UNIVERSITÀ DEGLI STUDI DI PAVIA E UNIVERSITÀ DEGLI STUDI DI BERGAMO

DOTTORATO DI RICERCA IN ECONOMICS AND MANAGEMENT OF TECHNOLOGY

Three essays on Open Innovation

Relatore:

Chiar.mo Prof. Stefano Denicolai

Tesi di Dottorato di

Federico Moretti

ANNO ACCADEMICO 2016/2017

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1. Introduction

1.1 Introduction on Open Innovation

Open Innovation is one of the hottest topics that has emerged in management literature in the past decade. According to Scopus dataset, ever since the introduction of the term, in 2003, over 3600 articles have been published on the topic. The paradigm has been applied not only in business studies, but also in several different subjects, ranging from medicine (Dandonoli, 2013), to biology (Toyoda, 2011), to food (Saguy & Sirotinskaya, 2014; Samadi, 2014), engineering (J. W. Chen, Zhang, Wang, & Wang, 2011) and psychology (Chatenier, Verstegen, Biemans, Mulder, & Omta, 2009) studies.

In addition to its raising importance in the academic world, however, the concept has been getting known and implemented also in real-life contexts: nowadays, a simple Google search of the term "Open Innovation", nowadays, returns almost 22 million results. Open Innovation has been recently implemented in policy measures: Regione Lombardia, for example, highlighted Open Innovation as one of the pillars of the so called "Smart Specialization Strategies", a plan aimed at supporting industrial and business development for the 2020 decade, and created a web platform where companies can share ideas and communicate their distinctive competences. The platform also works as a match-maker between organizations looking for potential business partners, gaining access to a community of innovators. As of June 2017, the platform has more than 6500 individuals and 2000 participating organizations[1].

But what is Open Innovation? And how was it introduced?

According to theory, the emergence of Open Innovation resulted from changes in the way organizations - led by Multinational Enterprises (MNEs) - conducted Research and Development (R&D) activities. The process started in the 1980s, reshaping the global innovation landscape and posing the roots for the emergence of a new framework, based on the principles of Open Innovation (J. Li & Kozhikode, 2009).

Historically, the Innovation Management process throughout the 20th century involved the requirement of *control* over the whole process. In the classic approach towards innovation,

[1] Regione Lombardia Open Innovation:
http://www.openinnovation.regione.lombardia.it/it/open-innovation

firms use internal resources and invest in Research and Development (R&D) functions to generate new products and then use intellectual property (IP) protection mechanisms to generate revenues from their investments (Wallin & Von Krogh, 2010). Most industrial firms traditionally followed this "closed" approach towards innovation processes, by organizing R&D functions within the firm's boundaries and focusing on in-house development and application of technological knowledge (Lichtenthaler & Lichtenthaler, 2010). General consensus was that of self-reliance: if a company wanted something to be done right, she needed to do it herself (Henry W. Chesbrough, 2003). The model was a virtuous cycle: the discovery of fundamental technology breakthroughs resulting from research activities helped innovative companies generating new products and features, superior to those of competitors. These new products and services helped boosting company sales and profits, thus increasing the subsequent budget for research and development. Increased budget also helped virtuous companies secure the best talents from the academia, pre-emptying competitors from acquiring promising scientists, and the cycle went on a self-reinforcing pattern (Svensson et al., 2010).

The paradigm started changing in the closing decades of the century, when a new wave of globalization opened up new markets for multinational firms, who modified their business models accordingly. Multinational firms started realizing that the world was abundant of dispersed knowledge which could be exploited, and that internal research and development was increasingly producing sub-optimal results, often times bearing the cost for maintaining intellectual property rights on inventions which were not generating income (Dodgson, Gann, & Salter, 2006). According to Chesbrough (2010) the emergence of the new business model for managing innovation activities resulted from four different factors: 1) increased workers' mobility, which favored the transfer of knowledge through spillovers; 2) the increased number of college graduates entering the workforce, increasing human and knowledge capital, and 3) the diffusion of venture capital funds, which helped increasing the availability of financial capital, generating a plethora of startups pursuing specific innovative projects.

In management literature, Henry Chesbrough's seminal work "The era of Open Innovation" (Svensson et al., 2010) was the first contribution that reflected the shift in managing the innovation process, and the first attempt at challenging the general principle of "Closed Innovation", by opposing it with the new concept of "Open Innovation".

Following the original definition, Open Innovation represents a new model to pursue activities where "*[…] firms commercialize external (as well as internal) ideas by deploying*

outside (as well as in-house) pathways to the market". (Svensson et al., 2010). Similar definitions are presented by the same Chesbrough in later studies, such as *"The Open Innovation paradigm assumes that firms can and should use external as well as internal ideas, and internal and external paths to market, as they look to advance their technology"* (H. Chesbrough, 2004) and other authors, such as West and Gallagher, who define Open Innovation as a process which "*[…] 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"* (West & Gallagher, 2006), or Lichtenthaler, who defines *"An Open Innovation approach refers to systematically relying on a firm's dynamic capabilities of internally and externally carrying out the major technology management tasks, i.e., technology acquisition and technology exploitation, along the innovation process. Thus, Open Innovation processes involve a wide range of internal and external technology sources, and a wide range of internal and external technology commercialization channels."* (Lichtenthaler, 2008c).

At its core, the concept of Open Innovation redefines the boundaries of the firm in the innovation process, which become porous (Svensson et al., 2010), allowing flows of ideas between the innovative firm and a variety of actors in the external environment, which include customers (Piller & Walcher, 2006), suppliers (Henry W. Chesbrough, 2003), competing firms (West & Gallagher, 2006), business partners (J. Du, Leten, & Vanhaverbeke, 2014; Mina, Bascavusoglu-Moreau, & Hughes, 2014), non-profit organizations (NPOs) (Holmes & Smart, 2009) universities (Goduscheit & Knudsen, 2015; Guimón & Salazar-Elena, 2015), research centers (Núñez-Sánchez, Barge-Gil, & Modrego-Rico, 2012), business incubators and accelerators (Hooge & Le Du, 2016; Onofrei, Hunt, Siemienczuk, Touchette, & Middleton, 2004), local governments (Ojasalo & Tähtinen, 2016; Vrgovic, Vidicki, Glassman, & Walton, 2012), or online communities (Fleming & Waguespack, 2007; West & Lakhani, 2008). Open Innovation involves companies exchanging ideas, knowledge and technology with actors in the external environment. These exchanges aim at improving firm's efficiency, effectiveness and managing risks associated with the innovation process (Wallin & Von Krogh, 2010)

Open Innovation provides multiple advantages to innovative firms, including: cost reduction in product development, faster time-to-market, product quality improvement, access to expertise outside the organization, i.e. customers and suppliers knowledge (Wallin & Von Krogh, 2010). Representation of the Closed and Open Innovation model, as designed by Chesbrough, are reported in the following Figure 1 and Figure 2.

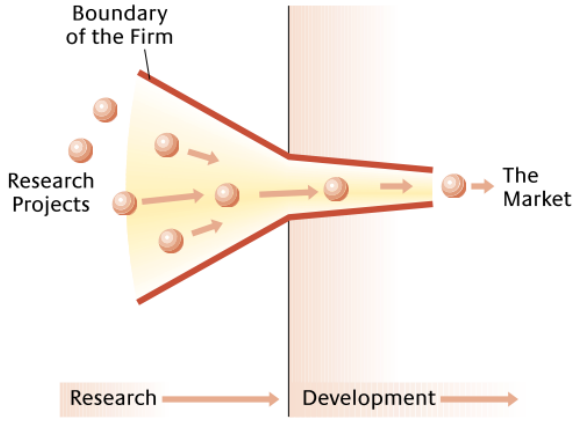

Figure 1: Closed innovation model (Chesbrough, 2003b, p.36)

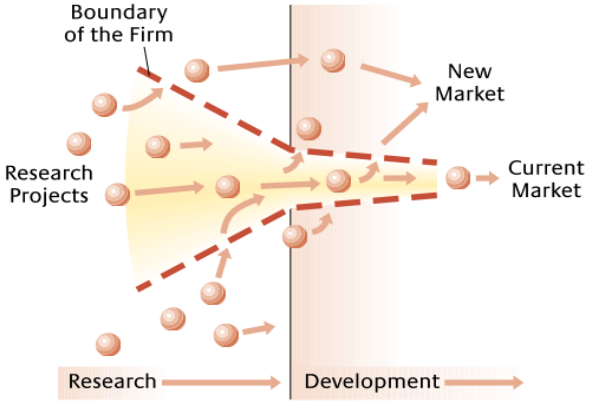

Figure 2: Open innovation model (Chesbrough, 2003b, p.37)

Such flows may contain either physical assets, i.e. *technology*, or intangible assets, i.e. *knowledge*. In Open Innovation literature, some authors clearly define in their works which category is the focus of their analysis (Lichtenthaler, 2008c; Lichtenthaler & Ernst, 2006). For most works, however, this distinction remains shady, as many authors use *"technology"* and *"knowledge"* as synonyms.

Following the model proposed by Enkel, Gassmann and Chesbrough (Enkel, Gassmann, & Chesbrough, 2009), we can categorize three processes of Open Innovation, which represent the direction of the flow of innovation: "*outside-in*", "*inside-out*" and "*coupled*".

The outside-in (inbound) process aims at enriching the company knowledge capital by internalizing externally developed technologies. In this view, companies search for valuable sources of knowledge in their environment, leveraging on potential sources of ideas arising

from other players, such as: suppliers, customers, competitors, research centers, universities. Inside-out (outbound) innovation represents a way companies use to earn profits by transferring internally developed ideas to the market through a variety of mechanisms, such as licensing agreements, partnerships, and sale of intellectual property. Finally, the coupled process includes all the situations where two (or more) partners engage in collaboration, partnership, joint ventures or co-creation agreements. The coupled process matches outside-in and inside-out activities of the partnering companies.

Based on the theoretical framework provided by Chesbrough, other scholars took up the task of studying the adoption of Open Innovation, starting from case studies of US-based multinational companies like Procter & Gamble (Dodgson et al., 2006), Cisco (Y. R. Li, 2009), or Apple, with the introduction of the iPod MP3 player (Rohrbeck, Hölzle, & Gemünden, 2009), and European companies like Deutsche Telekom (Rohrbeck et al., 2009) and Adidas (Piller & Walcher, 2006). At the same time, different scholars concentrated in defining consistent measures for Open Innovation (Michelino, Lamberti, Cammarano, & Caputo, 2015; Remneland-Wikhamn & Wikhamn, 2011), and set up the first empirical studies to sort out the effects of openness (Laursen & Salter, 2006; Lichtenthaler, 2009) and construct the framework for the adoption of open business models (Henry William Chesbrough, 2007). First revisions of early contributions (Dahlander & Gann, 2010; Enkel et al., 2009) highlighted the importance of going beyond the study of Open Innovation in pioneer firms (Lichtenthaler, 2008b, 2009) and to include the study of small and medium-sized firms (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). At the same time, a separate stream of literature - following von Hippel's User Innovation theory (von Hippel, 1986) – focused on the study of Open Innovation dynamics in the context of online communities (Fichter, 2009; West & Lakhani, 2008), whether open source (Mller-Seitz & Reger, 2010; Müller-Seitz & Reger, 2009), crowdsourcing (Tran, Hasan, & Park, 2012; Ye, Xu, Jia, & Jiang, 2012) and, later on, crowdfunding communities (Belleflamme, Lambert, & Schwienbacher, 2014; Mollick, 2014). A second wave of reviews (Huizingh, 2011; Randhawa, Wilden, & Hohberger, 2016; West & Bogers, 2014, 2017; West, Salter, Vanhaverbeke, & Chesbrough, 2014) is currently setting the framework for the extension of the phenomenon in the next decade, stressing the need to go beyond the traditional business-level of analysis and extending the framework to accommodate the introduction of community-based business models and open platforms, and promoting integration of Open Innovation with consolidated theories in the management field.

