feat of mechanical engineering; it contains software, communication systems, and new materials and its construction requires knowledge about this and many other fields. Firms derive competitive advantage from being expert at combining and integrating knowledge and technologies of others in novel and valuable ways. This requires firms to work with external actors, develop the capabilities to capture and integrate ideas and technologies developed by others, and learn especially from the ideas and insights of their customers and users (Cohen & Levinthal 1990; Chesbrough 2003, 2006).

By understanding networks, it is possible to gain insights into the interactions and relationships that support and constrain innovation. Networks enable individuals and firms to gain access to resources they do not possess, without necessarily having to buy them in a market transaction. They provide clues about where ideas may be located or where assets may be found to help realize the commercial potential of a new idea. Understanding networks is therefore central to innovation, as they offer a rich web of channels, many of them informal, and have the advantage of high source credibility: experiences and ideas arising from within are much more likely to be believed and acted upon than those emerging from outside (Powell et al. 1996).

A strength of networks is that they offer a way of bridging gaps between what firms do and what is possible. In that sense networks can enable the sharing of resources: for example, collaborative R&D projects where the costs and risks of investment to any individual firm would be prohibitive. In addition networks create the possibility for extensive self-help through experience sharing and learning. Cooperative networks in Europe have enabled small-scale industry to compete successfully in global markets through involvement in collaboration (Dodgson et al. 2008).

Freeman (1991) argues that networks should not primarly be explained by reference to costs, but rather in terms of strategic behavior, appropriation of knowledge, technological complementarity, and factors as trust, ethics and confidence in cooperativeness of others.

In addition to the positive benefits, networks can also have negative consequences. The network model of innovation may limit participating firms' access to complementary assets and hence their ability to achieve full commercial returns on innovation activity. Networks may trap firms in low- value parts of the value chain.

They might also have some features of cartels and conceivably exclude possible new entrants, with negative consequences for competition. The challenge for managers is how best to configure external relationships alongside the internal capabilities within firms to create value (Dodgson et al. 2008).

Central concepts in the study of such networks are: the relational, the structural, and the cognitive dimensions (Lechner et al. 2010; Nahapiet & Ghoshal 1998). These can be analyzed by using more specific constructs for each dimension: tie strength for the relational, centrality for the structural, and shared vision for the cognitive.

2.2.1 Tie Strength, Centrality and Shared Vision

Granovetter (1973), who introduced the concept of tie strength, defined it as a *"combination of the amount of time, the emotional intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie."* With strong ties at one extreme and weak ties at the other, it is viewed as a continuous measure (Hansen 1999; Lechner et al. 2010).

Researchers argue that both strong and weak ties produce a number of positive outcomes. Granovetter (1973) argues that weak ties lead to novel information by otherwise unconnected groups within an organization. He argues that weak ties are more likely to transfer non-redundant information, since the contacts are less likely to be connected. Conversely, other studies show the positive effects of strong ties, as they facilitate the transfer of fine-grained information and tacit knowledge, increase the level of trust and lead to support between the two actors within the social relationship. Some efforts are made to reconcile the differences between weak and strong ties by introducing a contingency argument to moderate the effects (Gulati 1998; Hansen, 1999; Uzzi, 1996; Lechner et al., 2010).

Network research mostly defines centrality as the position of an actor within the network. Several researchers emphasize that centrality in a network is connected to power and control, to superior information and resource flows (Gnyawali & Madhavan, 2001; Powell et al., 1996; Lechner et al., 2010), and to broad access to many resources, partners, or knowledge (Rowley et al., 2000). Some researchers emphasize the value of low centrality, arguing that it allows time for the focal actor,

since fewer ties require less time to maintain the relationships and support others in the big network. Furthermore, they outline that fewer connected partners decrease the risk of exposure to potential hindrance groups (Lechner et al., 2010) or leakage points whereby valuable information is conveyed to others (Gnyawali & Madhavan, 2001). Low centrality improves the ability of the focal actor to conceal activities from those opposing them. Lechner et al. (2010) introduce the notion that effects of low or high centrality are moderated by the type of initiative.

The cognitive dimension is increasingly recognized as an important element of networks (Gilsing et al., 2008; Lechner et al., 2010; Nooteboom et al., 2007). It refers to the similarity in representation, interpretation, mental models, and world views and to common backgrounds amongst different social actors within a network. The concept is based on the logic that shared understandings and structured regularities of mental processes influence economic action or limit economic reasoning.

There is broad evidence in literature that shared beliefs and common visions strongly influence strategic choices and actions taken. Furthermore, research states that shared vision leads to groupthink, as focal actors recognize the same risks and chances and perceive the same strategies and capabilities as valuable. Additionally, it improves communication and facilitates resource and information transfer between the focal actors. Scholars find positive or curvilinear performance implications of cognitive embeddedness, and others see its effect subject to moderating influences (Nooteboom et al., 2007; Lechner et al., 2010).

2.3 Global Networks for Open Innovation

Chesbrough (2006, 2007) differentiates between closed and open business models. Firms implementing closed business models focus primarily on internal value creation and rarely collaborate with partners; they only maintain simple buyer-seller relationships with the outside world. In contrast, open business models focus on external resources as key contributors to a firm's value creation process; value for the customer is co-created between actors in a network.

As discussed above collaboration with partners, customers, competitors and suppliers is recognized, thus, as an essential driver to enhance firms' performance and innovativeness (Von Hippel, 1988). Through close partner collaboration, firms implementing open innovation gain improved access to markets and knowledge, as well as to external resources and capabilities (Sandulli & Chesbrough, 2009).

Although open business models are by definition related to the establishment and management of ties to external partners, the field currently lacks a systematic approach to identify patterns and rules for the composition of partner networks underlying open business models (Zott & Amit, 2010).

Open Innovation can be considered a value-creation strategy that is an alternative to vertical integration. In this context companies increasingly build distributed global networks to sense markets trends, to tap into new knowledge and to provide further sources of new technology. To match the growing demand for innovation from customers, suppliers, etc., with the worldwilde supply of science and technology, large companies increasingly adopt ecosystems of innovation which link networks of people, universities, government agencies, and other companies (OECD, 2008). In such ecosystem some firms need to identify external knowledge and incorporate it into the firm; others seek external markets for their existing innovations. The pathways of network ties create opportunities for both types of innovation. Accessing a network allows a firm to fill in a specific knowledge need rapidly, without having to spend enormous amounts of time and money to develop that knowledge internally or acquire it through vertical integration. Networks can facilitate efforts to commercialize internal technologies, such as through creation of a spin-off, corporate venture investment in a start-up, or establishment of a joint venture (Chesbrough et al., 2006).

James Moore (1993) claims that firms in a business network evolve capabilities around a new innovation. Participating companies cooperate and compete to fulfill customer needs to deliver new products and services. Von Hippel (1988) looks at a firm's broader ecology for gaining useful knowledge for new product development and innovation that includes: (1) suppliers and customers, (2) university, government, and private laboratories; (3) competitors, (4) other nations. Globalization, indeed, alters the scope of open innovation as it drastically broadens

the array of potential partners. In fact global innovation networks include own R&D facilities abroad as well as collaboration with external partners and suppliers in which the different actors play multiple roles depending on the nature of their expertise. This complex and more open way of innovating requires cross-functional cooperation and interaction throughout companies, not only R&D units, but also manufacturing, marketing, sales and services, and enhanced interation with external parties, both public and private.

These networks are more common in the high-tech industries as they enable companies to cope with accelerating innovation cycles, global competition, complex products and services that incorporate multiple technologies, and the difficulty of controlling all the intellectual assets and qualified people needed for innovaiton (Powell et al., 1996; Mowery et al., 1996; Chesbrough, 2006, Brondoni, 2012). In this context companies need different sources of innovation to gain a greater flexibility (Brondoni, 2014; van de Vrande et al., 2006). This view is consistent with the theoretical assumptions of the relational view (Vanhaverbeke & Cloodt, 2014), according to which companies that collaborate are able to combine resources in a new and unique way, creating a competitive advantage than those companies implementing a stand-alone strategy.

A firm's external networks have been suggested as contributing to a firm's larger organizational ecology. Powell (1990) frames the network form of organizations and illustrates that networks are formed based on the reciprocity of complementary resources. He claims that this network organization is particularly appropriate to situations where there is a need for efficient and reliable information, such as know-how, technological capacity, manufacturing methods, and a spirit of innovation. As people are more likely to value information from someone that they know well, network organizations consider it is important to build trustful reciprocal connections.

Gulati (1998) explains how firms are networking using the notion of 'embeddedness', he pointed out that firms' strategic actions are affected by the social context in which they are embedded and the firm's social context is composed by the network's relationships among partners. The underlying embeddedness (Granovetter,

1985) refers to the fact that an organization typically has a history of how group members exchange information, resulting in social linkages between members.

Underlying embeddedness is the quest for information to reduce uncertainty, a quest that has been identified as one of the main drivers of organizational action. These networks are based on the collaborative efforts of specialist companies each providing complementary intermediate goods and services (Chesbrough et al., 2006).

In order to explain the networking behavior in an open innovation context, a valuable theory is that of value networks by Normann and Ramirez (1993). They call these networks 'value constellations', defined as inter-organizational networks linking firms with different assets and competencies together in response to or in anticipation of new market opportunities. A central firm sets up a value constellation through acquisitions, licensing agreements, non-equity alliances, joint ventures, contracting, and other types of relationships that go beyond arm's-length relations. Inter-organizational networks have many links with the practice of open innovation. One motivation for the development of value constellations is the complexity of products and services today, coupled with complex supply chains and market pressures. These networks are established to absorb externally developed knowledge to accelerate the speed of innovation. Another motivation for networking is to enable an innovating company to exploit new business opportunities stemming from currently available products and services. For example, new product and services may need radically different business models that would benefit from new value networks (Vanhaverbeke & Cloodt, 2006). These networks challenge us to think about innovation; innovation is not coming from one single firm but from outcome of collaborative interplay of the network partners.

Business networks have been found to have beneficial returns on innovation, resulting in increased patenting rates, improvements on existing products, and new product creation, faster time to market, and access to new markets (Powell et al., 1996). By providing access to complementary skills, scale benefits, and a broader knowledge base, network ties positively influence firm innovation (Ahuja & Lampert, 2001).

Vossen's study (1998) demonstrates that innovation in small firms is also hampered by a lack of financial resources and scant opportunity to recruit experts, but they can

overcome these difficulties by creating a business ecosystem to collaborate on innovation projects. This networking behavior makes them spread risk related to innovation from small capacity, and to share resources together to build products and services. As value is co-produced in these networks, the total value created depends directly on how well partners' objectives are aligned to each other's and on the commitment of the partners to invest in complementary assets (Teece, 1986). As a consequence network relationships have important effects on firm competitive advantage.

2.3.1 Network Relationships

Chesbrough, Vanhaverbeke and West (2006) introduced various network relationships that enable open innovation. They distinguish deep ties that enable a firm to capitalize on existing knowledge and resources and wide ties that enable a company to find new technologies and markets. Deep network ties are associated with geographical proximity to partners. These are usually networks based on trust because of long relationships. They are important for innovation potential but usually limited to incremental innovation. Wide network ties give access to a wider variety of knowledge, making it possible to access new opportunities and resources and to stimulate creativity and innovation leading to more radical innovation. Open innovation benefits from building ties that are wide and deep and from finding the right balance between these ties (Simard and West, 2006).

Building on Powell et al. (1996), Chesbrough et al. (2006) make another useful distinction in types of networks, between formal and informal network relationships. Formal ties refer to knowledge exchange between organizations based on contracts or other formal agreements and are associated with sharing explicit knowledge. Informal ties are often based on personal relationships at different levels in organizations and are associated with sharing implicit knowledge. Formal ties, such as alliances, research consortia and licensing agreements and informal ties often go hand in hand: formal relationships may emerge from informal arrangements, and *"beneath most formal ties, lies a sea of informal relations"* (Powell et al., 1996). Open innovation strategies benefit from both formal and informal ties for effective

transfer of knowledge in collaboration (Simard and West, 2006). Formal ties can be part of an explicit, planned open innovation strategy. Informal ties give opportunities for unplanned, spontaneous knowledge sharing but require special attention for abilities to capture external innovation by tacit knowledge sharing. Similarly March (1991) argues that companies balance their deep and wide ties, or explorative and exploitative ties.

Formal ties have been studied extensively, but the role of informal interorganizational ties is less well understood. However, informal networks might also be too 'closed' to generate the desired information from other organizations. Powell et al. (1996) remark that in biotechnology informal social networks are too tightly centered on star scientists that act as a bottleneck for information sharing. Hence, both formal and informal ties have their advantages and disadvantages and an innovating firm has to balance the mix to optimize the return on open innovation.

Networks of innovation are often based on repeated interactions between firms, and thus their tie strength depends on trust – particularly in regional clusters where firms and people develop a local reputation based on past interactions. Network forms rely on trust as a coordination mechanism (Powell, 1990; Uzzi, 1997). Empirical evidence suggests that inter-organizational trust, which is more institutionalized, is longer lasting than the interpersonal trust inherent in informal networks. Trust is crucial in reducing the risks associated with interfirm tie formation (Nooteboom et al., 1997).

Organizations must consider a balance of strong and weak ties for their open innovation strategy. Strong ties benefit from more institutionalized trust and are likely to be more quickly and easily activated, yet weak, and bridging ties provide access to new information which is paramount to innovation. There is an inherent trade-off between trust and novelty, safety and flexibility.

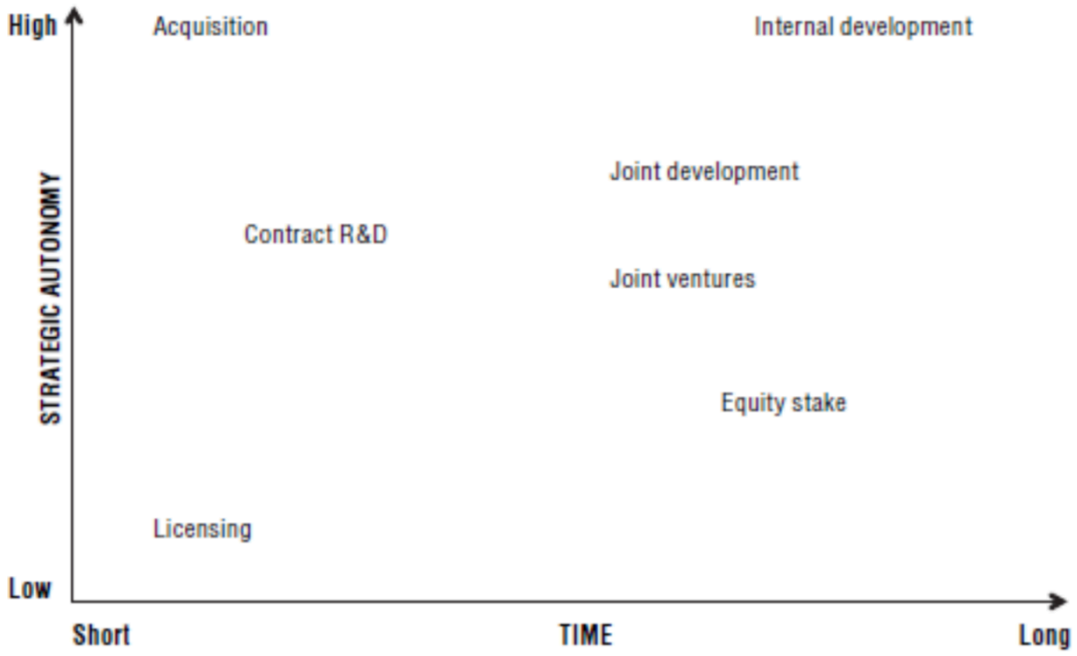
Overembeddedness happens when firms rely too much on repeated interactions with the same partners; when these partners are themselves linked through strong ties, the network becomes closed to external information and starts having access to only redundant information, leading to the stifling of innovation (Uzzi, 1997).

Granovetter (1973) emphasizes the 'strength of weak ties' to widen the scope of ties. Based on occasional, rather than frequent interactions, these ties offer more pathways

to new information, because they provide access to different networks and thus different sources of information. Informal professional affiliations, such as common organizational affiliations, are examples of weak ties that can be acted on in an open innovation model. Chesbrough et al. (2006) recommend maintaining diverse types of relationships to a diverse set of institutions for a successful open innovation strategy. There is, indeed, a delicate balance between exploration and exploitation activities (March, 1991). Exploration involves searching for new opportunities and developing new products or technological developments through alliances, whereas exploitation involves capitalizing on existing knowledge and resources.

In Open Innovation Networks firms have a number of different options ('modes') for accessing, sourcing and absorbing external knowledge and technologies, including purchasing (acquisition); licensing; joint venturing and alliances; joint development; contract R&D; collaborations with universities; equity in university spin-offs; and ditto in venture capital investment funds (OECD, 2008). The type of relationship a company chooses between the different available options will strongly affect its resources and strategic directions, with a clear trade-off between strategic autonomy of the firm and the time horizon of implementation (Figure 2).

Figure 2 Different Options to Access Knowledge in Open Innovation Networks



Source: ***Open Innovation in Global Networks*** **OECD (2008)**

In a similar vein there are different options for accessing and sourcing new knowledge and technologies (outside-in open innovation) and for transferring and commercialising them externally (inside-out open innovation). How firms will choose them depends on how core technologies and markets relate to them. Joint ventures and venture capital are typically used for both sourcing knowledge from outside and for commercialising 'own' innovations.

Internal development and acquisition are typically used in core technologies for core markets, as open innovation and collaborating with external partners may be too risky. Licensing is more appropriate when dealing with non-core technologies, either in sourcing them externally or in commercialising those developed internally. If technologies and markets are considered too unfamiliar, companies may want to step out by selling or spinning off activities (OECD, 2008).

2.3.2 Benefits and costs

Generally, from the perspective of the firm, technological collaboration is seen as a means of improving technological knowledge and skills. Although these networks occur in many different forms, and may reflect different motives, a number of generalizable assumptions underpin it.

The first is the belief that it can lead to positive sum gains in internal activities, that is, partner together can obtain mutual benefits that they could not achieve independently. Such benefits may include:

- Increased scale and scope of activities. The outcomes of technological collaboration may be applicable to all partners' markets, and thus may expand individual firms'customer bases (increased scale). Synergies between firms' different technological competencies may produce better, more widely applicable products (increased scope). Increasing the scale of resources to technology development can also raise entry barriers to other firms (Dodgson et al., 2008).
- Shared costs and risk. Technological collaboration can share the often very high costs, and therefore high risks, of technological development.

- Improved ability to deal with complexity. Closer technological integration between firms is a means of dealing with the complexity of multiple sources and forms of knowledge. It allows, for example, for the better transfer of tacit knowledge by providing a mechanism whereby close linkages among different organizations enable the development of sympathetic systems and procedures. It may also allow partners to unbundle discrete technological assets for transfer (Mowery et al., 1996).

A second assumption regarding these networks concerns the way they assist with environmental uncertainty. Increasingly sophisticated and demanding customers, growing competition and globalization of markets, and rapidly changing and disruptive technologies place pressures on firms to exist with, and attempt to control these uncertainties. This is believed to be achieved more easily in collaboration than in isolation. A number of analyses of collaboration link it with uncertainties in the generation and early diffusion of new technologies (Freeman, 1991).

A third set of assumptions underlying open innovation networks concerns its flexibility and efficiencies. Collaboration may be an alternative to mergers and acquisitions, which are difficult to change once entered into. As a governance structure, collaboration has advantages over the alternatives of arm's-length market transactions and vertical integration. It can allow firms to keep a watching brief on external technological developments without having to invest heavily. In this context interactions between large and small firms can be facilitated such that the resource advantages of the former are linked to the behavioural or creative advantages of the latter, while each maintains its independence (Dodgson et al., 2008). A large drug company, for example, may choose to collaborate with a small biotech firm as a means of developing its options, so that it can invest more heavily once the technology is better proven and better understood.

Potentially there are numerous advantages from open innovation networks if these assumptions hold: first of all, each firm utilizes the network's relationships to complement its knowledge in order to innovate more efficiently. Besides, firms belonging to these global networks benefit also from: cost savings (because R&D costs and risks can be shared); better access to specific resources and skills; knowledge and insights into markets, and faster time to market (Tyrrel, 2007).

At the same time there are also potentially adverse aspects of collaboration. Firms engaged in networks for innovation must balance the need to promote openness among partners while taking proactive steps to protect their core competences (Muller et al., 2012). West and Gallagher (2006) discuss how open innovation instills fears of losing control over proprietary knowledge and technology and over valued employees because it promotes porous organizational boundaries. When a firm is linked to other firms within a global network it is more likely to get some information about partners and to know their new projects; in these contexts partners could act opportunistically leveraging this information (Arrow, 1962); so having access to multiple collaborations can promote both innovative and imitative processes (Arrigo, 2012). Futhermore, as it will be observed in the following, there may be strategic dangers from firms that become overly reliant on externally sourced rather than internally generated technology (Laursen & Salter, 2006). Without internal technological competencies there can be no receptors for external technology, nor capacity for building technological knowledge, which, apart from its other benefits, provides the basis for attracting future partners.

Finally, a further cost of collaboration is about the network construction and management. Resource-based theory suggests that the decision as to selection is predicated the partners' potential to provide additional resources to their mutual benefit (Kogut et al., 1992). But searching for and deciding on who to collaborate with to create an effective network, scanning and monitoring the technological environments (Lichtenthaler, 2003) to search for potential partners (Makadok & Barney, 2001) requires financial resources and time.

2.4 Conditions of Open Innovation Effectiveness

The open innovation model is based on the idea that external sources of knowledge may often be more valuable than internal ones. Accordingly, open innovators integrate these external sources into their innovation processes and competitive strategy (Chesbrough, 2003). The focus on openness and interactions in studies of innovation reflects a wider trend in studies of firm behavior that suggest that the network of relationships between the firm and its external environment can play an

important role in shaping performance. For instance, Shan et al. (1994) find an association between cooperation and innovative output in biotechnology start-up firms. Ahuja (2000) finds that indirect and direct ties influence the ability of a firm to innovate, but that the effectiveness of indirect ties is moderated by the number of the firm's direct ties. Powell et al. (1996) investigate interorganizational collaboration in biotechnology and assess the contribution of collaboration to learning and performance, showing that firms embedded in benefit-rich networks are likely to have greater innovative performance. In sum, these studies point to the importance of open behavior by firms in their search for innovative opportunities and they suggest that performance differences between organizations can be ascribed to this behavior. In this context search strategies are strongly influenced by the richness of technological opportunities available in the environment and by the search activities of other firms (Levinthal & March, 1993). In industries, with high levels of technological opportunities and extensive investments in search by other firms, a firm will often need to search more widely and deeply in order to gain access to critical knowledge sources. In contrast, in industries where there are low technological opportunities and modest investments in search by other firms, a firm has weaker incentives to draw from external knowledge sources and may instead rely on internal sources. Together these studies shift attention toward the role of search strategies in explaining innovative performance and suggest that the conventional explanatory variables of innovation performance, such as size and R&D expenditure, need to be complemented by investigation into how differences in search strategy give rise to performance heterogeneity.

In connection with this greater engagement in boundary spanning innovation activities openness and inter-organizational interactions pose new managerial challenges. Despite its growing importance, many firms experience several challenges to actively manage the processes of open innovation. Research on large firms highlights that open innovation requires internal organizational complements that facilitate the absorption of external ideas and knowledge and to capture the value from it (Laursen & Salter, 2006).

Previous research show that organizational structure has been shown to impact a firm's ability to innovate (Tidd & Trewhella, 1997), to absorb, proceed upon, and

learn from external knowledge (Lichtenthaler & Lichtenthaler, 2009), and to relate to external parties. These aspects all represent ingredients for successful open innovation, yet the question remains as to how the organizational structure that a firm has implemented supports its open innovation activities directly. Hence in this section, I investigate how OI success is affected by different elements.

Research has suggested that external knowledge can only be utilized successfully when firms shape their organizational structure to facilitate open innovation (Bianchi et al., 2011; Dahlander & Gann, 2010). The potential to process information between internal units and these units and the external environment, respectively, is to a large extent determined by firms' organizational structures (Cohen & Levinthal, 1990). This highlights the importance of a firm's structural composition in the context of knowledge search and integration, and innovation.

Likewise, Piller and Ihl (2009) propose that firms can support open innovation by means of an appropriate organizational design. Looking at different dimensions of organizational structure, the authors argue that there are favorable levels of single structural variables that create an adequate environment to foster external knowledge integration, and thus the generation of innovative outputs.