Over the years, the Open Innovation paradigm has been linked to various established theoretical frameworks. A representation of the major frameworks and of the citing papers is provided in Table 1.

Table 1: Theoretical frameworks linked with Open Innovation

	Theory name	Cited papers	Citing paper
Theoretical frameworks	Theory of Economic Development	Schumpeter (1934)	Mention (2011), Bogers & West (2012), Laursen & Salter (2014), West & Bogers (2014), Lopez-vega et al (2016)
	Absorptive capacity	Cohen & Levinthal (1990)	von Hippel & von Krogh (2006), Licthenthaler & Ernst (2007), Lichtenthaler (2008), Tether & Tajar (2008), Liechtenthaler & Ernst (2008), Lichtenthaler (2008), Stam (2009), Harison & Koski (2010), Spithoven et al (2010), Bogers & Lhuillery (2011), Mention (2011), Remneland-Wikhamn & Wikhamn (2011), Huizing (2011), Chen et al (2011), Muller-Seitz (2012), Suh & Kim (2012), Frishammar et al (2012), Aslesen & Freel (2012), Robertson et al (2012), Tranekjer & Knudsen (2012), Remneland-Wikhamn & Knights (2012), Xia (2013), Cruz-Cazares et al (2013), Clausen et al (2013), Teirlinck & Spithoven (2013), Lichtenthaler (2013), Wikhamn (2013), Balka et al (2014), Laursen & Salter (2014), Cheng & Huizing (2014), Caner et al (2014), West & Bogers (2014), Patterson & Ambrosini (2015), Goduscheit & Knudsen (2015), Gesing et al (2015), Cruz-Gonzalez et al (2015), Hu et al (2015), Su et al (2015), Frishammar et al (2015), Ooms et al (2015), Hooge & Le Du (2016), Cheng et al (2016), Miozzo et al (2016), De Zubielqui et al (2016), Valentim et al (2016), Garcia-Martinez et al (2017)
	Dynamic capabilities of the firm	Teece et al (1997); Kogut & Zander (1993)	Hurmelinna et al (2007), Lichtenthaler (2008), Lichtenthaler & Ernst (2009), Mention (2011), Remneland-Wikhamn & Wikhamn (2011), Huizing (2011), Grote et al (2012), Frishammar et al (2012), Robertson et al (2012), Wikhamn (2013), Patterson & Ambrosini (2015), Hu et al (2015), Su et al (2015), Cheng et al (2016), Nitzsche et al (2016), Thanasopon et al (2016), Garcia-Martinez et al (2017)
	Transaction Costs Economics	Coase (1937), Williamson (1985)	Muller-Seitz & Reger (2010), Mention (2011), Rolandsson et al (2011), Remneland-Wikhamn & Knights (2012), Barge-Gil (2013), Teirlinck & Spithoven (2013), Lichtenthaler (2013), Wikhamn (2013), Felin & Zenger (2014), Love et al (2014), Gesing et al (2015)
	Resource-based view of the firm	Penrose (1959), Barney (1991)	Mention (2011), Barge-Gil (2013), Teirlinck & Spithoven (2013), Wikhamn (2013), Sabidussi et al (2014), Colombo et al (2014), Mina et al (2014), Bianchi et al (2014), Love et al (2014), Gesing et al (2015), Veer et al (2016), Nitzsche et al (2016), Sikimic et al (2016), De Zubielqui et al (2016), Thanasopon et al (2016), Garcia-Martinez et al (2017)
	Innovation Life cycle	Abernathy & Utterback (1978), Tushman & Andersen (1986), Foster (1986),	Schiele (2010)
	User innovation	von Hippel (1976), von Hippel (1986), von Hippel (1988)	Piller & Walcher (2006), Fuller et al (2008), Huizing (2011), Parjanen et al (2012), Fuller et al (2012), Aslesen & Freel (2012), Bogers & West (2012), Clausen et al (2013), Wikhamn (2013), Felin & Zenger (2014), Laursen & Salter (2014), Cheng & Huizing (2014), Caner et al (2014), West & Bogers (2014), Dahlander & Piezunka (2014), Jahanmir & Lages (2015), Cheng et al (2016)
	Agency theory	Fama & Jensen (1983)	Fu (2012)
	Knowledge-based view of the firm	Grant (1996a), Kogut & Zander (1996), Spender (1996)	Frishammar et al (2012), Frishammar et al (2015), Valentim et al (2016)
	Relational view of the firm	Dyer & Singh (1998)	Wikhamn (2013), Gesing et al (2015)
	Human capital	Becker (1964)	Garcia-Martinez et al (2017)

Perhaps, the most known association for Open Innovation is with Cohen and Levinthal's *"Absorptive capacity theory"* (W. M. Cohen & Levinthal, 1990), as a consistent number of Open Innovation studies, most of them related to inbound Open Innovation, cite it (including Aslesen & Freel, 2012; Harison & Koski, 2010; Hooge & Le Du, 2016; Remneland-Wikhamn & Wikhamn, 2011; Von Hippel & Von Krogh, 2006; Wikhamn, 2013). Other studies link Open Innovation with Eric von Hippel's (1976; 1986, 1988) *"User innovation"* theory, especially in community-based studies (including Dahlander & Piezunka, 2014; Felin & Zenger, 2014; Füller, Matzler, & Hoppe, 2008). Other studies link Open Innovation with Penrose (1995) and Barney's (1991) *"Resource-based view of the firm"* (Caner, Sun, & Prescott, 2014; Cheng, Yang, & Sheu, 2016; Mention, 2011; Sabidussi et al., 2014), or with Teece, Pisano and Shuen's

(1997) *"Dynamic capabilities framework"* (Grote, Herstatt, & Gemünden, 2012; Huizingh, 2011; Lichtenthaler & Ernst, 2009; Nitzsche, Wirtz, & Goettel, 2016; Thanasopon, Papadopoulos, & Vidgen, 2016), and even with Coase (1937) and Williamson's (2012) *"Transaction cost theory"* (Felin & Zenger, 2014; Remneland-Wikhamn & Knights, 2012; Rolandsson, Bergquist, & Ljungberg, 2011) and with Schumpeter's (2017) *"Theory of Economic Development"* (Bogers & West, 2012; Laursen & Salter, 2014; Lopez-Vega, Tell, & Vanhaverbeke, 2016). Other studies create links with the *"knowledge-based view of the firm"* (Frishammar, Lichtenthaler, & Rundquist, 2012; Grant, 1996; Kogut & Zander, 1996; Spender, 1996; Valentim, Lisboa, & Franco, 2016). Only Fu (2012) lists the *"agency theory"* as the relevant research framework.

Open Innovation literature presents links with recurring topics, drawn from management and entrepreneurship literature. First, and foremost, Open Innovation scholars widely cite Katz and Allen (1982) "Not Invented Here" approach, related to the acquisition and integration of externally-generated assets (Burcharth, Knudsen, & Søndergaard, 2014; Cheng & Huizingh, 2014; Lichtenthaler & Ernst, 2006, 2009; Mortara & Minshall, 2011; Ooms, Bell, & Kok, 2015; Roberts, Piller, & Lüttgens, 2016). Other studies (Bianchi, Chiaroni, Chiesa, & Frattini, 2011; Hu, McNamara, & McLoughlin, 2015; Love, Roper, & Bryson, 2011; Michelfelder & Kratzer, 2013; Snow, Fjeldstad, Lettl, & Miles, 2011; Xia, 2013) explore the differences of "exploration and exploitation" behavior of "open" organizations (March, 1991). A literature stream emerging from Open Innovation focused on the locus of distributed innovation (Aylen, 2010; Howells, James, & Malik, 2003), specifically addressing knowledge arising from networks of innovation (Powell, Koput, & Smith-Doerr, 1996) and communities, i.e. crowdsourcing communities (Bogers & West, 2012; Füller, Hutter, & Faullant, 2011; Jahanmir & Lages, 2015; Schemmann, Herrmann, Chappin, & Heimeriks, 2016; West & Bogers, 2014; Wikhamn, 2013), characterized by collective wisdom which should enhance the outcomes of innovation (Ebner, Leimeister, & Krcmar, 2009; Garcia Martinez & Walton, 2014; Hutter, Hautz, Füller, Mueller, & Matzler, 2011). A third separate stream of literature, emerging from research proposition of early Open Innovation studies highlight the implementation of open practices within the context of small and medium sized firms, characterized by size-related barriers – i.e. the liability of smallness and the liability of newness (Goduscheit & Knudsen, 2015; McGrath, 1996; Valentim et al., 2016) - which can hinder the degree of collaboration and technology exchange with external counterparts.

Despite its relative newness, Open Innovation has attracted the focus of various scholars in the last decade, as witnessed by the presence of thousands of contributions in the field. However, we believe there is still room to extend the subject, by going beyond the bulk of extant works, as well as sorting out still unresolved questions on the topic.

In the following paragraph, we list the objectives of the thesis. In the next chapter (Chapter 2), we provide a literature review on Open Innovation topic, which highlights the open research questions we try to address in the following three essays (Chapter 3, 4 and 5), while Chapter 6 offers some general conclusions.

1.2 Objectives of the work

The objectives of this dissertation are three-fold. Based on the outcome of the literature review presented in Chapter 2, we aim at extending the comprehension of Open Innovation and its diffusion in three different ways: 1) verifying the adoption of Open Innovation practices outside the corporate-based environment, 2) linking Open Innovation with traditional management theories, and 3) joining the current debate on a relevant Open Innovation topic.

To do so, first, we study the implementation of Open Innovation practices in a non-corporate environment, and at the individual level of analysis. We argue that the paradigm of Open Innovation, whilst being created as a corporate business model for organizing innovative activities inside firms, has the potential to unlock potential untapped sources of innovation which reside in non-corporate environments. Since Open Innovation is based on the logic of effective use of innovative ideas, irrespective of their source and commercialization modalities, it can favor the transmission of the so-called *"false negative"* ideas (Verlag, 2013) – ideas whose value is not evident in early phases of development but become commercially valuable in subsequent stages – which are largely overlooked or abandoned by profit-based organizations, but may be pursued by non-corporate entities. At the same time, the adoption of Open Innovation practices may trigger the commercialization generated in not-for-profit organizations, which usually overlook at potential business opportunities due to their nature. This also echoes the need posited by early open innovation studies (Gassmann, Enkel, & Chesbrough, 2010) which argue the need to look beyond the distinction between small versus large firms and deepen the understanding of the Open Innovation phenomenon in different contexts. Research laboratories appear an interesting domain in such sense, since their objective

is related to knowledge creation. Examples of early and effective Open Innovation emerge from Xerox Palo Alto Research Centre (Xerox PARC) (Henry W. Chesbrough, 2003) which contributed to the creation of many successful innovations, i.e. the Ethernet protocol or personal computer's Graphic User Interface (GUI), which were later acquired and commercialized by different companies. Similarly, university research laboratories pursue the same mission – knowledge creation – although they focus on generating new knowledge for the sole sake of discovery. This pursue may sometimes lead to the creation of ideas with enormous commercial potential which may get lost because of the academic environment, historically opposed to commercialization of its discoveries (*"hands off approach"*) (Colyvas, 2007). This approach has changed in recent decades, especially in the US, with the creation of technology transfer offices (Gubitta, Tognazzo, & Destro, 2016; Siegel, Veugelers, & Wright, 2007) which look at potential market opportunities for university discoveries. This model, however, focuses on outbound transactions which are mediated by legal personnel, therefore failing to address whether university researchers are – in fact – open to commercialization or rather forced to do so by their institutions. Hence, we focus on individual level of analysis in our manuscript.