Several studies have investigated the influence of organizational structure on a firm's search behavior, finding more specifically that it is the centralization of a firm's R&D organizational structure that leads to a higher probability of engaging in relationships with external partners. A higher degree of centralization is thus associated with increased openness. Likewise, other studies suggest that organizational structures embodied in basic organizational forms affects a firm's ability to search for and utilize external knowledge.

Besides the ability to identify and source external knowledge, firms need to be capable of developing and deploying external knowledge resources internally in a rent-generating manner (Dyer & Singh, 1998). Although there is a consensus that OI depends strongly on inter-organizational knowledge transactions (Chiaroni et al., 2011; Foss et al., 2011), organizational capabilities for dynamic knowledge management are also vital for the effective integration of external knowledge resources (Foss et al., 2011). Hence, the firm's internal organizational capabilities for managing external knowledge resources are likely to represent an important factor in

determining the effectiveness of openness in innovation. Cohen and Levinthal (1990) refer to this capability as the inward-looking component of a firm's absorptive capacity, and highlight its importance for effective organizational learning, as it facilitates efficient internal knowledge processing mechanisms. In this regard, organizational structure affects internal communication processes and also the likelihood of effective internal knowledge management (Nonaka & Takeuchi, 1995).

Following the argument of Cohen and Levinthal (1990), external search strategies remain ineffective without the ability of the firm to integrate external knowledge flows. In other words, even if a firm successfully manages to search for knowledge externally and to establish and maintain linkages to external knowledge sources, the firm will not be able to achieve higher levels of innovation performance in the absence of internal knowledge-processing capabilities.

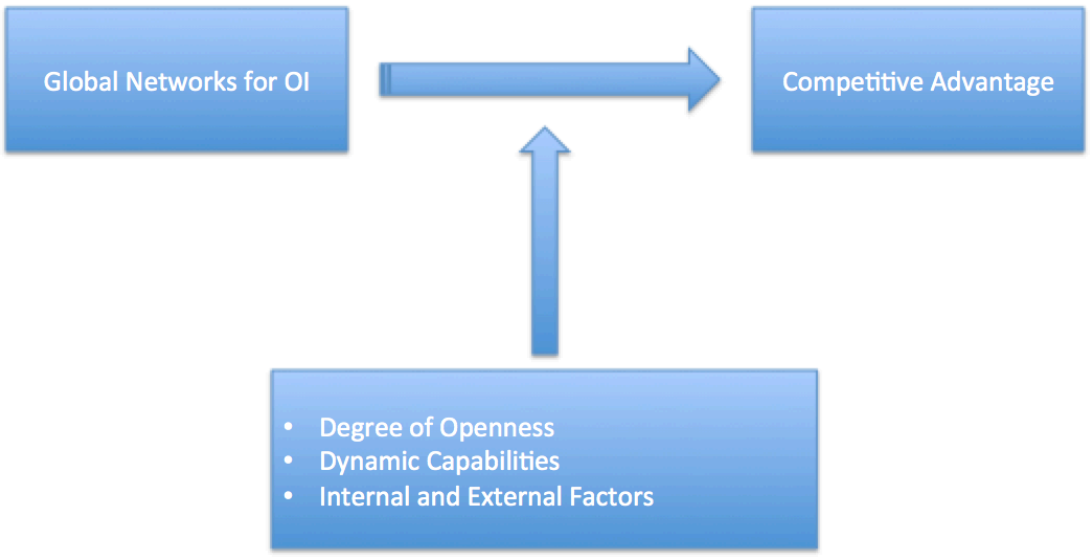
Hence, knowledge integration rather than access to knowledge resources themselves is critical (Grant, 1996). This integrative capablity determines how efficiently a firm can manage knowledge across boundaries and how productively new knowledge resources are utlized (Grant, 1996; Carlile, 2004). In previuos studies, this capability has been discussed predominantly within the conext of intra-organizational boundaries, such as across departments. In the context of Open Innovation, the applicability of integrative capability with regard to networks becomes increasingly relevant, as firms become more permeable with respect to external sources of knowledge. The ability to integrate external knowledge resources can be considered a dynamic capability as it aims at upgrading the firm's knowledge-based resources in order to advance and accelerate the firm's innovation process, and driving superior innovative performance (Amit & Schoemaker, 1993). This capability is related to the second class of dynamic capabilities 'seizing opportunities'; it refers to the capacity to address opportunities for external renewal and integrate these resources within the organization.

The degree of openness and integrative capability, however, cannot be treated in isolation. The external environment and the organizational culture have an important impact on Open Innovation performance. The contingency perspective suggests that relationships between strategies and performance differ across environmental conditions (Arora & Nandkumar, 2012). This means that it is also crucial to examine

the influence of environmental conditions on the value creation potential of Open Innovation strategies. In the OI literature, two external and one internal aspects have been highlighted as influential factors in the integration of external knowledge resources. First, prior research emphasizes the degree of turbulence in a firm's technological environment (Christensen, 2006; Huizingh, 2011). Second, it has been suggested that potential costs and benefits of Open Innovation are highly intertwined with different level of competition (Chesbrough, 2007; Dahlander & Gann, 2010). Hence, in evaluating external contingencies I foucs on different levels of technological turbulence and dynamics of competition. Regarding the internal dimension I focus on the organizational culture, as it has frequently been highlighted as an important factor to implement open innovation successfully (Gassmann et al., 2010; Huizingh, 2011; Lichtenthaler, 2011; Van de Vrande at al., 2010).

Following this reasoning I suggest that the degree of openness, dynamic capabilities and contingency factors (organizational culture, technological turbulence and competitive dynamics) have important effects on open innovation-based competitive advantage (Figure 3).

Figure 3 Conditions of Open Innovation Effectiveness



2.4.1 The Degree of Openness

In an Open Innovation context the network structure is more flexible and more responsive to changing needs and information and knowledge flows across the boundaries within and outside every firm. As knowledge can flow from multiple directions, firms in the network benefit from external knowledge hailing from dispersed locations, internalize local knowledge and share it across locations. In particular, the network configuration of global firms promotes external knowledge sources search and learning from each periphery of the competitive scenario (Arrigo, 2012). Collaboration with external partners is the core of OI implementation and it has been widely used as a measurement of OI since the publication of Laursen and Salter's 2006 paper mainly utilizing two dimensions: the breadth and the depth of interaction with partners. Jointly, breadth and depth can be characterized as a firm's degree of openness and both are likely to have an effect on the performance of the firm's overall OI strategy. Some researchers have verified that openness towards different actors, such as customers, suppliers, and universities, has a significant positive impact on the different innovation performance measures (Drechsler & Natter, 2012). Performance of Open Innovation refers to the extent to which externally accessed knowledge increases the quality and speed of the firm's internal innovation and product development processes (Van de Vrande et al., 2009). Building on network theory and the distinction between weak and strong ties it can be assumed that the effects of search breadth and depth are similar to the effects of weak and strong ties. Broad search displays the diversity of external sources and inputs and thus the multitude of external connections, whereas deep search designates the frequency of interactions with certain external sources and partners, and thus shows the intensity or strength of external connections (Laursen & Salter, 2006). The discussion about the impact of these different characteristics of external search can be linked to the structure and characteristics of firms' networks, where a similar discussion about the effects of different characteristics of firms' external relations is known. Of central importance in the latter is the assessment of tie strength, and thus the distinction between weak and strong ties (Granovetter, 1973; Hagedoorn et al., 2006; Rowley et al., 2000).

The breadth dimension of knowledge search is defined as "*the number of different search channels that a firm draws upon in its innovative activities*" (Laursen & Salter, 2006). Based on this definition, search breadth describes the diversity of a firm's search activities. Scholars claim that this type of search provides flexibility and is more likely to remain more general in its focus, and hence provides the firm with a comprehensive overview of available opportunities. Similar, research on inter-organizational networks is arguing that valuable knowledge which is necessary to achieve competitive advantage is broadly distributed in the firm's environment. Hence, the amount of network ties, or tie diversity, is seen as a salient predictor of a firm's innovation performance (Powell et al., 1996).

Tie diversity is, in its conception, similar to the breadth dimension of organizational search. Tie diversity and external search breadth provide the firm with complementary knowledge and at the same time lower the risk of information redundancy and risks from unforeseen developments. Exposure to knowledge from heterogeneous domains allows considering multiple perspectives and thus adds to the firm's repertoire of innovation ideas. In addition, knowledge inflows from diverse knowledge domains can help the firm to overcome tendencies to favor familiar over unfamiliar knowledge, and to thus avoid getting stuck in a familiarity trap (Ahuja & Lampert, 2001). Since innovations are considered to be results of the recombination of familiar and unfamiliar elements of knowledge, the more diverse the set of knowledge sources that a firm draws upon in its innovative activities, the greater are the opportunities for the firm to combine knowledge in complementary and novel ways, and thus the more likely these activities are to result in innovative output.

Although external search breadth is associated with innovative performance, there may be detrimental outcomes deriving from 'over-searching'. Koput (1997) provides three related reasons why over-searching may have a negative influence on performance. First, there may be too many ideas for the firm to manage and choose between. Ever more external knowledge acquisition will lead to knowledge increasingly being underutilized, not fully unveiling its potential, whereas the acquisition efforts and cost rise at the same time with the increase in acquisition quantity. Second, many innovative ideas may come at the wrong time and in the wrong place to be fully exploited. Third, firms face an attention and resource

allocation problem due to information overflow. Since there are so many ideas, few of these ideas are taken seriously or given the required level of attention or effort to bring them into implementation.

However, openness in innovation is not just about accessing a wide number of sources, but it also involves drawing knowledge heavily from these sources. Therefore, a second aspect to consider is the depth of relationships as it refers to how deeply or intensively firms draw from different external knowledge sources (Laursen & Salter, 2006; Drechsler & Natter, 2012). Key sources for innovators are often lead users, suppliers, or universities (von Hippel, 1988). For each of these sources, firms need to sustain a pattern of interaction over time, building up a shared understanding and common ways of working together. Thus, external search depth is the number of external partners that are deeply integrated into a firm's innovation activities. According to Laursen and Salter (2006) firms that draw deeply from external sources are more innovative, because they are able to build and sustain virtuous exchanges and collaborations with external actors. However, as in the case of search breadth, some firms can become too deeply reliant on external sources for innovation. Maintaining deep links with external resources requires resources and attention. Therefore, if a firm relies on too many deep relationships with many external sources, it will exhibit lower innovative performance.

As mentioned before, literature on networks employs the dimension of tie strength to assess the intensity of the relationship between a focal firm and its external partners (Granovetter, 1973). Tie strength distinguishes between weak and strong ties and increases with the frequency of interactions between partners. So, while weak ties are based on rather occasional and shallow interactions, strong network ties describe more frequent and intense relationships (Hansen, 1999). The close correspondence between the deep linkages described by Laursen and Salter (2006) and the strong network ties addressed in the network literature leads to the conclusion that external search depth is conceptually similar to the count of strong ties that a firm maintains within its network of external knowledge sources.

Tie strength, i.e. strong and weak ties, is related to different performance implications. While the attainability of higher levels of overall knowledge transfer is ascribed to strong network ties (Reagans & McEvily, 2003), weak ties are said to

offer pathways to different knowledge domains, and are thus more likely to offer novel information (Granovetter, 1973). However, the close and frequent interactions taking place in strong tie relationships facilitate the development of mutual trust which serves as a catalyst for the transfer of tacit knowledge. The latter has been found to be particularly important for innovation performance (Hansen, 1999). The establishment and maintenance of such deep linkages with external actors requires considerable investment (Laursen & Salter, 2006; Reagan & McEvily, 2003). These investments include time consuming and frequent face-to-face interactions as well as higher coordination efforts, or the creation of a mutual understanding and common knowledge (Hansen, 1999; Reagan & McEvily, 2003).

Summarizing these studies, strong ties encompass recurring interactions with the same partners and oftentimes specific contractual arrangements (Rowley et al., 2000). Weak ties, on the other hand, resemble rather infrequent and shallow interactions with changing partners who have lower mutual commitment (Dittrich & Duysters, 2007). Both types of ties were found to be important for firms' innovation performance. While weak ties offer access to a broad variety of information sources and diverse inputs, which in turn increases the chances for acquiring truly novel information, strong ties draw their advantage from the opportunity to build trust and common understanding in a certain relation, which is conducive to the exchange of more specific, tacit, and fine-grained knowledge (Rowley et al., 2000). The establishment of strong ties, hence the frequent engagement with certain external partners, requires investment and a longer-term focus of the involved partners. In order to justify these investments and to maximize the likelihood of success, firms may restrict the choice of partners (Hansen, 1999).

Additionally, the resources necessary to establish strong ties reduce the overall number of relations a firm can engage in. This in turn inhibits the search potential with regard to truly novel information (Rowley et al., 2000). Strong ties oftentimes represent interactions in rather dense, small, and redundant networks of actors already in acquaintance with each other. Weak ties, on the other hand, are less intensive with regard to mutual investment and offer bridges across the usual field of partners and search domains, thereby offering access to information sources previously unconsidered (Rowley et al., 2000). Hence, weak ties offer firms diversity

of contacts and bridges to non-redundant information sources, while deep ties offer intensity of contacts, trust, and redundancy in relations (Simard & West, 2006; Hagedoorn et al., 2006). In other words, weak ties give access to many external knowledge sources with higher novelty potential, which resembles the effects of broad search strategies, and strong ties allow for longer-term interactions with higher potential for specific knowledge creation and exchange, which resembles the effects of deep search strategies (Laursen & Salter, 2006).

Considering the fact that firms involved in multiple types of ties are more innovative than those which only utilise one type of tie (Lee et al., 2010), and that these networks are dynamic and evolve on the base of market conditions, two key issues emerge:

- the availability of a suitable system that can manage significant information about potential and actual partners;
- investments in dedicated figures to manage these networks who, rather than focusing only on finding ways to reduce costs, must be capable of identifying the potential of the relationship to generate effectiveness and efficiency in the medium and long term, from a more entrepreneurial perspective, and they must be able to analyse and assess the network evolution over time (Corniani, 2013).

In such a context *innomediaries* (innovation intermediaries) help to make markets for technology more efficient (Arora & Gambardella, 2010). Lee et al. (2010) note that in multi-firm networks the role of an intermediary is important since it carries out three direct activities. First, it collects information on technologies, markets, potential partners, and competitors. Second, it helps network construction and supports technology transfer to improve strategic technology management. Then, it manages the network. Finally, the intermediary conducts also two indirect activities, namely it develops the culture of collaboration and facilitates the collaboration.

Hence openness to external sources allows firms to source ideas from outsiders to deepen the pool of technological opportunities available to them. Innovation search is, however, not costless. It can be time consuming, expensive, and laborious. Laursen and Salter (2006) find that 'over-search' may indeed hinder innovation performance, identifying moments or tipping points after which openness, in terms

of breadth and depth, can negatively affect innovative performance. The possibility of over-search helps to create a more nuanced view of the role of openness, search, and interaction. The optimistic view of search ascribed great importance to openness of firms to external sources in the development of new innovative opportunities. Literature supports this view, but it suggests that the enthusiasm for openness needs to be tempered by an understanding of the costs of such search efforts. It suggests external sources need to be managed carefully so that search efforts are not dissipated across too many search channels.

2.4.2 Integrative capability

According to Penrose (1959), who identified knowledge and learning processes as a factor in determining the growth of the firm, Teece et al. (1997) define dynamic capabilities as the firm's capacity to sense and seize opportunities to reconfigure its knowledge assets and competencies, and a source of sustained competitive advantage.

As demonstrated in previuos studies and discussed above, firms are likely to differ in the extent to which they benefit from openness in innovation activities. In the following I argue that the various dimensions of integrative capability (namely a dynamic capability) help to explain these differential outcomes, as they enable the effective transfer, translation and transformation of external knowledge resources within inter-organizational networks.

Integrative capability has been associated with different dimensions, such as organizational and managerial processes (Teece et al., 1997), or organizational culture (Kogut & Zander, 1996). In an encompassing framework, Carlile (2004) differentiates between three facets of integrative capability that manage and integrate knowledge across boundaries: knowledge transfer, knowledge translation, knowledge transformation. While Carlile (2004) focuses on intra-organizational knowledge transfer between functions and divisions, the suggested dimensions of integrative capability also serve as a useful framework when discussing the transfer of resources in inter-organizational networks (Ridder, 2013).

Knowledge Transfer Capability. Once the firm opens up its innovation process and gains access to external knowledge resources , it needs to develop an ability for intra- and inter-organizational knowledge transfer to allow the relocation and diffusion of this knowledge resources within the organization. This requires an information processing approach that deals with storing, diffusing and retrieving the newly accessed knowledge (Carlile 2004). Kale and Singh (1999) found that a set of knowledge management principles, including articulation, codification, sharing, and internalization are essential elements of performance in the context of inter-organizaional networks. Articulation, codification and diffusion of external knowledge can be supported by systematic knowledge management processes and technoligcal systems and tools. Several authors have highlighted the role of information and communicaton technology in supporting the shift towards Open Innovation (Dodgson et al., 2006; Chiaroni et al., 2011). Furthermore in the dynamic capabilities literature processes for articulating and codifying knowledge resources have been highlighted as important mechanism for changing the firm's knowledge base (Zollo & Winter, 2002; Zahra et al., 2006). Together these processes and tools constitute the firm's knowledge management infrastructure. The firm's existing knowledge management infrastructure needs to be adapted in order to support the new business model that relies heavily on externally generated knowledge (Chiaroni et al., 2011). An appropriate knowledge management infrastructure should support the transfer of external resources and the diffusion to the corresponding parties within the firm (Verona & Ravasi, 2003). Hence, a critical element in the systematic integration of external knowledge is the existence of a knowledge management infrastructure that fosters the transfer, diffusion and sharing of knowledge with external parties within the network and within the firm. Such a knowledge management infrastructure determines a fimr's transfer capability in the context of Open Innovation.

The internal diffusion of external knowledge resources will enable new applications and rent-generating combinations of external and internal knowledge resources (Verona & Ravasi, 2003). Thereby, an appropriate knowledge management infrastructure enhances the productive utilization of external knowledge resources and increases the chances they get embedded within ren-generating applications. As

a consequence, the firm's knowledge transfer capability constitutes an important aspect of external knowledge integration which helps frims to harness their Open Innovation strategies and convert them into positive innovative outcomes.

Knowledge Translation Capability. External knowledge resources often derive from different 'thought worlds' with idiosyncratic meanings and interpretations attached to it (Carlile, 2004). Particularly if external knowledge resources stem from non-firm institutions, such as universities or customers, these resources may come in certain formats that are alien to the knowledge-acquiring firm. Due to the disparity of external knowledge resources and their unfamiliar forms, divergent interpretations may be developed within the acquiring firm (Nonaka, 1994). Therefore, external knowledge resources are not easily applied in the new organizational context, even if they are accessible via an appropriate knowledge management infrastructure. This means that effective integration of external knowledge resources requires a process of translation and adaptation. Common meaning of external knowledge resources needs to be created which aligns with the new organizational context.

Common meaning can be created by designing appropriate structures and mechanism, which allow for the coordination of external knowledge resources. The concept of organizational structure for external knowledge integration includes, for example, the establishment of new organizational roles supporting the management of the relationships with different actors and the adoption of external knowledge resources (Petroni et al., 2011). Examples of such new roles are 'champions' who led the process of adoption of Open Innovation, 'gatekeepers' for managing the firm's interface with external partners and environment, or 'integration experts' who are able to select and integrate external knowledge and manage compex structures (Chiaroni et al., 2011; Petroni et al., 2011). Gatekeepers, for instance, are typically capable of understanding and translating externally acquired knowledge, they facilitate external communication, filter the incoming information and provide it to organizational members. With the help of these key individuals and other structural mechanism, external knowledge resources can be translated according to the new organizational context.

Organizational structures devoted to the integration of external knowledge resources facilitate their translation into the firm's innovation process (Chiaroni et al., 2011). They help to establish a common meaning of external knowledge resources and, thereby, establish fit with the organization's characteristics. Translation makes external knowledge resources firm-specific as they are interpreted and applied within the unique organizational context. Transformational characteristics (Amit & Schoemaker, 1993) of external knowledge resources are activated as these new interpretations and applications develop. This means that organizational structures for external knowledge translation allow firms to capture greater benefits from their openness in innovation.

Knowledge Transformation Capability. In the context of Open Innovation differents interests are likely to arise as openness reduces the frontline role of internal researchers in the innovation process (Petroni et al., 2011). This is likely to result in negative attitudes towards the implementation of external knowledge resources, which have been labeled as the 'not-invented-here syndrome' (Chesbrough, 2003). Employees have typically invested heavily in the internal accumulation of specific knowledge and feel deeply committed to this knowledge, which they now fear to be 'at stake' (Carlile, 2004). For instance, if engineers have internally developed a new mechanical tool, they will feel their knowledge to be 'at stake' if the firm decides to acquire a similar tool outside. However, the firm adopt Open Innovation activites, employees need to be willing to adapt their own knowledge base and integrate externally acquired knowledge. When such conflicts arise, transforming the internal knowledge base is a political and cultural process of negotiating and defining common interests (Carlile, 2004).

Knowledge transformation capability helps to create such common interests by stimulating commitment and crafting appropriate values and norms. Promoting and rewarding openness in innovation encourages employees to transform their current approaches to managing knowledge. Transforming the internal knowledge base can be achieved via different mechanism. For example, employees can be encouraged, both formally and informally, to implement external knowledge resources. Henderson and Cockburn (1994), for instance, stress the importance of managerial

systems in the form of incentives and rewards. In addition a common language and clear communication patterns need to be established, which provide a normative sanction of how activities are to be organizaed and what kind of information is to be collected and evaluated (Kogut & Zander, 1992). Such elements of transformation capability nurture an Open Innovation culture that shifts mind-sets away from 'not-invented-here' to 'proudly-found-elsewhere'.

Nurturing an Open Innovation culture also stimulates the enactment of idiosyncratic routines and interactions between employees within the firms, and between actors within inter-organizational networks. These idiosyncratic routines and interactions are essential for activating tha transformational characteristics of external knowledge resources that make these resources firm-specific. This allow firms to capture value from their openness and translate it into positive innovation outcomes. As a consequence, transformation capability helps the firm to alter its current approach to managing knowledge and stimulates idiosyncratic routines. This results in a positive effect on the returns from openness.

Summarizing the first dimension of Carlile's (2004) framework, knowledge transfer capability, describes information-processing activities for managing knowledge across boundaries, including knowledge storage, processing and retrieval. The second dimension, knowledge translation capability, recognizes that knowledge often comes from different 'thought worlds'. Hence, common meaning needs to be created by translating knowledge and adapting it to the organizational context. The third dimension, knowledge transformation capability, refers to the creation of common interest by establishing commitment and appropriate values and norms in order to encourage usage of knowledge resources. Knowledge transfer, translation and transformation constitute underlying dimensions of integrative capability in the context of Open Innovation. They represent a set of higher order organizing principles (Kogut & Zander, 1992; Grant, 1996) that enhance the productivity and efficiency of externally accumulated knowledge resources, thereby reinforcing their contribution to positive Open Innovation outcomes.

2.4.3 Critical Internal and External Factors

As discussed above the degree of openness and capabilities cannot be treated in isolation. Environmental conditions (internal and external) have an important impact on the potential value of acquiring and integrating new resources. The contingency perspective suggests that relationships between strategies and performance differ across environmental conditions (Arora & Nandkumar, 2012). As environments vary in their degree of uncertainty and munificence and as these conditions affect the value creation potential of new knowledge, the integration of external knowledge is at least partly contingent on a firm's environment (Sirmon et al., 2007).

This means that it is also crucial to examine the influence of environmental conditions on the value creation potential of Open Innovation strategies. In the OI literature, two external and one internal aspects have been highlighted as influential factors in the integration of external knowledge resources. Regarding the internal dimension I focus on the organizational culture, as it has frequently been highlighted as an important factor to benefit from Open Innovation (Gassmann et al., 2010; Huizingh, 2011).

As for external dimensions, first, prior research emphasizes the degree of turbulence in a firm's technological environment (Christensen et al., 2005; Huizingh, 2011). Second, it has been suggested that potential costs and benefits of Open Innovation are highly intertwined with different level of competition (Chesbrough, 2007; Dahlander & Gann, 2010). Hence, in evaluating external contingencies I foucs on different levels of technological turbulence and dynamics of competition.

Regarding the internal contincengy factor, organizational culture influences knowledge management, and thus knowledge transfer, as it creates the context within which the organization shapes assumptions about knowledge, and the processes of distribution, as well as it constitutes the general context for the social interactions required for the exchange of knowledge. Previuos studies show that it has an important role in Open Innovation performance; in addition, culture has frequently been highlighted as an important factor to implement open innovation successfully (Gassmann et al., 2010; Huizingh, 2011; Lichtenthaler, 2011; Van de Vrande et al., 2010). In this regard, literature gives special emphasis to aspects such as

communication and attitudes towards external knowledge (Chesbrough & Crowther, 2006; Keupp & Gassmann, 2009).