In the following chapters, we join the ongoing literature debate with two contributions which link the effects of Open Innovation practices on firm performance. In the first article on the topic, we link the adoption of Open Innovation with the renowned theory of market entry timing, and measure the combined effects of openness and timing strategies on firm performance. The link between Open Innovation and Entry-timing strategy emerges from the consideration of the advantages of Open Innovation in respect to closed innovation, in such that the adoption of Open models of innovation speeds up the development process, allowing firms to market their products and services faster (H. Chesbrough & Crowther, 2006; Wallin & Von Krogh, 2010). We argue that the validity of such statement has been so far overlooked by extant studies, therefore we propose the investigation of the issue as part of this dissertation.

Finally, we argue that extant contributions are yet to find a consensus on the direction of such effects, and that current literature may benefit from the use of better methodology in addressing the extent of Open Innovation practices, thus we propose a contribution by linking the extent of inbound Open Innovation and its effect on firm performance, measured in accordance to three dimensions: 1) economic, as the growth of firm turnover; 2) financial, measured as the growth of firm stock prices; and) human resources., measured as the growth of the firm in terms of employment. This aims at overcoming what we believe is a current

limitation of Open Innovation literature, namely relying on “openness” measures which are scale-based and self-reported.

1.3 Acknowledgements

Chapter 5 is co-authored by Daniele Biancardi, PhD, University of Milan.

2. Literature review on Open Innovation

2.1 Introduction

Open Innovation has been one of the most debated topics in innovation management literature since the introduction of the term, in 2003. At its core, the concept of Open Innovation represents *"a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with each organization's business model"* (Ollila & Yström, 2016)*, which reshapes the way in which companies conduct innovation, leveraging on internal as well as external paths to the market for internally- and externally-generated knowledge.*

In the past fourteen years, the term Open Innovation has spread rapidly, not just in academic production, but also in society. As an example, the recent maneuver of the Italian government called "Industry 4.0", which aims to promote the competitiveness of the manufacturing sector through the financing for the development and acquisition of newly, completely integrated technologies for production, poses "Open Innovation" as one of the pillars upon which the plan is settled.

However, despite the widespread adoption of the term, there is still confusion about the how and why Open Innovation is conducted, as well as which categories of actors are involved in the process. Specifically, in recent years, scholars have proposed previous reviews in the Open Innovation field (Dahlander & Gann, 2010; Randhawa et al., 2016; West & Bogers, 2014). For example, Dahlander and Gann (2010) focused on the direction and nature of interaction, classifying works according to inbound-outbound and pecuniary-nonpecuniary dimensions (Dahlander & Gann, 2010). Similarly, West and Bogers (West & Bogers, 2014) concentrated on reviewing works about the firm use of external sources of knowledge, studying inbound and coupled Open Innovation articles, while Randhawa et al (2016) perform a bibliometric review of Open Innovation articles. We believe that previous works fail to address important dimensions in the frame of Open Innovation, such as defining the extent of counterparts involved in the process, or the level of analysis which Open Innovation studies adopt.

We try to improve such classification by introducing two dimensions which were not implemented in previous studies, the number of transaction counterparts – unspecified, specified (dyadic) or firm-community transactions – and the level of analysis considered –

individual, project, or firm-level. We argue that such dimensions complement existing studies which are rather scant in defining which type of relationships do firms adopt in an Open Innovation framework, mainly relying on classifications about relationship breadth and depth, as proposed by Laursen and Salter (2006) and of pecuniary-based and non-pecuniary based, as proposed by Dahlander & Gann (2010). Additionally, to our knowledge, no distinction has been pointed out by previous reviews in respect of the unit of analysis. We seek whether additional levels of analysis are present in extant studies, focusing on micro-levels of analysis (individual and project level works), thus excluding industry or ecosystem-based studies.

The paper is organized as follows: in the next paragraph, we briefly introduce the design and methodology used to perform the review, and the dimensions of the framework used to categorize contributions. In the results section, we present descriptive results of the review analysis, and then analyze in detail the contributions according to the dimensions of the presented framework. In the discussion section, we briefly summarize the state of the art emerging from the review process, address the literature gaps that are still present in the literature, and highlight those which we are trying to fill in the following chapters of the dissertation. Finally, we conclude the paper by stating research limitations and open research questions which are beyond the scope of this thesis.

2.2 Research design

This work proposes a review of the Open Innovation literature. The search was conducted in January 2017 using Reuters' Web of Science (Web of Knowledge) database. This database is widely recognized in management literature and was used as a source for previous studies in the field (Dahlander & Gann, 2010; West & Bogers, 2014). As keywords, we entered the term *"Open Innovation"* in the topic field. Web of Science automatically searches for all papers with the containing the selected terms in the following fields: title, abstract and authors keywords. Initial analysis returned 2,343 results.

We additionally filtered according to the following dimensions: document types, which were limited to *"Articles"* and *"Reviews"*; paper category, which was limited to *"Management"* studies; and language, which was limited to *"English"*. Publication years and research indexes were not limited, thus including all articles published as of the end of January 2017. The analysis returned 642 articles, which were marked and downloaded on a local file.

We decided to additionally filter the returned articles by including only those published in the top 10 innovation journals, according to the Association of Business Schools' (ABS) Ranking of 2015. The list of selected journals is reported in Table 2.

Table 2: Top 10 Innovation Journals - ABS Ranking 2015

Journal name
Creativity and Innovation Management
Industry and Innovation
Innovation-Management, Policy and Practice
International Journal of Innovation Management
Journal of Engineering and Technology Management
Journal of High Technology Management Research
Journal of Product Innovation Management
R and D Management
Research Policy
Technovation

The selection returned 242 articles. We additionally searched for double entries – eliminating one paper[2] - and for retracted articles, eliminating three works by Lichtenthaler[3]. we subsequently read the abstracts and introduction of the remaining 239 papers, finally selecting 169 contributions for review[4]. The list of the selected articles – including abstracts – is presented in Table 34 in the Appendix section. These articles were read thoroughly and categorized according to the framework presented in Figure 3. Dimensions of the framework included: the form of Open Innovation - inbound, outbound and coupled; the number of transaction counterparts – unspecified (focused on a single firm), specified (focused on dyadic transactions) or firm-community interactions; and the unit of analysis – individual-, project-, or firm-level. Additional categorization included the nature of the study: theoretical, qualitative

[2] Spithoven, A., Frantzen, D. & Clarysse, B., (2010) "Heterogeneous firm-level effects of knowledge exchanges on product innovation: Differences between dynamic and lagging product innovators", *Journal of Product Innovation Management*, 27(3), pp.362–381.

[3] 1. Lichtenthaler and Muethel (2012) "The role of deliberate and experiential learning in developing capabilities: Insights from technology licensing", *Journal of Engineering and Technology Management*

2. Lichtenthaler and Frishammar (2011) "The Impact of Aligning Product Development and Technology Licensing: A Contingency Perspective", *Journal of Product Innovation Management*

3. Lichtenthaler (2010) "Determinants of proactive and reactive technology licensing: A contingency perspective", *Research Policy*, 39, p. 55–66

and quantitative, the size of the firm – small, medium or large, and the geographical location – regions and countries, if indicated.

This framework provides the guideline to categorize works in three different groups, which are described in detail in the following results section.

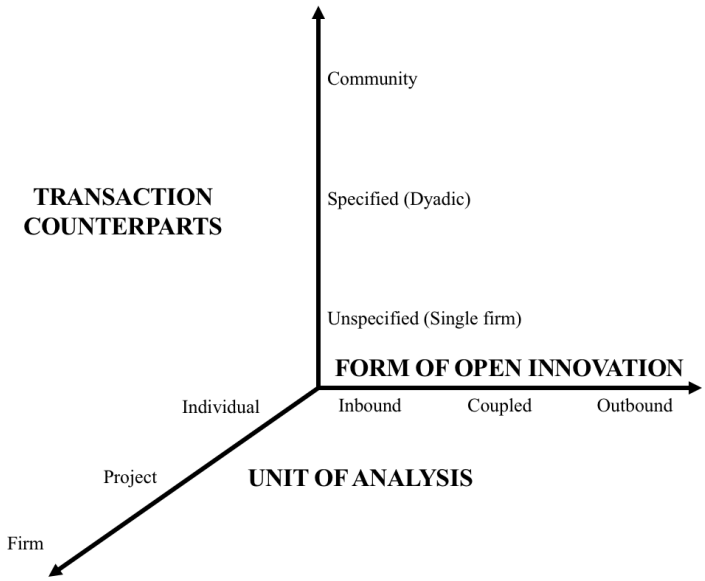

Figure 3: Review framework - dimensions

2.3 Descriptive findings

The selection process retrieved 169 papers distributed in the period 2006-2017. Details about the publications distribution over time is presented in Figure 4. On average, the data shows an increasing trend in Open Innovation research in the last decade, with almost 15 contributions per year, on average, and a median of 16 articles per year. The maximum number of published contributions – 25 – was reached in 2016.

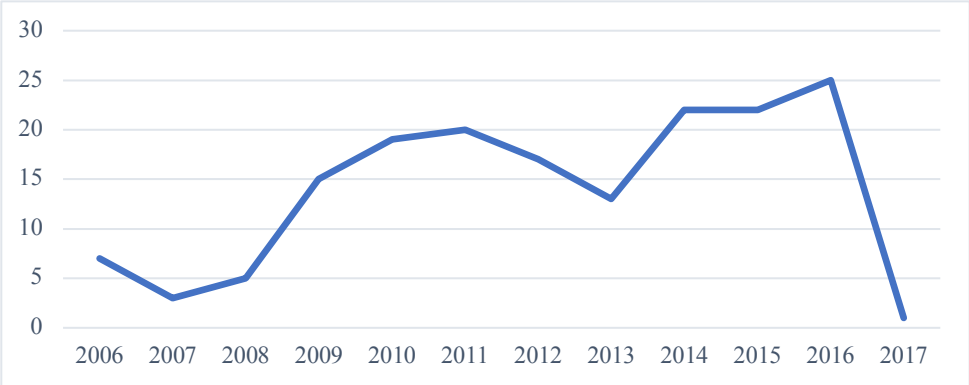

Figure 4: Articles distribution over year - selected sample

Turning to the journals, we find that one of the 10 selected for the analysis – the Journal of High Technology Management Research – did not publish contributions in the Open Innovation topic. Therefore, the review analysis is restricted to nine journals. Details about article distribution among the selected journals are presented in Table 3.

Table 3: Open Innovation paper distribution - Selected journals

Selected journals	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	%
Creativity and Innovation Management						3	4	2	1	7	2		19	11,24
Industry and Innovation			2		1	1	1	1	1	1			8	4,73
Innovation-Management Policy and Practice				1		1	5			1	2		10	5,92
International Journal of Innovation Management											4		4	2,37
Journal of Engineering and Technology Management			1					1	2	2	1		7	4,14
Journal of Product Innovation Management		1	1		2	1	3	3	4	2	5		22	13,02
R&D Management	6	1		10	10	4	1	1		2	6		41	24,26
Research Policy	1		1	1	3	2	2	2	11	2	4		29	17,16
Technovation		1		3	3	8	1	3	3	5	1	1	29	17,16
Total	*7*	*3*	*5*	*15*	*19*	*20*	*17*	*13*	*22*	*22*	*25*	*1*	*169*	*100,00*

Among the selected journals, R&D Management was the most active in the field, with 41 published contributions (24% of total), followed by Technovation and Research Policy (both with 29 articles, 17%), and the Journal of Product Innovation Management (22 articles, 13%). Creativity and Innovation Management published 19 articles (11%), followed by Innovation-Management Policy & Practice (10 articles, almost 6%), Industry and Innovation (8 articles, almost 5%), and Journal of Engineering and Technology Management (7 articles, 4%). Finally, the International Journal of Innovation Management published 4 articles among those selected in the review sample (2%).