Opening up the innovation process starts with a mindset (Gassmann et al., 2010) that requires building a culture which is conducive to developing networking capabilities. Organizational culture is closely linked to network embeddedness (Noorderhaven et al., 2002) and plays an important role in the willingness and ability of an organization to identify, assimilate and exploit external sources of innovation in such a way that it contributes to performance.

The importance of organizational culture and certain cultural traits, such as communication, or attitudes regarding external knowledge, new ideas or failure, is also confirmed by research on the features of an innovation-supportive culture. Hurley and Hult (1998) emphasize that cultural support for innovation stems from culture being learning oriented. In a literature review, Ahmed (1998) finds open communication, openness to external ideas, the acceptance of failure, and the integration of individuals and units to be relevant for an innovation-supportive culture. Similarly, Martins and Terblanche (2003) find that a culture which positively influences aspects such as team cooperation, open communication, or mistake handling will be supportive for creativity and innovation. Furthermore, building on the literature on market orientation as a cultural trait of organizations (Jaworski & Kohli, 1993), Day (2001) finds that one of the three elments for successful market-driven organizations is *"an externally oriented culture with dominant beliefs, values, and behaviors emphasizing superior customer value and the continual quest for new sources of advantage"*. Market-driven firms (Narver & Slater, 1990) identify and satisfy customers needs more efficiently than competitors, in this way they create customer value propositions that are superior compared to those offered by rivals. This implies the development of new value propositions based on: higher rates of innovation, minimum cost and the best differentiation from competitors.

In sum, the success of open innovation is related to the effective transfer of knowledge throughout all the organizations' relevant units, which is based on favorable conditions regarding knowledge transfer and communication. These are established by an externally oriented culture towards new ideas, market opportunities and failures as well as favorable general attitudes towards external knowledge.

Besides internal factors, external characteristics are likely to have an impact on the extent to which firms benefit from Open Innovation (Huizingh, 2011). Prior research emphasizes technological turbulence as an important contingency factor for benefitting from innovation in general (Jansen et al., 2006) and from collaborative innovative activities in particular (Hagerdoorn, 1993). Technological turbulence, which can be defined as the rate of technological change (Jaworski & Kohli, 1993), reduces the chances of profiting from internally developed technology, as current products are becoming obsolete more quickly. According to Teece (1986), firms that operate in industries that are characterized by rapid technological change are unlikely to possess the full range of knowledge requirements necessary for successful innovation. In addition, by pursuing a closed strategy to innovation in such environments, firms may not be able to cover all required costs by means of internal R&D investments. Thus, with increasing technological turbulence firms that are adopting a highly extrovert innovation strategy may be better off (Christensen et al., 2005). Firms that are subject to high technological turbulence should benefit more from openness due to reduced costs of innovation and a larger range of knowledge resources that will allow them to keep abreast with rapid technological change.

In addition, high technological turbulence implies a larger opportunity set of external knowledge sources. Industrial settings that are characterized with technological turbulence and high levels of perceived technological opportunities are usually also characterized by frequent new technology introductions and high levels of R&D spending (Zahra, 1996). Organizations that pursue Open Innovation can capitalize on these circumstances by tapping into these various technologies and R&D investments. Therefore firms that are operating in a highly turbulent technological environment should benefit more from openness than firms that are operating in a relative placid environment in which opportunities for external knowledge sourcing are scarce. Hence, the external condition of technological turbulence is likely to enhance the benefits deriving from openness in innovation.

In addition to technological turbulence, prior research suggests that potential costs and benefits of Open Innovation are dependent on different levels and dynamics of competition that firms face in their environment (Chesbrough 2007, Dahlander & Gann 2010). In this context, competitive dynamics can be characterized by the extent

to which external environments are subject to accelerating degrees of competition. Accelerating competition implies that many firms seek superior performance, although they cannot all be superior at the same time (Eisenhardt & Martin 2000). Therefore these competitive environments are associated with intensive pressures for higher efficiency. Such competitive pressures often lead to significantly reduced organizational slack (Zahra, 1996). However significant amounts of resources are required for the effective sourcing and integration of external knowledge resources (Foss et al., 2011). If these resources are not sufficiently available, firms are less able to translate their Open Innovation activities into positive innovation outcomes. Hence, high competitive dynamics and resulting efficiency pressures lead to resource scarcity, which constraints firms in capturing value from their openness in innovation. Finally, Open Innovation may involve more direct costs of competition. These costs of competition emerge from the risk that one actor within the Open Innovation network could act opportunistically and behave in bad faith (Dahlander & Gann, 2010). Chesbrough (2007) shows there are substantial risks involved in cooperating in innovation, but also benefits above all related to reduced R&D costs and time to market. Indeed, Open Innovation weakens the protection of the institution's knowledge base and its core competencies, the corporate crown jewels, and with increasing competitive dynamics, firms face innovation and imitation processes simultaneously. In this context IPRs, rather than being focused only on defending acquired positions, as it is seen in markets that are closed to global competition, need to enhance inflows and outflows of innovation, according to the competition paradigm that stimulates companies to act *'before and better than competitors'* (Brondoni, 2012). Since companies compete in a situation of intense rivalry defined by political, social, economic and technological markets instability, they cannot simply react to the competitors' moves or to the customers' requests but they need to anticipate them. According to this logic market-driven firms manage innovation from a strategic point of view with a continuous monitoring of the innovations introduced by the rivals, and interactions with stakeholders. As a consequence these firms are more successful in responding to environmental trends and in developing new capabilities that lead to competitive advantage (Hurley & Hult, 1998, Arrigo, 2012). Therefore in global markets, characterized by accelerating

degrees of competition, firms benefit from open innovation optimising their performance. In such a context the success of R&D activities is related to the capacity to exploit the competition (Brondoni, 2012).

3. OPEN INNOVATION ADOPTION: THE PANASONIC CASE

In connection with a greater engagement in boundary spanning innovation activities, openness and inter-organizational interactions pose new managerial challenges. Despite its growing importance, many firms experience several challenges to actively manage the processes of open innovation and to benefit from it. Research on large firms highlights that open innovation requires internal organizational complements that facilitate the absorption of external ideas and knowledge and to capture value from it (Laursen & Salter, 2006). As already pointed out internal organizational practices, resources and capabilities for innovation are important antecedents of a firm's ability to benefit from external knowledge.

The shift towards open innovation requires firms - both large and small - to implement new managerial practices and structures, in terms of 'how to do open innovation'. First anecdotal case studies on firms that evolve from a closed towards an open innovator indicate that these firms implement new managerial capabilities for open innovation at different managerial levels. Finally, to establish these new capabilities firms need to go through an organizational change process with different stages. However, the transformation process from closed to open innovation is still little understood. Thus, the following case study will provide new insights into the managerial dimensions of open innovation, analyzing the struggling transformation process of a Japanese corporate group from its conventionally adopted closed technological innovation model to open innovation.

3.1 Introduction

The subject of analysis is Panasonic Corporation as that company represents one of the most active corporate groups in Japan in terms of its diversification into related business activities and also expansion into overseas markets. The company also exemplifies the decentralized structural design in which many of the company's operations are organized as either sovereign product divisions or separate legally independent subsidiaries with strategic and managerial autonomy as if they formed

an equity alliance or a network structure with free-standing firms, which is a typical distinction of large and established firms in Japan.

Panasonic, previously named Matsushita Electric Industrial Company (until 2008), is a comprehensive electronics manufacturer and one of the largest firms in that industry in the global market.

The electronics industry of Japan faced some of particularly large changes in its economic environment and experienced dramatic challenges in global competition. Since the industry adapted the conversion to the digitization of electronics technology around 2000, Panasonic began reforming its structural and operational design by going through a fundamental reorganization of its entire corporate group. This change had become necessary in order to centralize and integrate the resources that had been accumulated among operating divisions and subsidiaries. This overall integration and utilization of resources within the whole Panasonic group eventually meant the renewed commitment to a closed innovation model within individual operating units that would give the company a temporary recovery in market competitiveness and financial performance.

Panasonic, however, lost its competitive power in changing market environments, especially after the 'Lehman Shock' in 2008. By holding on to a closed innovation model, the group company basically could not adapt to the shifting market and technological conditions. Although Panasonic has since 2008 aimed at integrating its conventional model of R&D with open innovation, the conversion process is still ongoing.

In the following I shortly introduce the main characteristics about technological innovation in large Japanese firms. Then I analyze the transformation of the organizational structure and R&D processes of the Panasonic corporate group. The information and data used for case study are collected from multiple secondary sources, including company publications, annual reports, web pages and scientific publications.

3.2 The Network Structure and Technological Innovation

Research involving the network structure and technological innovation of a company has lately been a popular subject of academic inquiry. Examples of such business networks include Japanese Keiretsu, South Korean chaebol, Taiwan's global corporations and the business houses in India. In fact, globalization, has increased the market power of corporations based in countries with a high propensity to innovation (the Japanese firms), and promoted the growth of new countries, especially in the Far East (Brondoni, 2013). These realms are typically described as the amalgamation of legally independent companies through equity and/or non-equity ties, a general feature of these organizations is that they represent technologically unrelated diversification (Colpan & Hikino, 2010).

In contemporary Japan, business networks are based on a system of formal and informal ties, including also institutions and the social environment. These organizations are called *Keiretsu*, the common goals of the firms within it, is to grow through reciprocity agreements and global economies of scale (Berglof & Perotti, 1994; Brondoni, 2013). Therefore, *Keiretsu* organization is by definition a network organization, a web of overlapping, reciprocated, direct and indirect ties, which enables loose but broad coordination among a set of independently-managed firms.

Two types of *Keiretsu* have garnered the attention from scholars and practitioners: the horizontal and the vertical *Keiretsu*. The first type consists of companies from different business sectors and with the presence, within the network, of banks and insurance companies. The second type is characterized by the dominance of manufacturing and trading firms with numerous subsidiaries and affiliated companies (Miyashita & Russell, 1996).

One example of the last type is the Panasonic group where the parent company is in the electronics business and its independent subsidiaries and affiliated companies are operating in technologically related businesses. This type of organization consists of dominant large companies in today's Japanese economy. Much scholarly writing on the vertical *Keiretsu* sees the close, cooperative, and flexible relations typical of these networks facilitating responsiveness, coordination, and learning among the affiliated firms. Unlike the arms-length and adversarial supplier relations typical of

the American auto industry, *Keiretsu* suppliers supported one another by, for example, assisting in the development of products, parts, processes, and people.

In the case of the vertical *Keiretsu* the interplay between internal organization and diversification strategy is particularly notable. Usually deployed as a large manufacturer and its chains of upstream suppliers and downstream distributors, the ancillary firms clustered around a parent manufacturer also served to expand the latter's product market scope.

While an older school of Japanese dual economy thought saw the parent manufacturers in such vertical networks exploiting the smaller and dependent up- and down-stream firms as risk buffers, later scholarship based on better evidence described the partnership between supplier and the assembler as one of risk-sharing: each party supporting the other by absorbing some portion of its costs and risks (Okamuro, 2008). Furthermore numerous case and survey studies show the advantages in efficiency and innovation terms of the close, trusting, and collaborative relationships typical of the vertical *Keiretsu* (Asanuma, 1989; Dyer, 1996).

Hobday and Colpan (2010) argue that these networks facilitate innovation by providing 'innovation infrastructure' which consists of critical assets, including financial and human resources, knowledge sourcing, and vertical intermediation. Network partners may also be in an advantageous position to source the required resources for innovation as the other member firms may provide the skills, equipment, and other resources that are readily available within the network.

The extent to which firms source technology externally, both vertically and horizontally, is certainly affected by industrial structures. A commonly cited reason for the high levels of external integration in the Japanese industry, for example, is the structure of industry itself. The large business networks – the Keiretsu – control a wide range of diversified interests and can facilitate close trading relationships and cooperation and strong technological linkages between contractors and subcontractors (Dodgson et al., 2008).

Technology transfer within the network occurs in a way similar to that of open innovation, where independent and autonomous divisions and subsidiaries within the group may provide the necessary knowledge to the focal firm or other operating

units. The case of Panasonic shows the challenges a large firm has to face in adopting the Open Innovation paradigm.