Among the selected articles, 27 were published in 7 Special Issues published by the following journals: 1) R&D Management's 2011 issue on *"Outsourcing R&D"* (Bianchi, Chiaroni, et al., 2011; Lichtenthaler, 2011b) and 2016 issue on *"Transferring Knowledge"* (Bianchi & Lejarraga, 2016; Y. Chen, Vanhaverbeke, & Du, 2016; Galán-Muros & Plewa,

2016; Manzini & Lazzarotti, 2016; Veer, Lorenz, & Blind, 2016); 2) Industry and Innovation's 2011 issue on *"Organizing inter- and intra-firm networks"* (Bogers & Lhuillery, 2011); 3) Technovation's 2011 ISPIM Special Issue on Open Innovation (Bianchi, Cavaliere, Chiaroni, Frattini, & Chiesa, 2011; Chiaroni, Chiesa, & Frattini, 2011; Huizingh, 2011; Mention, 2011; Porter & Newman, 2011; Praest Knudsen & Bøtker Mortensen, 2011); 4) Research Policy's 2014 issue on *"Open Innovation: new insights and evidence"* (Belderbos, Cassiman, Faems, Leten, & Van Looy, 2014; Colombo, Franzoni, & Rossi-Lamastra, 2015; Dahlander & Piezunka, 2014; J. Du et al., 2014; Felin & Zenger, 2014; Gambardella & Panico, 2014; Henkel, Schöberl, & Alexy, 2014; Laursen & Salter, 2014; Mina et al., 2014) and 2016 special section of Vol.45 Issue 7 on *"Patent Use"* (Arora, Athreye, & Huang, 2016; Miozzo, Desyllas, Lee, & Miles, 2016); and 5) Journal of Engineering and Technology Management's 2015 issue on *"Leveraging users as innovators: managing the creative potential of individual customers"* (Jahanmir & Lages, 2015; Parmentier, 2015).

2.3.1 Nature of the study

Details about distribution of articles according to their contribution are presented in Table 4.

Table 4: Article contribution - selected sample

Contribution type	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total	%
Theoretical	2		2	1	1	4	2	2	2	1			17	10,06
Review					1				1		1		3	1,78
Quantitative	1	2	2	7	7	9	10	9	17	14	19	1	98	57,99
Qualitative	4	1	1	7	10	7	5	2	2	7	5		51	30,18
Total	*7*	*3*	*5*	*15*	*19*	*20*	*17*	*13*	*22*	*22*	*25*	*1*	*169*	*100,00*

As we can see, the majority of works propose quantitative studies (98, 58% of total), followed by qualitative studies (51, 30%), while only 17 papers in the sample propose theoretical contributions (10%), and only 3 are literature reviews (Dahlander & Gann, 2010; Randhawa et al., 2016; West & Bogers, 2014).

Analyzing the evolution of studies over time (Figure 5), we see that the number of theoretical contributions remains constant over time, while qualitative and quantitative studies different trends: the former group has a peak in 2010 and a decreasing trend in the following years. Conversely, quantitative studies show a constant increasing trend. The picture is

consistent with theory building: after early theoretical studies[5], a second wave of works emerge, usually in the form of single (Chiaroni et al., 2011; Dodgson et al., 2006; Y. R. Li, 2009; Rohrbeck et al., 2009) or multiple case studies (H. Chesbrough & Crowther, 2006; Chiaroni, Chiesa, & Frattini, 2003; Galati, Bigliardi, & Petroni, 2016; Hughes & Wareham, 2010), followed by a third wave of quantitative studies which try filling literature gaps emerging from early contributions and literature reviews. In this sense, after 14 years since its introduction, Open Innovation literature appears to be in the third wave.

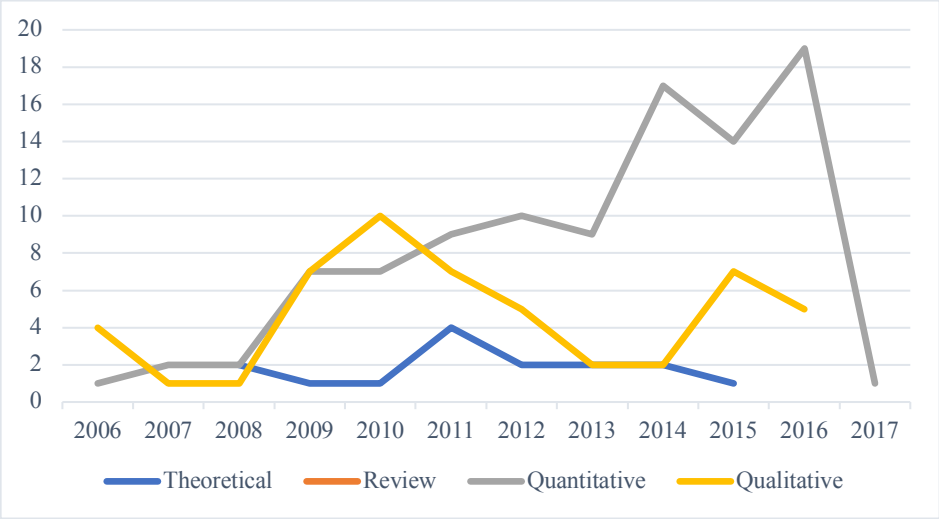

Figure 5: Evolution of article contribution over time - selected sample

2.3.2 Geographical distribution

We reported geographical distribution of the samples used for analysis. Details about article distribution according to geographical location are reported in Table 5.

[5] Which have been presented in the previous chapter and are beyond the objective of this review

Table 5: Article distribution according to geographical region - selected sample

Type	Region	Articles	Distribution
Single region	Africa	1	0,59
	Asia	13	7,69
	Europe	86	50,89
	North America	7	4,14
	Oceania	1	0,59
Cross-regional	North America and Europe	6	3,55
	North America, Europe and Asia	1	0,59
Unspecified	Unspecified	54	31,95
Total	*Total*	*169*	*100,00*

Europe is the region with the largest share of contributions in Open Innovation literature, with 86 published articles (almost 51%), followed by Asia (13 articles, almost 8%), and North America (7 articles, about 4%). Only 2 studies (De Zubielqui, Jones, & Lester, 2016; Egbetokun, 2015) are settled in Africa and Oceania (only 1% of the sample), and only a handful of studies are cross-regional (7 articles, 4%). Of them, 6 studies include North American and European samples (Hu et al., 2015; Michelino et al., 2015; Miozzo et al., 2016; Perkmann & Schildt, 2015; Sieg, Wallin, & von Krogh, 2010; Xia, 2013), while only 1 contribution compares samples from North America, Europe and Asia (Belderbos et al., 2014).

2.4 Framework findings

In the following sections, we propose a review of the major contributions in the selected sample, categorized according to the proposed framework presented in section 2. For each dimension of the framework, we propose the emerging themes in literature.

2.4.1 Form of Open Innovation

Based on the work of Enkel, Gassmann and Chesbrough (Enkel et al., 2009), we adopt the classification of Open Innovation processes in 1) Outside-in (inbound) Open Innovation, 2) Inside-out (outbound) Open Innovation and 3) Coupled Open Innovation practices.

The first group – inbound Open Innovation – refers to *"internal use of external knowledge"* (Huizingh, 2011) and includes all activities the firm adopts to enrich its knowledge base through integrating suppliers, customers and other (external) knowledge sources (Enkel et

al., 2009). The second group – outbound Open Innovation – refers to *"external exploitation of internal knowledge"* (Huizingh, 2011) and includes all activities the firm adopts to earn profits through the transfer of internally developed ideas to the market through external channels (Enkel et al., 2009). The third group – coupled Open Innovation, include the combination of inbound and outbound activities, and the *"co-creation with (mainly) complementary partners through alliances, cooperation, and joint ventures during which give and take are crucial for success"* (Enkel et al., 2009).

Building on the review proposed by West and Bogers (West & Bogers, 2014), we used the three modes of Open Innovation as the first dimension for the review. Details about the distribution are reported in Table 6.

Table 6: Article distribution according to modes of Open Innovation

Direction	Articles	Distribution
Coupled	85	50,30
Inbound	63	37,28
Outbound	21	12,43
Total	*169*	*100,00*

The distribution between the three dimensions is uneven: the majority of studies seem to focus on coupled Open Innovation practices (85 articles, 50%), more than one third of studies are inbound-focused (63 articles, 37%), while only 21 studies focus on outbound practices (12%). In the next section, we propose the emerging trends for each of the abovementioned categories

2.4.1.1 Inbound

From the analysis of the 63 articles focused on inbound Open Innovation, two main topics emerge: a closed versus Open Innovation model comparison and the use of externally-generated knowledge and technology along the steps of the innovation process.

2.4.1.1.1 Closed versus Open Innovation

In his seminal work (Svensson et al., 2010), Chesbrough proposed the Open Innovation model in opposition to the classical, vertically-integrated model of innovation. Some scholars have subsequently fueled the debate, proposing comparisons between closed and open approaches toward innovation (Cruz-Cázares, Bayona-Sáez, & García-Marco, 2013) and studying the transition process from a closed-based innovation system to an open one (Chiaroni et al., 2003; Dodgson et al., 2006; Y. R. Li, 2009), an analysis of the different degrees of firm openness in innovation (Andrés Barge-Gil, 2010).

In particular, Dodgson et al (2006) study the shift towards openness of consumer goods multinational Procter and Gamble (P&G) and the implementation of their *"Connect and Develop"* strategy, while Li (2009) analyzes the evolution of Cisco's network and the creation of its business ecosystem. Similarly, Chiaroni et al (2003) study the transition from closed to Open Innovation approach of four Italian manufacturing firms. Barge-Gil (2010) studies the relationship between firms openness according to their size, R&D intensity and industry classification and found through the analysis of a sample of Spanish firms and distinguish between open, semi-open and closed innovators. From his analysis, he argues that open innovators are larger and more R&D intensive than closed innovators, although they are smaller and less R&D intensive than semi-open companies. In addition, both open and closed innovators are generally not involved in high-tech sectors. Conversely, Cruz-Cazares et al (2013) addresses the firm's choice between internal development (make) and the externalization of R&D activities (buy) strategy or the adoption of the two (make-buy) strategies at the same time, using a sample of Spanish manufacturing firms, and they found that firms rely on external acquisition as a mean to reduce risks associated with environmental uncertainties, or when they do not possess adequate internal resources or they lack experience; otherwise, they tend to organize activities internally. Moreover, firms tend to prefer a make-buy approach when faced with high market dynamism and when technological resources are of high complexity.

2.4.1.1.2 Use of external knowledge

The second stream of inbound-based works addresses the use of external knowledge along the different phases of the innovation process: knowledge and technology sourcing, acquisition and

transformation, and management. In the sourcing phase, various studies address the locus of dispersed knowledge (Lopez-Vega et al., 2016; Porter & Newman, 2011) and technology (Laursen & Salter, 2014; Sabidussi et al., 2014) which firms can acquire, whether it is in the company's external environment – i.e. suppliers (Schiele, 2010), customers (Jahanmir & Lages, 2015) and consumers (Füller, Matzler, Hutter, & Hautz, 2012), universities or consultants (Tether & Tajar, 2008) - or online – i.e. in open source (Mller-Seitz & Reger, 2010; Müller-Seitz & Reger, 2009; Rolandsson et al., 2011; Stam, 2009), brand-specific (Füller et al., 2008; Parmentier, 2015) or avatar-based (Kohler, Matzler, & Füller, 2009) communities, or in a dispersed crowd (Garcia Martinez & Walton, 2014; Schemmann et al., 2016); in addition, scholars address the role of different means through which the company can acquire such knowledge – i.e. through idea toolkits (Piller & Walcher, 2006), contests and competitions (Ebner et al., 2009; Kathan, Hutter, Füller, & Hautz, 2015), the use of social media (S. Du, Yalcinkaya, & Bstieler, 2016; Ooms et al., 2015; Roberts et al., 2016), knowledge brokerage or collective creation projects (Parjanen, Hennala, & Konsti-Laakso, 2012).

As regards the acquisition and transformation phase, various scholars address the challenges related to the implementation of openness, i.e. employees' negative attitude towards Open Innovation (Burcharth et al., 2014) such as the *"not-invented-here"* (NIH) (Lichtenthaler & Ernst, 2006) and *"not-shared-here"* (NSH) syndrome (Burcharth et al., 2014), and the role played by the firm's absorptive capacity (Bogers & Lhuillery, 2011; Hughes & Wareham, 2010; W. Patterson & Ambrosini, 2015; Robertson, Casali, & Jacobson, 2012; Spithoven, Clarysse, & Knockaert, 2011; Valentim et al., 2016) to overcome these issues.

To successfully manage Open Innovation, firms must overcome organizational barriers which hinder the implementation of externally generated technology, i.e. the NIH syndrome. Lichtenthaler and Ernst (Lichtenthaler & Ernst, 2006) extend the study on NIH by proposing a comprehensive framework for knowledge management tasks for the Open Innovation framework, according to the three phases of knowledge acquisition, accumulation and exploitation. They argue that companies may suffer from overly-negative not-invented-here versus overly-positive buy-in approach in the acquisition phase, from all-stored-here approach versus relate-out syndrome in the knowledge accumulation phase, and from only-used-here versus sell-out approach in the knowledge exploitation phase. Similarly, Burchart et al (2014) address the effects of not-invented-here and not-shared-here approaches in Open Innovation practices, and verify that NIH and NSH prevent the adoption of inbound and outbound practices, respectively.

As regards absorptive capacity, Hughes and Wareham (Hughes & Wareham, 2010) study the adoption of inbound practices in the strategy of large pharmaceutical companies. Similarly, Valentim et al (2016) analyze the existence of absorptive capacity – along the four steps of knowledge acquisition, assimilation, transformation and exploitation – in the context of biopharmaceutical companies. Their results show that the key components for absorptive capacity are mainly sequential, thus forcing firms to articulate the acquisition process linearly to generate value from external knowledge. Bogers and Lhuillery (2011) argue that firms' absorptive capacity is function-based, as firms organize around different functions (R&D, but also manufacturing and marketing) to gather different types of external knowledge and then organize activities internally to manage the knowledge absorption process. In a similar vein, Robertson et al (Robertson et al., 2012) claim that firms' absorptive capacity requires a broad set of knowledge to be coupled with a broad range of actors from different functions (such as technology management, human resources management, relationship management) whose interest may be aligned provide solution to complex implementation problems. Absorptive capacity may also lie outside of firm boundaries, i.e. in research centers, which help partner companies develop system-level absorptive capacity through knowledge intelligence services, knowledge agency and repository functions (Spithoven et al. 2010).

Finally, only Bogers and West (Bogers & West, 2012) treat the topic of managing inbound Open Innovation. They distinguish between integrated and distributed models of firm innovation, and then review the characteristics of the main models of distributed innovation: Open Innovation, user innovation, community/social production, co-creation, open source and crowdsourcing. They subsequently propose that firms should strategically manage the three challenges related to distributed innovation: identifying supply of external innovations, supporting the continuous flow to the organization and elaborate ways to profit from innovations.

2.4.1.2 Outbound

Three topics emerge from the analysis of outbound-focused contributions: the process of technology externalization, the dynamics of knowledge revealing, and the outsourcing of R&D functions.

2.4.1.2.1 Technology externalization

Technology externalization process is studied along different steps, including identifying external technology opportunities (Bianchi, Campodall'Orto, Frattini, & Vercesi, 2010; Frishammar et al., 2012), external technology commercialization (Bianchi, Chiaroni, et al., 2011; Bianchi & Lejarraga, 2016; Hu et al., 2015; Lichtenthaler & Ernst, 2007), external technology exploitation (Bianchi, Frattini, Lejarraga, & Di Minin, 2014; Lichtenthaler, 2010) and management (Lichtenthaler, 2008d, 2011b). Firms can create ad hoc methodologies to exploit internal resources in the external environment (Bianchi et al., 2010), and generate commercialization opportunities. Frishammar et al (2012), using a sample of Swedish manufacturing firms, posit that integrating general and specific knowledge has a positive effect on firm's technology commercialization intelligence, i.e. the ability of the firm to scan the environment to search for technology licensing opportunity, and indeed on the technology commercialization (ETC) performance of the firm. External technology commercialization is increasingly getting adopted by innovating firms, although the extent of such activities is still limited when compared to the internal exploitation of externally-generated technologies, and that the development of external technology commercialization practices is brought forward by a limited number of pioneering firms, who are able to generate profits (Lichtenthaler & Ernst, 2007). The organizational design of external technology commercialization activities depends on the firms' corporate strategy, and on the volume of transactions conducted. In firms where the relevance of ETC is high, the tendency is to create dedicated ETC functions who act independently. Conversely, firms tend to manage transactions with temporal endeavors (Bianchi, Chiaroni, et al., 2011) when the relevance and the intensity of out-licensing agreements is low. In a study on out-licensing deals in the bio-pharmaceutical sector, Hu et al (2015) found that the extent of out-licensing deals is positively associated with the entrepreneur's social status and firm's previous experience in commercial alliances. Firms are attracted in licensing deals by the recognition of the firm's intellectual property rights and by their experience in managing alliances. Similarly, Bianchi and Lejarraga (2016) found that the firm intellectual capital – measured as the percentage of employees with advanced skills – coupled with employees' experience in licensing activities - increase firms' licensing revenues.

As regards external technology exploitation, Lichtenthaler (2010) argues that firm's success on Open Innovation is contingent upon environmental factors, and that licensing is an attractive strategy in contexts characterized by strong appropriability regimes and high technology transaction rates, thus when firms have strong patent protection and face relatively

low transaction costs. In addition, Bianchi et al (2014), in a study on Spanish manufacturing firms, found that firm technological resources have a positive effect on firm's licensing performance – in the form of increased profits and relational resources, and that the effect is reinforced by the firms' endowment in marketing resources.

External knowledge management relies on the firm's relative capacity, i.e. the ability to retain knowledge outside of the firm boundaries over time, by leveraging on the firm's relations network (Lichtenthaler, 2008d). In a subsequent study (Lichtenthaler, 2011b), he argues that management of technology licensing activities is based upon four factors: firm's licensing strategy, process, organization and culture, and that firms may adopt five different approaches depending on the level of integration of technology licensing as part of corporate strategy.

2.4.1.2.2 Revealing

A second group of outbound-related works addressed the dynamics of outbound knowledge transfer, either in the form of willing transfer through free (Tranekjer & Knudsen, 2012; Von Hippel & Von Krogh, 2006) and selective revealing (Henkel, 2006; Henkel et al., 2014), or unwilling transfer, occurring through knowledge leakage (Frishammar, Ericsson, & Patel, 2015).

Free revealing entails a situation in which an innovator reveals private information voluntarily, making it a public good (Von Hippel & Von Krogh, 2006). Free revealing, in the spectrum of Open Innovation, is beneficial when competing firms have knowledge which is closely related to the innovating firm's "secret" core knowledge and when patenting benefits are low. Free revealing brings positive benefits to the revealing firm since it accelerates the path of diffusion of the revealed technology, it can trigger network effects and it may help the innovation become the industry "dominant design" (Von Hippel & Von Krogh, 2006). Tranekjer and Knudsen (2012), by studying a sample of Danish manufacturing and R&D companies, verified that more than half of the firms in the sample are providers to other firms' new product development processes, and over 97% of them received knowledge from outside providers to improve their new product development. Knowledge providers are mainly identified with firms' suppliers, and they freely reveal to benefit from partner knowledge development.

Although diffused, however, free revealing is not yet a common practice: in a study on embedded Linux software producers, for example, Henkel (2006) found that firms apply restrictive practices when revealing, and selectively share only part of their proprietary information. In a subsequent study, Henkel et al (2014) found that reason to reveal is associated with customer demand, and the degree of revealing is related to perceived technical and marketing-related benefits achieved by the revealing firm.

Complementary to the revealing behavior, Frishammar et al (2015) address the case in which companies may suffer from knowledge leakage, i.e. an unconscious or uncontrolled transfer of knowledge from the company to a third party. The authors argue that leakage may occur when the firm's appropriability regime is weak or when competitors are highly efficient in absorbing knowledge, and leakages may have detrimental effects on the firm's competitive advantage. However, potential damage is contingent upon the nature of the leaked information and the competitive positioning of the recipient.

2.4.1.2.3 R&D outsourcing

Finally, a limited number of studies address the impact of outsourcing for firm R&D function (Andries & Thorwarth, 2014; Bhutta, 2015). Hsuan and Mahnke (2015) propose that small firms are more likely to engage in R&D outsourcing, and that the benefits of this practice decrease according to firm size. Andries and Thorwarth (2014) argue that outsourced research has a larger impact than internal R&D due to the creation of economies of specialization and knowledge spillovers among the firm and R&D partners. However, such benefits are counterbalanced by the arising transaction costs to acquire external knowledge, an increased complexity in assimilating and leveraging upon acquired knowledge, and a more difficult allocation of intellectual property rights between the acquiring firm and the outsourcing partner. In their study on Flemish firms, however, they find that in-house and outsourced R&D are equally productive, irrespective of firm size. Nevertheless, small firms are more prone to outsource basic research to a larger extent than medium- and large-sized firms, who can leverage on better outcomes from internal R&D.

2.4.1.3 Coupled

Coupled-Open Innovation contribution focused on two literature streams: the analysis of the various forms of coupled Open Innovation practices and the adoption of such practices in different contexts. In addition, five articles include reviews (Dahlander & Gann, 2010; Randhawa et al., 2016; West & Bogers, 2014) or editorial contributions which partially review literature on Open Innovation (Gassmann et al., 2010; Huizingh, 2011).

2.4.1.3.1 Forms of coupled Open Innovation

Various scholars studied the various forms of coupled Open Innovation, focusing on collaboration/partnership relationships (Galán-Muros & Plewa, 2016; Goduscheit & Knudsen, 2015; Guimón & Salazar-Elena, 2015; Manzini & Lazzarotti, 2016; Mention, 2011; Miozzo et al., 2016; Perkmann & Schildt, 2015; Teirlinck & Spithoven, 2013; Veer et al., 2016) and alliances (Caner et al., 2014; Faems, De Visser, Andries, & Van Looy, 2010; Garcia Martinez, Zouaghi, & Sanchez Garcia, 2017), the interaction with innovation intermediaries (Lichtenthaler, 2013; Porto Gómez, Otegi Olaso, & Zabala-Iturriagagoitia, 2016a; Sieg et al., 2010) and co-creation activities (Belderbos et al., 2014; Füller et al., 2011; Su, Lin, & Chen, 2015).

Collaboration with external partners may bring benefits to the firm: relationships with market-based partners increases the degree of novelty of firm products, while interaction with science-based partners increases the probability of introducing new to the market innovations (Mention, 2011). Similarly, firm collaboration with universities guarantees access to complementary knowledge (Guimón & Salazar-Elena, 2015). However, interaction with universities does not come without costs: cooperation between firms and universities is positively related to resource availability (Galán-Muros & Plewa, 2016), therefore the lack of resources on the two sides reduces the extent of collaboration (Goduscheit & Knudsen, 2015). In this sense, intermediary organizations, such as research and technology organizations or the consortia (Perkmann & Schildt, 2015) facilitate transactions between the two parties. Innovation intermediaries considered in the literature are divided into agents – consulting companies and technology brokers – and providers of media services (Lichtenthaler, 2013) – online platforms, like InnoCentive (Sieg et al., 2010). In addition, Gomez (2016a), labels *"trust builders"* all those organizations – intermediaries, brokers and boundary organizations - which

help increase firm interactions. Lichtenthaler (2013) argues that companies adopt three approaches to intermediaries: 1) passive, 2) reactive and 3) proactive approach, and proposes that so far innovation intermediation has produced limited success due to the passive approach to such activities adopted by the majority of firms. Sieg et al (2010) propose that challenges related to intermediation contribution may be addressed through enlisting adequate internal resources to deal with innovation intermediaries, selecting the right problems to be solved by the intermediary and formulate problems in adequate ways, so that external contributors can formulate novel solutions.