3.2.1 Open Innovation in Japan

At this stage of the 21st century, Japanese firms are homing in on what is important if they are to survive in global markets and revitalize their organizations. Outstanding Japanese firms maintain and develop organizational cultures rooted in the shared values of teamwork, commitment and community spirit for activities creating organizational knowledge based on accumulated tacit knowledge. Following Japan's economic crises in the 1990s, some scholars are now witnessing the phenomenon of Japanese firms looking to revitalize their innovative capacity through Western management practices (Kodama, 2009).

Japanese companies were global innovation leaders in numerous industries in the 1980s and 1990s. From electronics to automobiles to shipbuilding to consumer products, the rest of the world stood in awe over the achievements of companies such as Matsushita, Toyota, Mitsubishi, and Sony. While some companies such as Toyota remain at the cutting edge and most Japanese companies' technological capabilities remain strong, more recently the comparative position of Japanese companies in global innovation has been eroded in a number of industries, especially consumer electronics. One possible reason for this is the growth of open innovation around the world in the past ten to twenty years, and the slow response of Japanese firms to the opportunities offered by open innovation. A second reason may be that Japanese firms, while remaining strong in technology, have not been able to lead the development of new business models. Although the innovation system in Japan has been said to be characterized by the "not invented here" (NIH) attitude primarily taken by large companies, a shift to open innovation involving external collaboration is becoming increasingly important given technological progress and more intense global competition.

The Japanese social and economic context is very different from all the Western countries. For this reason the general characteristics of large Japanese companies should be described to better understand the context of their shift to a model suitable

to open innovation. This paradigm is mostly based on the US business environment and economic structure. An argument persists among Japanese scholars that open innovation does not effectively fit into the Japanese settings because of a unique institutional environment in Japan that is different from those of the United States. Furthermore, as Japanese companies have grown by the accumulation of internal resources and by the practical use of those resources, previous studies suggest that the companies may not actively use external resources beyond the firm itself even when they become available (Odagiri et al., 1996).

Therefore, historically Japanese companies have followed the model of closed innovation by developing and holding on to intrafirm technological resources and capabilities. However, they have been quite active in some aspects of open innovation, such as the deployment of some internally developed technological resources outside of the firm. It is common for large Japanese firms to establish subsidiaries or form joint ventures for commercializing those resources instead of selling off underutilized and idle resources to outside parties in the market. It is actually one of the general features of large Japanese firms that pile up numerous subsidiaries by spinouts and split offs from the original parent company (Shiba & Shimotani, 1997). Chesbrough (2006b) argues that these cases of spin-offs from a parent company represent the entry strategy to a new market as the basis of one form of open innovation processes among Japanese firms.

Theoretically in these contexts a subsidiary remains closely tied to its parent company in terms of technological interconnectedness, as it is usually spun off based on the R&D activities committed by the parent firm that commits to related diversification. In Japan, however, the stock listing of both parent and subsidiaries companies on the same exchange is commonly observed (Colpan & Hikino, 2010). The relationship between the parent company and its parent subsidiaries often become somewhat distant as the subsidiaries start having their own public shareholders whose voice has to be heard by the management of the subsidiaries even when it conflicts with the parent company.

This mechanism of strategic and operational autonomy on the part of the product divisions and especially subsidiaries forms the potential basis of the group-encompassing innovation. Group-encompassing innovation can be considered a form

of semi-open innovation since the technological inflows and outflows is open to the other network companies but closed to the outside. According to Chesbrough (2013) some Japanese firms, however, also attempted to actively incorporate full open innovation as well, although this form of innovation remains still not so usual in Japan.

3.3 Panasonic at a glance

The case of Panasonic is especially striking for its dynamic interaction between the changes of its corporate group structure and the shifts in its R&D organization. Panasonic is a diversified electronic company operating since 1918, long known as Matsushita Electric Industrial Company. In 2008 the firm adopted the present corporate identity of Panasonic Corporation to unify its global brand name under 'Panasonic'. By its shift to multidivisional structure in 1933, the company was actually one of the pioneers in adopting such a structural form in Japan.

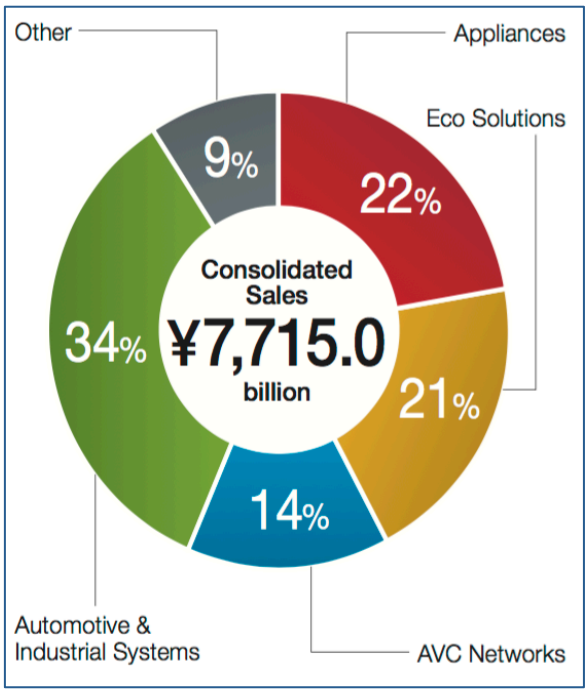
Since its founding in 1918, the company has expanded globally and now operates 469 subsidiaries. Today Panasonic is a worldwide leader in the development of diverse electronics technologies and solutions for customers in the consumer electronics, housing, automotive, enterprise solutions and device industries. The group is comprised of various business domain companies, each of them has its distinct R&D, production, and sales functions that satisfy specific consumer needs worldwide. Committed to pursuing new value through innovation across divisional lines, the company uses its technologies to create '*a better life and a better world*' for its customers.

The 5 business segments of Panasonic are (figure 1):

- Appliances (flat panel TVs, air-conditioners, refrigerators, washing machines, personal-care products, microwave ovens, home audio equipment, video equipment, vacuum cleaners, rice cookers, bicycles, electric motors, compressors, showcases, large-sized air-conditioners, fuel cells, etc.);
- Eco-solutions (lighting fixtures, lamps, wiring devices, solar photovoltaic systems, water-related products, interior furnishing materials, ventilation and air-conditioning equipment, air purifiers, nursing-care-related products, etc.)

- AVC Networks (aircraft in-flight entertainment systems, PCs, projectors, digital cameras, mobile phones, surveillance cameras, fixed-phones and faxes, social infrastructure systems equipment, etc.)
- Automotive & Industrial Systems (car-use-multimedia-related equipment, electrical components, lithium-ion batteries, storage batteries, dry batteries, electronic components, electronic materials, automation controls, semiconductors, LCD panels, optical devices, electronic-components-mounting machines, welding equipment, etc.)
- Other (Detached housing, rental apartment housing, land and buildings for sale, home remodeling, imported materials and components, etc.)

Figure 4: Percentage of Fiscal 2015 Sales for each segment



Source: Panasonic Annual Report 2015

3.3.1 R&D Overview

Based on the *"5 times 3 matrix chart"* (3 regions: Japan, Europe, and Overseas Strategic Region covering Asia, China, Middle East, and Africa overlaid onto 5 businesses: Consumer Electronics, Housing, Automotive, B2B Solutions, and

Devices), Panasonic Group promotes a growth strategy and R&D activities that generate new customer values. In order to achieve growth, Panasonic's respective Divisional Companies in line with their growth strategy focused on developing new technologies and new products that will support the future, aiming to further strengthen the businesses where they have strengths. In addition, the newly established Advanced Research Division has taken on the role of innovative mid- to long-term research in new fields (Figure 2).

Figure 5: Panasonic R&D Overview

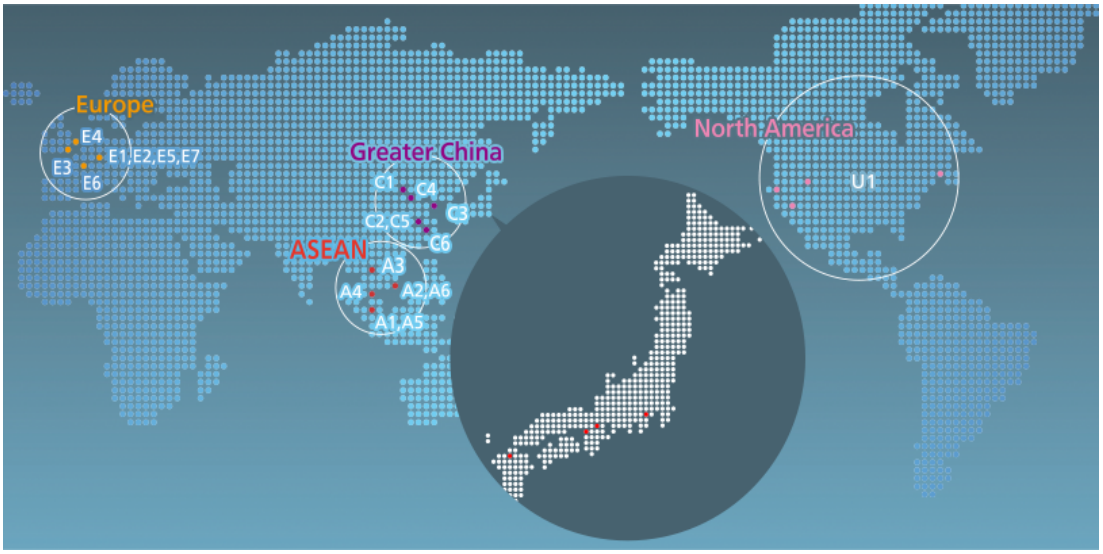
Source: Panasonic Global website

In order to promote R&D activities that generate new customer values, Panasonic is advancing a global-based R&D system in optimal locations, leveraging local talents and skills (figure 3).

As for the future challenges, in 2016 Panasonic launched its R&D 10-Year Vision website, which introduces its R&D vision and initiatives. In order to realize "*A Better Life, A Better World*" Panasonic has defined key areas for R&D as IoT/Robotics and Energy, and will use its strengths in technology while pursuing further technological innovation. In the field of IoT/Robotics, Panasonic will focus on artificial intelligence (AI), sensing, and User Interface/User Experience (UI/UX) in 4 segments (AI Robotics Home Appliances, Autonomous Driving/ Commuter, Stores and Service Solutions, Next-generation Logistics and Transport). And with respect to Energy Panasonic will focus on storage and hydrogen energy in 3 segments (Home Energy Solutions, Building and Regional Energy Solutions, Automotive Energy Solutions).

Panasonic is aiming to expand its contribution to *'better living'* everywhere. This means that in the variety of spaces where customers go about their lives, spaces ranging from inside the home, the office, the store, the automobile, and the airplane, as well as the town, Panasonic will provide not only single pieces of hardware, but also total solutions including software and services. In doing so Panasonic needs to leverage the strengths that it has long developed in its consumer electronics business, and the strengths of their business partners who have in-depth expertise in various spaces, and works to combine these strengths by pursuing open innovation strategies. In this way, Panasonic create new value e new competitive advantage' sources. The President of Panasonic, about the evolving innovation strategy, argues: *"Going forward, as we continue to carry out these activities, we will aggressively move forward and become 'a new Panasonic'. So please stay tuned to Panasonic"*(Panasonic Annual Report, 2015).

Figure 6: Global R&D Map



Source: Panasonic Global website

3.4 Transformation of the R&D Organization toward Openness

In 1992 Panasonic established the operational principle of the divisional management organization that held the independent responsibility in strategic implementation as well as part of the strategic formulation as long as the particular division remained profitable. In order to secure that free hand of divisional sovereignty, the division management had to continuously invest in R&D to develop new products. As each operating division and subsidiary had their own product life cycles, the operating units, seeking promising opportunities in new products, started strategizing product diversification (Kodama, 2007). With the growing demand in domestic as well as international markets until the early 1990s, the rivalry among operating divisions enhanced the competitive power for the whole group at Panasonic. In the recessionary times since then, however, the rivalry between operating units has had a negative impact as they tightly protected their technological knowledge stemming from their R&D internal activities. Of course, the exclusive utilization of technological knowledge by operating units and their unwillingness to share such knowledge with other units worked against the basic interest of the whole Panasonic group. Since the major competitive advantages of the corporate group derive from the shared resources across operating units in technological knowledge and brand

names, such non-collaborative behavior among operating units resulted in a sub-optimal level of competitiveness and a lower level of profitability for the whole group.

The technological environment of growing electronics digitization naturally changed the dynamics of R&D organization and consequently financial performance when the negative outcomes of the group became evident. While developmental resources were distributed across the operating divisions and subsidiaries within the vast Panasonic group, the corporate headquarters remained incapable of integrating all of those sources. Therefore, in 1992 the corporate headquarters attempted to shift towards a more centralized R&D organization by creating the 'President's Project for the Whole Panasonic Corporation'. This project was a development scheme led by the group headquarters that confiscated a part of the product development authority, which operating divisions and subsidiaries had previously held. The technical section of the corporate headquarters took charge of the mid- and long-term projects exceeding one year for commercial production in the Information Technology Equipment Division, while that division continued to be in charge of the projects that could come up with commercial products within one year. However, as long as the business of significant operating subsidiaries remained profitable enough, the centralizing measure that the corporate headquarters attempted to institute did not produce an effective impact across the whole group (Nakazono et al., 2014).

In 1995 Panasonic took its first step towards Open Innovation, when the company started engaging in a joint development project with Plasmaco, a New York based firm that was established in 1987 to come up with plasma display panels that could operate with alternate current electricity (AC-PDP). Panasonic itself had committed to plasma display using direct current electricity (DC-PDP) because technologically the latter was presumed doable while the former had faced some engineering difficulties. As the difficulties were gradually resolved, Panasonic decided to form an alliance with Plasmaco in order to keep pace with the development of AC-PDP, which was technically superior to DC-PDP. Ultimately, the Panasonic-Plasmaco alliance resulted in the acquisition of Plasmaco by Panasonic in 1996 (Nakazono et al., 2014).

However the turning point came in 2001 when the collapse of the IT bubble seriously affected Panasonic's financial standing and forced the company to integrate and utilize the intragroup technological resources that were scattered across the operating divisions and subsidiaries. The measure was intended to cut burgeoning costs by eliminating overlapping investment in R&D and other functions across the operating units. It was also regarded as a strategic response to come up with new products by more effectively mobilizing the intragroup resources. As long as the integration and rationalization of the R&D processes went as planes, it sounded natural to the management in the headquarters to commit to the basic reorganization without adding more costs for product development. This line of group-wide reorganization toward integration and unification, designated as the 'Nakamura Reform', which was led by Kunio Nakamura, who assumed Panasonic's presidency in 2001, revived the company, which had strategically struggled ever since the early 1990s, when the Japanese economy fell into its distressing recession (Nakazono et al., 2014). This reform aimed to coordinate the R&D efforts between the intragroup divisions and subsidiaries, with the purpose of accelerating and strengthening innovation. Nakamura surely knew the challenging environment and the urgent necessity for the corporate restructuring especially in product development that the Panasonic group was facing. He stated: *"When the economy was growing rapidly, independent operations in the group encouraged good competition, but now we need to cut redundancy to cope with a digital consumer electronics era that request a huge R&D cost"* (Nakazono et al., 2014). Nakamura swiftly reorganized the major business subsidiaries one after another into a wholly owned subsidiary. Subsequently Panasonic reorganized the whole group into 14 business domains and reclassified each operating division or business subsidiary into one of the domains. The central R&D laboratory was abolished and then reorganized as the separate and independent R&D facilities at the level of each domain, which would be coordinated by the R&D administration department of the headquarters (Kodama, 2007). It is critical to note once more that the Nakamura Reform created the R&D model that became open within the entire Panasonic group, which was a step forward relative to the segmented R&D organization within individual operating divisions and subsidiaries.

The group-wide reorganization commanded the clear and basic philosophy of eliminating overlapping businesses across product divisions and group- affiliated subsidiaries, and was meant to integrate technology and managerial resources (especially those in product development) scattered across the corporate group. Thanks to the Nakamura Reform, the integration and unification of dispersed technology was achieved to establish an effective research and development organization. It was conceived as the coherent integration of growth strategy at the group-headquarters level and technology policy at the operating-unit level. Panasonic could then intensively invest its group-level developmental resources in implementing specific strategic products designated as 'victory goods'. Thanks to this round of reorganization of the R&D model, Panasonic successfully launched such products as the digital camera Lumix and the PDP television Viera. It is thus generally recognized that the reorganization of the entire Panasonic group, which Nakamura instituted, achieved a certain level of corporate and financial success in turning around the troubled company in the first half of the 2000s (McInerney, 2007).

However, Panasonic became engulfed in the downturn of business again in the second half of the 2000s, especially after the Lehman Shock in 2008. Both macroeconomic and microeconomic factors were responsible for the lagging business results of Panasonic, and the entire consumer electronics industry of Japan, for that matter. First, the continuous recession of the Japanese economy, the volatile demand movements of advanced industrial nations, and the rapid expansion of emerging markets all created a taxing environment for Japan's established large manufacturers, such as Panasonic. On the micro- economic side, the notable rise of the competitive power of East Asian large firms, particularly Samsung and LG, of South Korea, started challenging the once dominant position of Panasonic and other Japanese firms, like Sony and Sharp, in the domestic market of Japan and more so in global markets.

In response to such fundamental changes in the external environment, Panasonic under the strong and capable leadership of Nakamura, established the Center for Industry-University Collaboration in 2003. It became an intermediary between the university community and the whole group. Since those days, the R&D department

of the corporate headquarters has played the central role in adopting the open innovation model.

Then, in 2008 Panasonic founded the Tokyo R&D center, which cooperated with external research institutions, such as third parties into related domains, ministries and government offices, and universities, in order to promote high-technology development together. The company moved further by founding the Innovation Promotion Center for advancing development projects with critical importance or high urgency in 2010. This institution, in addition to the usual function of product development in general, possessed the specific mission of integrating partners and competitors into the whole Panasonic corporate group organization and of combining the R&D resources scattered across the network. Since these organizations were established as a response to environmental changes, they assumed the primary role of achieving a synergistic effect through the reorganization of the whole group structure and operation to advance cooperation between cross-industrial domains within the network.

Since 2011, Panasonic has committed to the reform of the R&D department of the corporate headquarters. For this purpose, the Advanced Research Division and the Production Engineering Division, and similar organizations were established at the headquarters level. The major purpose of these organizations was to maximize synergy among operating units in the Panasonic network. By doing so, technological competitiveness was expected to be enhanced. This goal was intended to be achieved by creating new businesses, developing products with novel ideas, and furthering advanced research and development by accelerating resource sharing across the network. In 2012, Panasonic installed the Open Innovation Promotion Section within the R&D department of the corporate headquarters along this line of advancing the model of open innovation.

In order to advance its new open innovation model, Panasonic actively participated in such interfirm organizations as the Japan Open Innovation Forum of Nine Sigma Japan, an intermediary specialized in the promotion of various innovations. Panasonic also committed to Open Innovation forum founded by NEDO (New Energy and Industrial Technology Development Organization), an independent government agency promoting research and development as well as deployment of

industrial, energy and environmental technologies. (Chesbrough, 2013). Through participating in private and government- led open innovation schemes, Panasonic gradually accumulated the knowledge needed for a shift from its conventional closed innovation model to a more open one. Nevertheless, as will be explained in the following, the process to incorporate the open innovation model is still ongoing.

3.4.1 Changes of Innovation Processes

What kind of influence has the integration of the Panasonic corporate group and its changes to R&D organization had on the firm's innovation processes? Here, an analysis could be made in three chronological phases:

1. The conventional structure of the corporate group and the decentralized management and R&D organization;
2. The transition to a more integrated model of corporate organization and R&D conduct starting in 2000;
3. The resulting organizational and administrative structure with more integrated and concentrated resources at the corporate-group level.

First, the decentralized managerial structure that Panasonic had long nurtured and had led to duplicating and overlapping business and product domains among its operating units. Within those product markets, individual divisions and subsidiaries naturally competed against each other as they aimed to maximize market share and enhance financial performance on their own. Allegedly, those operating divisions and subsidiaries treated technology and pertinent information, especially about products, as strictly confidential, and leading to other operating units was unthinkable (Kodama, 2007). In order to solve such a sectionalist dilemma, Panasonic consecutively introduced various measures for changing the R&D organization, but as long as the operating units has final decision-making authority about product development, such reforms did not bring about satisfactory group-level integration. Each operating division and business subsidiary continued to invest in their own R&D and product developments and sales and marketing of products. Since Panasonic headquarters still respected the independence and responsibility of

management at every operating unit, this consequently resulted in closed innovation within operating units.

Next, the development of the structural integration of the Panasonic corporate group eliminated the duplication of business domains among principal operating divisions and subsidiaries, which transformed Panasonic's organization of R&D activities, making them more open and accessible across the operating units. With this change, the divisions and subsidiaries could now actually utilize the technological resources accumulated beyond their own units within the Panasonic group. The company furthered this shift toward the group-wide sharing of technological knowledge by structuring a universal platform for the whole group organization. Furthermore, by establishing the group- encompassing marketing headquarters, the sales channel of audio-visual and home electronics within the domestic market was transferred from individual business units to the single Panasonic organization. The R&D model thus basically became open beyond individual operating divisions and subsidiaries but still remained closed within the entire Panasonic corporate group.

Finally, the Panasonic corporate group has lately committed to the wholesale utilization of intragroup technology across the operating divisions and subsidiaries while it has actively started seeking resources beyond the group boundaries. The practical utilization of external technology is gradually advancing in new business fields, such as robotics, in which the Panasonic group and its constituent operating units did not possess proprietary competitive resources.

3.5 Open Innovation at Panasonic

The basic principle for Panasonic's shift to Open Innovation has been to seek technological resources that had not been developed within the whole corporate group. One typical example of Panasonic's commitment to Open Innovation was its entry into the new field of robotics business. In 2009 Panasonic headquarters founded the Open Laboratory, with access for outside parties, such as medical experts, university and academic organizations, research institutions, parts suppliers, and other interested organizations. Each of these external organizations was allowed to utilize Panasonic's facility for their own needs, including component-engineering

development and technical improvements. Often an outsider actually visited the open laboratory, where technical information was exchanged and the commercialization of products was arranged between Panasonic and interested outside parties.

Another example of Panasonic commitment to Open Innovation is the R&D agreement signed with Tesla Motors in 2011 to develop a new generation of battery cells. The R&D collaboration resulted in a nickel-type cathode technology optimized for electronic vehicles, which provided the highest energy density and the best performance cells in the market. In addition, the new cathode metal enables higher capacity without affecting the current charge voltage and it is not influenced by the fluctuations of the price of cobalt, normally used in the previous battery technologies, and the technology safety system inside the battery reduce the risk of fire. The partnership was beneficial for both companies and in 2013 the two companies continued this partnership renewing the agreement. In 2014, Tesla and Panasonic announced the construction of a battery factory, the Gigafactory, in Nevada; it will produce batteries for significantly less cost using economies of scale, innovative manufacturing, reduction of waste, and the optimization of locating most manufacturing process under one roof.

Until the early 2000s, in the proprietary electronics businesses that constituted the major business sector of the Panasonic group, by contrast, innovation activity was based on the synergy within the group and still remained far more common that the utilization of open innovation processes beyond the group boundaries. For example, in the air purifier business, the Alleru-Buster antiallergy technology that Panasonic Electric Industrial owned and the Nano-E technology that its major heavy-equipment subsidiary (Panasonic Electric Works) developed were successfully integrated to bring technological and commercial achievement. However, the actual process for creating intragroup technological sharing between member firms turned out to be challenging and the examples of failure to achieve synergistic effects within the group were numerous. Adjustments for operative integration within the whole Panasonic group have become an urgent, yet time-consuming and difficult, task for the top management in the group headquarters. In spite of its urgency, the acquisition of external technological knowledge and resources through open innovation processes has been a secondary consideration.

In summary, core technology developments are mainly implemented in-house and contribute to the accumulation of expertise. Furthermore Panasonic promotes dynamic collaboration with other companies by implementing joint development with outstanding external partners and positively adopting external partners' outstanding technology. Integrating heterogeneous technologies is especially important to realize a growth strategy in all the 5 business areas, and collaborating with external partners possessing leading technologies is an urgent task. More specifically, Panasonic exploits open innovation processes especially for its non-core business, where the group has not yet developed adequate capabilities across its business domains. In this context knowledge integration is crucial to create new competences by acquiring new sources (including path- breaking resources) across technology and industry boundaries through dynamic collaborations (Kodama 2009). However one of the Panasonic R&D goals in the mid-long term is to expand Open Innovation strategies in core and non-core business.