In the context of cooperation management, some recent studies address the role of intellectual property protection and appropriability systems (Manzini & Lazzarotti, 2016; Miozzo et al., 2016; Veer et al., 2016). In a case study about Italian service firm MR&D, Manzini and Lazzarotti (2016) argue that intellectual property protection mechanisms are enforced depending on the phase of innovation processes and on the type of partner involved in the relationship. In the first phases of development, legal mechanisms are rarely used, due to uncertainty, while stronger measures can be adopted in later stages, where risk is lower. In a quantitative study on appropriability mechanisms in American- and European-based knowledge intensive business services (KIBS), Miozzo et al (2016) highlight a "paradox of appropriability", in that firms do not regard protection mechanisms being the most effective measure to protect innovation, although there is a positive relations between the use of such mechanisms and the extent of collaborations. In addition, high emphasis on protection generates negative outcomes on collaboration, turning into a barrier. In a similar vein, Veer et al (2016) – in a study on German firms – found a positive and significant relation between the degree of collaboration breadth and depth and the risk of firms facing potential imitation. The use of intellectual property rights mitigates that risks, while the use of contracts to regulate relationships does not.

As regards technology alliances, previous literature focused on the relationship between firms' alliance portfolio and their financial performance (Caner et al., 2014; Faems et al., 2010; Garcia Martinez et al., 2017): Faems et al (2010) suggest the existence of an indirect relationship between the diversity of firms' technology alliance portfolio and their product innovation performance, while Martinez et al (2017) posit that there is an inverted-U relationship between degree of firms' alliance portfolio diversity and firms' incremental and radical innovation performance. Caner et al (2014), in contrast, study the relationship between

firm degree of centrality inside a technology alliance network, and the level of inward and outward technology transfer on the firm's invention output.

For co-creation activities, two studies analyze co-patenting: Belderbos et al (2014) analyze the relation between co-patenting and value creation and appropriation, and find that co-patenting creates value for the firms involved, especially when firms decide to co-patent with university partners, while challenges to value appropriation are particularly pronounced when co-patenting is conducted with partners operating in the same industry. Similarly, Su et al (2015) study the relation between firm ownership structure and the value of technological knowledge co-creation, revealing an increasing trend in co-creation which in turn confirms the diffusion of the Open Innovation paradigm. In contrast, Fuller et al (2011) addresses individual participation in co-creation processes carried out through online idea competitions, and find that the co-creation experience is positively related to the perceived sense of community developed within the context, the sense of autonomy, enjoyment and competence expressed by participants, and in turn can enhance quantity and quality of user contributions.

2.4.1.3.2 Adoption of coupled Open Innovation practices

In parallel to the study of various forms of coupled OI, some scholars have verified the implementation of Open Innovation practices in different contexts. In this view, scholars have mainly focused on two dimensions: firm size and sector of activities. As regards firm size, early study focus on the implementation of Open Innovation practices in large and very large companies (H. Chesbrough & Crowther, 2006; Gassmann et al., 2010) and multinationals (Mortara & Minshall, 2011), while subsequent studies broadened the spectrum by verifying the implementation in small- and medium-sized firms (van de Vrande et al., 2009; Vrgovic et al., 2012). Sectors of implementation include both high tech – i.e. software (Harison & Koski, 2010), biotechnology (Seldon, 2011), biopharmaceuticals (Bianchi, Cavaliere, et al., 2011), automotive (Ili, Albers, & Miller, 2010) - as well as low tech, traditional sectors, such as food (Galati et al., 2016) and cement industry (Chiaroni et al., 2011).

2.4.1.4 Summary

So far, scholars in the Open Innovation field seem to have devoted much attention to inbound- and coupled-based practices, while studies on outbound Open Innovation are still limited. The picture is consistent with arguments proposed in early studies by Lichtenthaler (2009), who posits that outbound Open Innovation practices have been neglected by scholars in the field.

We see that inbound practices have extensively been addressed over the entire integration process, while the strategic process in which companies decide which technologies to externalize, the modalities and the conditions to secure deals have only been touched upon by Bianchi et al (2010). In addition, going back to Enkel et al (Enkel et al., 2009) definition, we see that – in the spectrum of inbound Open Innovation practices – joint ventures as a mode of coupled Open Innovation have been overlooked by current literature.

2.4.2 Transaction counterparts

We now turn our attention to the second dimension of our framework, namely number of transaction counterparts involved in the transaction. The classification ranges from articles focused on unspecified transactions of a single focal firm, the analysis of dyadic interactions between firms and a limited number of external stakeholders, to transactions between a focal firm and a community. Details about article distribution according to the degree of openness are reported in

Table 7.

Table 7: Article distribution according to the number of transaction counterparts

Transaction counterparts	**Articles**	**Distribution**
Community	44	26,04
Specified (dyadic)	47	27,81
Unspecified (single firm)	78	46,15
Total	*169*	*100,00*

The majority of contributions address the organization of Open Innovation activities of a single firm with unspecified counterparts (78 articles, 46%), while works on dyadic and community-based transactions in the sample are almost equally distributed, with 47 articles

(almost 28%) and 44 articles (26%), respectively. In the next section, we propose the emerging trends for each of the abovementioned categories.

2.4.2.1 Unspecified (Single firm)

The largest number of studies in the sample focus on the implications of openness related to single firms. Three streams emerge: the study of intra-firm openness, firm capacities and open strategy, and the effects of openness on firm activities, particularly on firm performance.

2.4.2.1.1 Intra-firm openness

Few studies concentrate on the application of the Open Innovation paradigm at a sub-firm level, namely addressing the concept at the individual level (Salter, Ter Wal, Criscuolo, & Alexy, 2015), at project level (N. Kim, Kim, & Lee, 2015; Thanasopon et al., 2016) or studying intra-firm collaboration in large companies (Grote et al., 2012; Michelfelder & Kratzer, 2013).

Salter et al (2015) address the impact of openness on performance at the individual level. By analyzing a sample of 329 scientists, they study the effects of the degree of personal openness to external sources of knowledge to scientist ideation performance, i.e. the ability of individuals to generate new ideas. Results show that individual openness towards external sources of knowledge increases individual ideation performance, helping scientist come up with new and valuable ideas for their firm. Kim et al (2015) study project level antecedents of Open Innovation in Korean small-and medium-sized firms. Thanasopon et al (2016) study the effects of project openness in the fuzzy front end of innovation, using a sample of Thailandese firm projects. They argue that the level of openness is a significant predictor for the reduction of technical and market uncertainty in the innovation process, and that such effects, in turn, increases potential innovation success.

Grote et al (2012) address the effects of cross-divisional collaboration in innovation of large firms in Germany, Switzerland and Austria, and find that integration mechanisms have positive and significant influence in front-end collaboration activities, as well as between reward systems and collaboration. Finally, they argue that collaboration in early stages have a positive effect on company success. In a similar vein, Michelfelder and Kratzer (2013) study the effects of strong and weak ties in firm R&D collaboration, and find that the combination of

the two ties combined produce positive and significant effects on innovation exploration and exploitation outcomes.

2.4.2.1.2 Firm capacities and Open Innovation strategies

The second stream of works focus on firm capacities, including absorptive capacity (Bogers & Lhuillery, 2011; Ooms et al., 2015; W. Patterson & Ambrosini, 2015; Robertson et al., 2012; Valentim et al., 2016; Xia, 2013) and relative capacity (Lichtenthaler, 2008d), the extent of firm appropriability regime (Hurmelinna, Kyläheiko, & Jauhiainen, 2007) and on firm strategies to manage openness, including insourcing strategies (Y. Chen et al., 2016; Lopez-Vega et al., 2016; Porter & Newman, 2011), outsourcing (Andries & Thorwarth, 2014; Teirlinck & Spithoven, 2013), and technology exploitation (Lichtenthaler, 2010).

Firms' absorptive capacity can be split into potential or realized (Xia, 2013), depending on the outcome of the process. Determinants of potential capacity are given by the prior level of internal knowledge, which usually depends on the level of internal research and development investments (Ooms et al., 2015), and the share of skilled employees within the innovating firm (Xia, 2013).

In terms of strategies to manage the acquisition of external knowledge, Porter and Newman (2011) argue that there are five stages, which include: 1) literature review of existing knowledge, 2) research profiling, 3) technology mining, 4) structured knowledge discovery, and 5) literature-based discovery. Similarly, Lopez-Vega et al (2016) argue that search strategy depends on the combination of a search space and the definition of search heuristics, i.e. the modes how a firm should search.

Only two studies address the topic of outsourcing strategies: Andries and Thorwarth (2014), by using a sample of Flemish firms, study whether internal and outsourced R&D activities contribute differently to firm performance. They find that in-house and outsourced R&D activities have a similar effect on firm performance, irrespective of firm size. When it comes to basic research activities, however, the outsourcing produces positive effects for small-sized firms, whereas medium- and large-sized firms benefit more from internally-conducted basic research. In addition, Teirlinck and Spithoven (2013), using a sample of Belgian SMEs, find that medium-sized firms are the least involved in R&D outsourcing, whereas small firms tend to avoid collaboration in research.

2.4.2.1.3 Effects of openness on firm performance

The third group of studies focuses on the effects of Open Innovation on firm performance (Cruz-González, López-Sáez, Navas-López, & Delgado-Verde, 2015; Faems et al., 2010; Hung & Chou, 2013; Lichtenthaler, 2009), measured in terms of innovation performance (Andræs Barge-Gil, 2013; Berchicci, 2013; Chiang & Hung, 2010; Spithoven, Frantzen, & Clarysse, 2010) New Product Development (NPD) (S. Du et al., 2016; Roberts et al., 2016) and product innovation performance (Bianchi, Croce, Dell'Era, Di Benedetto, & Frattini, 2016).

There is a heterogeneity of views in this topic, since many authors propose positive relationships between openness and firm performance, while others argue there is a negative or non-linear relation between such variables. As an example, Lichtenthaler (2009), posits that outbound innovation has a positive effect on firm performance, and that the strength of the effect is positively moderated by environmental factors such as industry transaction rate and competitive intensity. However, other authors, such as Cruz-Gonzalez et al (2015), using a sample of Spanish medium and large firms, find that the breadth of search has a negative effect on firm performance. In addition, some authors, such as Hung and Chou (2013) only find partial support in the relationship between openness and performance. In their study of high-tech Taiwanese manufacturing firms, they find that external technology acquisition (ETA) has a positive and significant relation with firm performance, while the relationship between external technology exploitation (ETE) and performance is not significant. In addition, they find that the extent of internal R&D positively moderates the relationship between ETA and firm performance, that internal R&D and ETE have complementary relationships with firm performance and that technological turbulence positively moderates the relationship between ETA and performance, but not the one between ETE and performance.

The same is true for measurement choices: authors are yet to find a comprehensive measure to define firm performance. As an example, Spithoven, Frantzen and Clarysse (2010) measure innovation performance through the combination of three measures: 1) the level of knowledge externalities - both inter- and intra-organizational, 2) the extent of firm cooperation in research activities, again both inter- and intra-organizational, and 3) the degree of firm strategic protection, measured as appropriability. In contrast, Du et al (2016) propose NPD performance as the combination of self-reported measures regarding 1) new product achievement of required performance objectives and 2) perceived overall success of the

product. Bianchi et al (2016) – alternatively - categorize product innovation performance as the share of new products developed and commercialized by the firm in a given year.

2.4.2.2 Specified (Dyadic)

Works regarding dyadic transaction focus on various forms of relationship modes and the interactions between firms and different categories of counterparts. The following table summarizes the studies within the sample which address the major interaction modes and the actors involved (Table 8).

Table 8: Interaction categories and main contributions - selected sample

Interaction	Mode	Counterparts	Main contributions
Collaboration	Collaboration	Suppliers, competitors, customers, universities and consultants, private and public research institutes, designers	Ili et al (2010), Laursen and Salter (2014), Love et al (2014), Egbetokun (2015), Bengtsson et al (2015), Veer et al (2016), Manzini and Lazzarotti (2016), Miozzo et al (2016)
		Non-profit organizations	Holmes and Smart (2009)
		Intermediaries, research centers/units	Lichtenthaler (2013), Spithoven et al (2010), Gambardella and Panico (2014)
		Market partners, science partners	Mina et al (2014), Gesing et al (2015), De Zubielqui et al (2016)
		Universities and intermediaries	Guimon and Salazar-Elena (2015), Goduscheit and Knudsen (2015)
		Consultants, knowledge specialists/knowledge providers	Tether and Tajar (2008), Tranekjer and Knudsen (2012)
	Collaboration - competition	Market partners, science partners, intra-group and competitors	Mention (2011)
	Collaboration, licensing	Suppliers, customers, other firms/universities	Suh and Kim (2012), Aslesen and Freel (2012)
Partnership	Partnership	Suppliers	Dittrich et al (2007)
		Market partners, science partners	Du et al (2014)
		Other firms	Frishammar et al (2015)
		Suppliers, competitors, customers and universities	Segarra-Cipres et al (2012)
	Partnership, supply/purchase of scientific services, in/out licensing	Suppliers, customers, competitors, consultants, private R&D institutes, universities, government, public research	Bianchi et al (2011)
	Integration	Suppliers	Schiele (2010)
	Partnership, integration, acquisition	Customers, suppliers, competitors, commercial laboratories, research institutes, universities, and subsidiary companies	Sabidussi et al (2014)
Co-creation	Co-creation	Other firms, universities and government	Su et al (2015)
	Co-patenting	Other firms	Belderbos et al (2014)
Licensing	Licensing	Other firms	Lichtenthaler and Ernst (2007), Lichtenthaler and Ernst (2009), Bianchi et al (2011), Frishammar et al (2012), Wang and Li-Ying (2014), Hu et al (2015), Sikimic et al (2016)
	Patenting, licensing	Network	Caner et al (2014)

Authors address four main types of interactions, in increasing order of formalization: collaboration, partnership, co-creation and licensing.

A number of studies focus on dyadic collaboration with the firm and a number of counterparts, inside the firm value chain – e.g. suppliers and customers – competitive environment – e.g. competitors, and a number of external stakeholders, including universities, public and private research centers, consultants and designers (Bengtsson et al., 2015; Egbetokun, 2015; Ili et al., 2010; Laursen & Salter, 2014; Love, Roper, & Vahter, 2014; Manzini & Lazzarotti, 2016; Miozzo et al., 2016; Veer et al., 2016).

Here, again, we find no consensus on whether such relationships have a positive or negative effect for innovating firms: as an example, Bengtsson et al (2015) using a sample of manufacturing firms from Sweden, Finland and Italy, find that partner breadth has a negative effect on innovation performance, in terms of efficiency and novelty. Conversely, deep relationships with few selected partners have a positive effect. In contrast, Egbetokun posits (2015) that informal relationships with a variety of partners is likely to increase firms' innovativeness.

Additional works focus on specific subsets of counterparts for firm collaboration, including innovation intermediaries or research centers (Gambardella & Panico, 2014; Lichtenthaler, 2013; Spithoven et al., 2011), or with universities and intermediaries (Goduscheit & Knudsen, 2015; Guimón & Salazar-Elena, 2015), or with consultants and knowledge specialists (Tether & Tajar, 2008) or analyzing the collaborating behavior from the side of the knowledge providers (Tranekjer & Knudsen, 2012). Other studies propose comparisons between firm collaborating with market- and science-based partners (De Zubielqui et al., 2016; Gesing, Antons, Piening, Rese, & Salge, 2015; Mina et al., 2014). Finally, only Holmes and Smart (2009) study the relation between firm and non-profit organizations.

As with collaboration-focused contributions, works studying partnership interactions in the Open Innovation field are group among those which address partnership relations with suppliers (Dittrich & Duysters, 2007), market- and science-based partners (J. Du et al., 2014) and with other firms (Frishammar et al., 2015), and those which analyze alliances (Segarra-Ciprés, Bou-Llusar, & Roca-Puig, 2012), partner integration (Schiele, 2010) and acquisition (Sabidussi et al., 2014).

Only two works focus on co-creation (Su et al., 2015) and co-patenting (Belderbos et al., 2014), while a more consistent stream of literature focuses on knowledge exchange in the form of licensing (Bianchi, Chiaroni, et al., 2011; Frishammar et al., 2012; Hu et al., 2015; Lichtenthaler & Ernst, 2007, 2009; Sikimic, Chiesa, Frattini, & Scalera, 2016; Y. Wang & Li-Ying, 2014).

In sum, Open Innovation studies focusing on dyadic interactions address four main channels of exchange, from informal collaboration mechanisms, to partnership agreements, co-creation and formalized knowledge exchange through licensing agreements. Only a limited number of studies couple collaborative and competitive behavior (Mention, 2011), or analyze formal and informal transfer mechanisms (Aslesen & Freel, 2012; Suh & Kim, 2012).

2.4.2.3 Community

This group of studies address the interaction between firms and communities, i.e. firm networks and virtual communities. In addition, a number of studies concentrate on OSS companies and OSS communities.

2.4.2.3.1 Firm networks

A number of studies focus on physical networks created among firms, specifically considering collaborative network among firms (Snow et al., 2011) intermediated network models among SMEs (Lee, Park, Yoon, & Park, 2010; Vrgovic et al., 2012; Wincent, Anokhin, & Boter, 2009), and the Open Innovation arena (Ollila & Elmquist, 2011), a situation where the innovation intermediary of a network acts – at the same time – as a facilitator and as a key player within the network. In addition, Muller-Seitz (2012) proposes a network-level analysis of the practices adopted to increase absorptive and desorptive capacity through the study of an inter-organizational network in the semiconductor industry, SEMATECH.

Snow et al (2011) analyze IBM's Blade.org, a community dedicated to the development of IBM blade technology. Such collaborative model offers increase efficiency and effectiveness of member firms, and is increasingly used in situations where the potential of a new technology is yet unknown or when a specific technology is to become the industry standard.

SMEs typically are less active in searching for partners and collaborating in the commercialization phase (Lee et al., 2010). These difficulties are amplified in the context of emerging markets, since small and medium firms are usually faced with difficulties arising from the liability of smallness – i.e. lack of resources, lack of knowledge and lack of skilled employees – in addition to unstable legal and judicial framework and inadequate infrastructures (Vrgovic et al., 2012). In this view, a network model coordinated by an intermediary agency may boost innovation and openness (Lee et al., 2010; Vrgovic et al., 2012). In addition, Wincent et al (2009) posit that granting a network board continuity has a positive effect on the network innovation performance.

2.4.2.3.2 Virtual communities

In addition to physical communities, Open Innovation literature has addressed the interaction between firms and online/virtual communities (West & Lakhani, 2008). Scholars have mainly focused on the role played by certain groups, e.g. idea promotors (Fichter, 2009) and on the behavior of participants in online communities (Hutter et al., 2011; Kathan et al., 2015), and in the strategies adopted by firms to gain value from communities (Balka, Raasch, & Herstatt, 2014; Dahlander & Piezunka, 2014)

In the context of innovation communities in Germany, Fichter (2009) posits that the success of Open Innovation community projects depends on the ability of project promotors of operating across organizational boundaries, when competencies and resources are distributed among a number of partners.

Community participants adopt both cooperative and competitive behaviors (Hutter et al., 2011). Kathan et al (2015) argue that – according to the extent of cooperation – participants in online communities can be divided into three separate groups: I) free riders, II) initial givers, and III) reciprocal givers. They argue that reciprocal givers significantly submit higher quality ideas than the other groups.

Firms cooperating with online communities seem to experience issues when trying to capture value from them: in the context of Dell IdeaStorm platform, Dahlander and Piezunka (2014) argue that companies are not successful in eliciting ideas from contributors, even when they explicitly ask for them. Similarly, Balka et al (2014) argue that the best strategy for companies to capture value from distributed settings is to adopt a selective revealing strategy. However, the incomplete openness hinders the potential of value creation by external contributors.

2.4.2.3.3 Open source companies and open source communities

Open innovation literature on open source is linked to open source company strategies (West & Gallagher, 2006), specifically in dealing with tensions between proprietary software and the implementation of open source software models (Rolandsson et al., 2011), the presentation of open source case studies, such as the creation of an open source car project, OSCar (Mller-Seitz

& Reger, 2010; Müller-Seitz & Reger, 2009), and the implications of network and community participation (Hwang, Kim, & Kim, 2009; Stam, 2009)

In an early study, West and Gallagher (West & Gallagher, 2006) link the use of open source to the Open Innovation paradigm, and propose four patterns where open source companies can combine internal and external sources of innovation: performing pooled R&D, when creating spinouts, when selling complement products and services and when trying to motivate users to produce complements that are donated to the community. Rolandsson et al (2011) argue that opening up the software development process to open source community raises tensions between open and proprietary practices that are present inside the firm, since programmers have to manage a commercially-oriented logic, which is typical of proprietary, profit-oriented business contexts with community-oriented logic, which is typical of open source community contexts.

Participation in OSS communities brings many advantages, including increasing firm innovative and financial performance (Stam, 2009). In addition, Hwang et al (2009), by studying a sample of Korean OSS firms, demonstrate that network participation increases technology innovation, in terms of new products, significantly improved products or processes.

2.4.2.4 Summary

In short, we see a balanced distribution of current literature among the different contributions, with the largest group of articles addressing the effects of openness on a single corporation; specifically, on the effects on its performance. However, Open Innovation literature is yet to find consensus in defining the antecedents and the determinants of openness, as well as in sorting the effects on firm performance. In addition, as proposed by the framework, all studies focus on the implications of openness on the single firm, or analyze one-on-one transactions, or firm-community interactions, while intermediate forms between dyadic and community transactions are still not addressed. Thus, we find a consistent gap in literature in the proposal of studies of multilateral and unmediated knowledge and technology exchange between actors not operating in a network or in a community. As such, *"triadic"* relationships have been neglected by literature, and only partially touched upon by Goduscheit and Knudsen (2015), who address the relationship between SMEs, universities and the mediating role of research and technology offices (RTOs) to facilitate the transaction.

Moreover, while dyadic-based contributions have extensively addressed various relationship types and the counterparts involved in the transaction, extant literature – besides Guimon and Salazar-Elena (2015) has overlooked the geographical provenience of such counterparts, whether in-state or foreign, thus leaving enormous room for further studies to link the Open Innovation with international business literature.

Finally, while Open Innovation literature is increasingly devoting attention to the crowdsourcing phenomenon, it still appears far from integrating under its umbrella the use of crowdfunding, as an alternative way to finance innovative projects.

2.4.3 Unit of analysis

The third dimension considered for the analysis is the unit of the analysis of the selected studies. We sorted articles which propose studies at the individual, project or firm-level. Again, details about the distribution are reported in Table 9.

Table 9: Article distribution according to the unit of analysis

Unit of analysis	**Articles**	**Distribution**
Firm	144	85,21
Project	7	4,14
Individual	12	7,10
Unspecified	6	3,55
Total	*169*	*100,00*

The vast majority of contributions propose firm-level analysis (144 articles, 85%), while the remaining part is almost equally distributed among individual-level and project-level contributions –12 (7%), and 7 (4%) articles, respectively. 6 articles (almost 4%) could not be categorized in any of the groups proposed. In the next section, we propose the emerging trends for each of the abovementioned categories.