Panasonic Open Innovation strategy focuses on 3 main activities:

- Joint research with universities and research institutions outside Japan: Imec (Belgium), CEA (France), Fraunhofer (Germany), MIT (USA), Stanford (USA), National Chiao Tung University (Taiwan), etc.; cooperation with over 100 national research institutes and university laboratories. Panasonic research centers have been established on campuses at Kyoto University, Osaka University, and Nagoya University, and joint research is being carried out.
- Exchange with other industries and co-creation with other major companies.
- Collaboration and technology procurement based on 3 assumptions: breaking away from self-reliance; emphasis on speed; win-win relationship building.

3.5.1 Panasonic Venture Group

In order to enhance the shift towards an Open Innovation model, Panasonic founded the Panasonic Venture Group, a unit of Corporate R&D Strategy Office, which uses venture capital to strengthen co-development relationships with Panasonic R&D units. This unit comes from the idea that to innovate effectively is crucial to establish

partnerships with external partners (universities, corporations, research institutes, etc.) whose resources complement the company's capabilities. To complement Panasonic's internal innovation goals, the Venture Group sources venture-backed start-ups with compelling technologies that align with Panasonic's innovation strategies. With visions aligned, the Venture Group makes investments that support strategic relationships between Panasonic and other companies, with the ultimate goal of enhancing value for customers.

As a strategic investor, the Panasonic Venture Group makes venture capital investments in companies to foster technology-centric partnerships. Companies that receive investments from Panasonic Venture Group present clear, strategic competitive advantages to Panasonic research and product development units. Investments are typically in the range of $1 to 3 million for companies that have a demonstrated, proven technology. These companies have developed compelling technologies in the areas of home networking, semiconductors, reconfigurable processors, digital content, security, printed electronics, optics and other areas.

The Venture Group identifies venture-backed companies with compelling technologies, and then champions partnerships between these companies and Panasonic to accomplish the following goals:

1. Expand Panasonic's leadership position by incorporating innovative technologies into existing products, enabling Panasonic to further enhance customer value and grow its existing business;
2. Diversify Panasonic's business through innovation-based technology partnerships that lead to competitive advantage and enhanced customer value in new growth areas;
3. Accelerate the speed to market of Panasonic products through partnering;
4. Make sound investments that strengthen the partnerships, while generating positive ROI and securing business advantage for Panasonic.

3.5.2 Obstacles to the adoption of Open Innovation

Panasonic seriously started shifting toward the practical use of open innovation only after the big economic shock in 2008, as mentioned above. The substantial shift in

the macroeconomic and competitive environment, particularly in electronics business sectors, changed the market demand, while leading to the emergence of competitive suppliers in emerging markets. In particular, the digitization of electronic technology has reduced the barrier to entry for the industry and induced new competition, which has resulted in stiff price competition between established and newly emergent firms (Nakazono et al., 2014). Although Panasonic had philosophically transformed itself to appreciate the significance of open innovation, it continued to utilize a semiopen innovation model within the group. In contrast with the emergence of new businesses and technologies, such as robotics, the product division of the company incorporated advanced technologies from external sources to launch new products and cut costs.

Responding to the shift in technological and market environments since the 1990s Japan's corporate groups reoriented their strategy in terms of product portfolio and geographical scope and also restructured their organizational design to be more tightly integrated between operating units to maximize the effective use of accumulated resources. This process of strategic reconsideration and organizational consolidation was a necessary and appropriate measure in the new and more competitive environment but was an obstacle to the adoption of an open innovation model.

In summary this analysis shows the major characteristics of the basic changes in innovation processes and the R&D organization of Panasonic that had become a focal issue in the context of the comprehensive restructuring at the entire group level. As the case of Panasonic illustrates, although there is a trend toward open innovation in many Japanese firms since the 2000s, it encounters the ambiguity and dilemma of centralization versus decentralization of R&D along other organization functions. After examining these issues, we can draw the conclusion that open innovation paradigm should be assessed in the context of organizational and national culture and external environments. Thus, open innovation represents the contextual characteristics of firm locations, which engender differences in the application of open innovation such that open innovation at Japanese firms develops gradually when compared to that of Western firms.

3.6 Emerging Issues

In 2004 Mr Hajime Sasaki, chairman of the NEC Corporation, had an interesting and important analysis of open innovation at the Japan International Patent Licensing Seminar. He argued in an address to the Japanese International Intellectual Property Society in Tokyo that the term Open Innovation was a little misleading. He stated that, understood properly, it should be viewed as open-closed innovation. The Panasonic case shows that openness is necessary to create value for customers in the innovation process, and to enable a value chain to deliver that value profitably. A certain amount of closed-ness is needed, however, to make a profit from innovation and to be able to continue to innovate in the future. According to Mr Sasaki, at NEC they regard open innovation as an open-closed process (Chesbrough, 2006b). Intel also exemplifies the open-closed approach. Much of the internal R&D it undertakes is done to connect the company to external research in its supply chain (through its Components Research Lab) or to its customers and developers (through its Intel Architecture Labs). Intel also spends more than US$100 million annually in funding university research, seeking new ideas that it can bring into its business. Intel does not own these ideas; it does, however, gain early access to them. So Intel is open in these regards. To capture value from these ideas, however, Intel uses its internal labs. Most of Intel's internal research is concentrated in its Microprocessor Research Lab, which focuses on new generation Pentium technologies and architectures. It is very closed about the activities in this part of its business and it seldom out - licenses any of its work in this lab to other companies. So Mr Sasaki's point is well taken. This support the notion that, instead of speaking of a dichotomy of closed versus open innovation, the idea of open innovation needs to be placed on a continuum, ranging from closed to open, covering different degrees of openness (Dahlander & Gann, 2010).

As many practitioners and scholars argue that open innovation requires a more formal approach for managing various inflows and outflows, another implication concerns the adoption of the paradigm. According to Chesbrough and Brunswicker (2013) many large firms still engage in open innovation in a trial-and-error manner. Large firms are exposed to quite significant challenges when they started to engage

in open innovation. Today, these challenges still remain and have only slighted been reduced. The most critical challenges are to manage the journey from closed to open innovation internally, and to sustain external relationships with innovation partners. The Panasonic case suggests that implementing open innovation is a challenging process. It is a systemic shift that requires re-thinking many aspects of one's business to utilize it effectively. R&D alone cannot fully implement open innovation. Other parts of the organization, in marketing, in business development, and in supporting functions like human and resource management, must get on board for it to work effectively. Formal documentation of open innovation processes helps, but growing a culture that supports open innovation is at least as important for its effectiveness.

Furthermore, Open Innovation concepts are not equally applicable to all industries and all countries. Internal and external environmental conditions (organizational culture, technological turbulence, high competitive dynamics) have an important impact on the potential value of acquiring and integrating new resources. For example, the nuclear reactor industry depends mainly on internal ideas and has low labor mobility, little venture capital, few start-ups, and relatively little research being conducted at universities. Whether this industry will ever migrate towards open innovation is questionable (Chesbrough, 2006b).

Panasonic shows that open innovation paradigm should be assessed in the context of organizational and national culture and external environments. Thus, it can be assumed that open innovation represents the contextual characteristics of firm locations, which engender differences in the application of open innovation.

Many industries including those of copiers, computers, disk drives, semiconductors, telecommunications equipment, pharmaceuticals, biotechnology, and even military weapons and communications systems are currently undergoing a transition from closed to open. For such businesses, a number of critically important innovations have emerged from seemingly unlikely sources. Indeed the locus of innovation in these industries has migrated past the confines of the central R&D laboratories of the largest companies and is now situated among start-ups, universities, research consortia and other partners. And the trend goes well beyond high technology. Other industries such as automotive, health care, banking, insurance, and consumer package goods have also been moving toward Open Innovation.

To conclude, managing open innovation has not yet materialized as firms pay rather limited attention to different kinds of managerial practices. Managing Open Innovation doesn't imply making a decision on 'either formal' or 'informal'. It requires both dimensions. Overall, strategic guidance and cultural values are more important than written and standardized routines for innovation or metrics for open innovation.

CONCLUSION

This dissertation contributes to an emerging theory of Open Innovation by providing a better understanding of the phenomenon and exploring the adoption of the paradigm within global firms.

Open Innovation can be considered a value-creation strategy that is an alternative to vertical integration. In this context firms increasingly build distributed global networks to sense markets trends, reduce time to market, tap into new knowledge and provide further sources of new technology. However external technological sources are not enough to innovation success, increasing attention must be paid to a firm's capability to interact with its environment and to integrate external knowledge. In that sense OI success is closely related to dynamic capabilities (to integrate sources and manage inter-organizational relationships with partners who possess these critical resources) and environmental contingencies (organizational culture, technological turbulence, dynamics of competition).

In an Open Innovation context the network structure need to be flexible and responsive to changing needs and information and knowledge flows across the boundaries within and outside the firm. Thus external sources need to be managed carefully so that search efforts are not dissipated across too many relationships. On the base of these assumptions two key issues emerge:

- the availability of a suitable system that can manage significant information about potential and actual partners;
- the importance of investments in dedicated figures who help network construction and management in the medium and long term, and support technology transfer to improve strategic technology management.

In connection with a greater engagement in boundary spanning innovation activities, openness and inter-organizational interactions pose new managerial challenges. Despite its growing importance, many firms experience several challenges to actively manage the processes of OI and to benefit from it. Research on large firms highlights that OI requires internal organizational complements that facilitate the absorption of external knowledge and to capture value from it (Laursen & Salter, 2006). Thus the shift towards OI requires firms to implement new managerial practices and structures, in terms of 'how to do Open Innovation'. First case studies

on firms that evolve from a closed towards an open innovator indicate that these firms implement new managerial capabilities for Open Innovation at different managerial levels. Finally, to establish these new capabilities firms need to go through an organizational change process. However, the transformation process from closed to Open Innovation is still little understood. In that sense the Panasonic case provides new insights into the managerial dimensions of OI, analyzing the struggling transformation process from a closed technological innovation model to an open one.

First of all, the Panasonic case suggests that the adoption of OI is a systemic shift that requires re-thinking many aspects of one's business to utilize it effectively. R&D alone cannot fully implement OI. Other parts of the organization, in marketing, in business development, and in supporting functions must get on board for it to work effectively. Formal documentation of open innovation processes helps, but growing a culture that supports it is at least as important for its effectiveness.

Secondly, evidence from Panasonic confirms that internal and external environmental conditions (organizational culture, technological turbulence, high competitive dynamics) have an important impact on the potential value of acquiring and integrating external knowledge. Open Innovation paradigm should be assessed in the context of organizational and national culture and external environments. Thus, it can be assumed that open innovation represents the contextual characteristics of firm locations, which engender differences in the application of the paradigm.

Furthermore, Panasonic shows that openness is necessary to accelerate the innovation process, and to market success. However, a certain amount of closed-ness is needed to profit from innovation and to be able to continue to innovate in the future. The basic principle for Panasonic's shift to Open Innovation has been to seek technological resources that had not been developed within the whole corporate group. More specifically, Panasonic exploits open innovation processes especially for its non-core business, where the group has not yet developed adequate capabilities across its business domains. In this context knowledge integration is crucial to create new competences by acquiring new sources (including path-breaking resources) across technology and industry boundaries through dynamic collaborations (Kodama, 2009). This support the notion that, instead of speaking of a dichotomy of closed versus open innovation, the idea of open innovation needs to be

placed on a continuum, ranging from closed to open, covering different degrees of openness (Dahlander & Gann, 2010). However one of the Panasonic R&D goals in the mid-long term is to expand Open Innovation strategies in core and non-core business.

As many practitioners and scholars argue that Open Innovation requires a more formal approach for managing various inflows and outflows, a relevant implication concerns the adoption of the paradigm. According to Chesbrough and Brunswicker (2013) many large firms are exposed to quite significant challenges when they started to engage in OI, and they still engage in the paradigm in a trial-and-error manner. Today, these challenges still remain and have only slighted been reduced. The most critical challenges are to manage the journey from closed to open innovation internally, and to sustain and manage external relationships with innovation partners.

This study is subject to limitations and evidences future research directions. First, the validity of the research should be further assessed by conducting more extensive qualitative and quantitative studies, also analyzing different industries and countries. Second, the research explores only one type of partner of the Open Innovation network. Further studies should investigate other Open Innovation actors, addressing calls for research on OI adoption in SMEs and the supporting role of innovation intermediaries in creating and managing relationships between large firms and SMEs. Finally although OI business models are by definition related to the establishment and management of relationships to external partners, the field currently lacks a systematic approach to identify patterns and rules for the composition of partner networks underlying these business models.

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