2.4.3.1 Individual level

Only a handful of studies in the sample address openness at the individual level. The authors analyze the behavior of various categories of individuals, including individual scientists (Salter et al., 2015) programmers (Rolandsson et al., 2011), users/customers (Chou, Yang, & Jhan,

2015; Füller et al., 2012), brand community members (Füller et al., 2008) and laggards (Jahanmir & Lages, 2015).

Organizations can exploit users' creativity, interest and motivation to contribute to innovation activities (Füller et al., 2012). Users such as brand members are used as a source of innovation by organizations since they typically are passionate about the company products and services (Füller et al., 2008). In contrast, an equally useful source of innovation is represented by late adopters or "laggard" users (Jahanmir & Lages, 2015). Such users – in contrast to loyal brand users - are not driven by enthusiasm towards a specific firm products or services, like brand community members, but rather decide to buy because they have to. This group of users represent a rather untapped source of innovation for companies in later stages of development.

Individuals provide benefit to their organizations: Salter et al (2015) study how individuals' access to external sources of knowledge impacts ideation performance, i.e. the ability to generate ideas that are selected and implemented by his/her firm. Access to external knowledge increase variety and alertness of individuals, and this - in turn - has a positive effect in generating valuable ideas for their firm.

2.4.3.2 Project level

Project-level contributions are mainly proposed in the context of virtual community platforms, and study a variety of initiatives, all based on crowd participation (Schemmann et al., 2016), such as open source projects (Mller-Seitz & Reger, 2010; Müller-Seitz & Reger, 2009; West & O'mahony, 2008), idea competitions (Ebner et al., 2009; Parjanen et al., 2012) and design competitions (Füller et al., 2011; Hutter et al., 2011; Kathan et al., 2015).

Idea competitions are *"[…] the invitation of a private or public organizer to a general public or a targeted group to submit contributions to a certain topic within a timeline. An idea-reviewers committee evaluates these contributions and selects the rewarded winner(s)"* (Ebner et al., 2009, p. 347). Ideas competitions are usually created to solve a corporation problem, with the participation of an unknown crowd of contributors (Schemmann et al., 2016). In idea competitions, information is shared among a social network of contributors proposing ideas to solve a common problem (Parjanen et al., 2012). Participants may be driven by intrinsic – e.g. sense of belonging or social utility - or extrinsic motivations – e.g. monetary compensations (Ebner et al., 2009). In a similar vein, design competitions are increasingly adopted by

companies – e.g. Swarovski – to get access to a dispersed community of creative users willing to contribute. These contests allow companies to reduce time spans and expenses, by partially externalizing new product development process, while at the same time increasing customer loyalty to the brand (Füller et al., 2011). In these contexts, users adopt both collaborative and competitive behavior, or a combination of the two, known as "communitition" behavior (Hutter et al., 2011).

2.4.3.3 Firm level

We use EU classification of firm dimension, thus considering small enterprises those employing between 10 and 49 employees, medium enterprises those employing between 50 and 249 employees, and large firm those employing more than 250 employees. We only listed the articles explicitly specifying the number of employees of single firms or sample studied. Details about article distribution according to firm size are reported in Table 10.

Table 10: Article distribution according to firm size

Firm size	**Articles**	**Distribution**
Large	22	15,83
Medium	1	0,72
Medium and large	10	7,19
Small	1	0,72
Small and medium	14	10,07
Small, medium and large	21	15,11
Unspecified	75	53,96
Total	*169*	*100,00*

Unfortunately, 75 articles – almost 54% - did not explicitly report the required indicators, therefore were listed in the *"unspecified"* category. For the remaining articles, the majority of them focus on the analysis of Open Innovation in large-sized firms (22 articles, almost 16%) or in medium and large firms (10 articles, almost 6%). Only 2 contributions study Open Innovation in the context of small (Wincent et al., 2009) and medium (Manzini & Lazzarotti, 2016) enterprises, while 14 articles (10%) study samples of the two groups combined. The remaining 21 contributions (15%) use samples which include small, medium and large-sized firms alike.

2.4.3.3.1 Small and medium

The study of the adoption of Open Innovation practices in small and medium-sized firms is more recent, with van de Vrande et al (van de Vrande et al., 2009) being the first and most known contribution. Subsequent studies address the adoption of Open Innovation by firms in developing countries (Vrgovic et al., 2012), the strategies adopted by SMEs to manage Open Innovation (Lee et al., 2010), the interaction among SMEs in network models (Pullen, De Weerd-Nederhof, Groen, & Fisscher, 2012), between SMEs and universities (Goduscheit & Knudsen, 2015), the effects of knowledge management practices (Valentim et al., 2016) and external knowledge inflows in developing firm absorptive capacity, innovation and performance (De Zubielqui et al., 2016).

2.4.3.3.2 Large

As mentioned in the introduction section, most early studies focus on the implementation of Open Innovation practices in the context of large firm companies. These contributions are divided into single case studies of American and European multinationals - such as Procter & Gamble (Dodgson et al., 2006), Cisco (Aylen, 2010), Adidas (Piller & Walcher, 2006), Nokia (Dittrich & Duysters, 2007), Deutsche Telekom (Rohrbeck et al., 2009), Italcementi (Chiaroni et al., 2011), Volvo (Remneland-Wikhamn & Knights, 2012), and Renault (Hooge & Le Du, 2016) – multiple case studies, such as Aylen's (2010) *"historic"* study on the adoption of a closed versus Open Innovation approach in the steel manufacturing industry in the 1920s, analyzing the case of Armco and Columbia Steel, Chiaroni et al (2003) study on four Italian firms in the cement, concrete, steel pipes and automotive breaks sector, Schiele's (2010) contribution of early supplier integration of six firms operating in a consortium, and Chesbrough and Crowther's (H. Chesbrough & Crowther, 2006) study on the implementation of Open Innovation in non-high-tech contexts.

Finally, samples of large-sized companies have more recently been used for quantitative analysis (J. Du et al., 2014; Grote et al., 2012; Hu et al., 2015).

2.4.3.4 Summary

Literature is mostly unbalanced towards firm-level analysis, whereas different levels have only been investigated by a limited number of studies. For a complete framework of Open Innovation, various levels of analysis should be taken into account: from individuals, to industrial networks, and even to state-wide policies for Open Innovation. Additionally, in the vast majority of cases, the perspective adopted in the proposed studies is that of the innovating firm, while the point of view of single contributors (Füller et al., 2008, 2012; Salter et al., 2015), or that of organizations involved as a counterpart in the transaction has seldom been adopted.

2.5 Discussion and introduction to the following chapters

2.5.1 Discussion

Based on the analysis of 169 works on Open Innovation, we find that the majority of works concentrate on the analysis in European countries, and – to a lower extent – in American and Asian countries, while other geographical areas and cross-regional studies are largely neglected by previous literature. In addition, current literature shows a predominance of studies addressing inbound- and coupled-based transactions, with a focus on single firms - particularly on the effects of openness on firm performance, and on the implementation of Open Innovation practices at firm level, while non-firm-centric perspectives have been so far overlooked by scholars.

In terms of the direction of innovation, inbound practices have been analyzed over all the phases of the integration process, while outbound strategies have only been addressed by a handful of studies (Bianchi, Chiaroni, et al., 2011; Lichtenthaler, 2011a). Additionally, in terms of coupled Open Innovation, literature has devoted much attention to collaboration, partnership and licensing, while joint ventures, as proposed by Enkel et al (Enkel et al., 2009) has been overlooked by scholars.

A large number of studies, following the study of Laursen and Salter (2006) analyze the effects of openness on firm performance. However, there is still no consensus about the causality effects between the two groups. In addition, we found no contribution – other than Goduscheit and Knudsen (2015) – addressing multilateral transactions between three or more

actors not involved in a network or a community. In such, we believe literature should look at "triadic" transaction as a potential topic for further analysis.

Similarly, while extant contributions have extensively addressed various relationship types and the counterparts involved in the transaction, Open Innovation literature has overlooked the geographical provenience of such counterparts. With the exception Guimon and Salazar-Elena (2015), who analyzed university-business collaboration between foreign subsidiaries of multinationals and local Spanish universities, literature has so far neglected the location of counterparts involved in a transaction - whether in-state or foreign – as a factor affecting the level of openness. This leaves enormous room for further studies to link the Open Innovation with international business literature.

Moreover, while Open Innovation literature is increasingly devoting attention to the crowdsourcing phenomenon, it still appears far from integrating under its umbrella the use of crowdfunding, as an alternative way to finance innovative projects.

Finally, we see that Open Innovation literature is mostly focused on firm-level analysis, whereas only a handful of articles address the topic from at different levels, including individual level (Füller et al., 2008, 2012; Jahanmir & Lages, 2015; Salter et al., 2015) and project level (Ebner et al., 2009; Füller et al., 2011; Hutter et al., 2011; Kathan et al., 2015). In a similar vein, literature is mainly firm-centric, whereas the point of view of different stakeholders – i.e. knowledge providers (Tranekjer & Knudsen, 2012) or firm counterparts, in general - is largely neglected.

This study contributes to the extant literature of Open Innovation by implementing the dimensions according to which Open Innovation literature is systematized, introducing complementary dimensions which were not considered by previous review contributions, specifically the number of counterparts involved – a single entity, two entities or a community, and by sorting out the different levels of analysis the literature proposed up until now. However, the review was limited to the ten best-ranked journals according to the ABS 2015 Ranking in the field of innovation, thus may not include important contributions published in general management journals which are active in the Open Innovation field, i.e. MIT Sloan Management Review, Harvard Business Review, California Management Review, and others.

This work proposes the main research gaps, which are to be addressed in the following chapters of this thesis proposal: 1) to what extent are Open Innovation practices implemented

in a non-corporate environment? 2) how are openness and time-to-market choices related to firm performance? and 3) what are the effects of externally-acquired versus internally-generated intangible assets on firm's performance?

2.5.2 Introduction to the following chapters

The article in chapter 3 aims at exploring the adoption of Open Innovation practices in a non-corporate environment at the individual level, specifically in the context of an American university laboratory. The contribution is needed since the majority of Open Innovation contributions published in the last decade adopted a firm-centric perspective, and analyzed interactions at the firm level, thus leaving room for studies about the adoption of Open Innovation practices in non-corporate environments, and at different levels of analysis. Results show that despite the lab's active orientation towards commercialization and collaboration with industrial counterparts, the degree of implementation of Open Innovation practices is still limited, the main determinant for Technology Transfer (TT) remains publication, and that online communities represent a potential mechanism to overcome the current gap in promoting lab research. The study contributes to the existing Open Innovation literature by assessing the perceived quality of Open Innovation practices at the individual level, and in a non-corporate context. For literature, this study is the first attempt to investigate the adoption of Open Innovation practices in a university laboratory. For university managers, the study proposes that while active commercialization efforts through Open Innovation practices are still limited, channels like online communities offer valuable – and yet untapped – resources for promotion of university activities.

The article in chapter 4 explores the relationship between entry timing strategies, the level of inbound openness of firms and their performance, through an empirical analysis of 100 Italian-based manufacturing and service firms, for years 2014 to 2016. Market-entry timing has been extensively studied by management scholars. However, up to now, there is still no general consensus upon which strategic approaches company may adopt, since scholars argue that entry timing strategies are influenced by contingent factors. In this view, we argue that the level of inbound openness acts as a moderator to the relationship between firms' entry timing strategy and the resulting performance. Despite potential consensus, however, the relationship between firms' openness and entry-timing has mainly been overlooked by extant literature, leaving room for empirical testing of such relationship. Results show the that strategic choices regarding

when to enter in a market do not generate consistent results in terms of market growth, if taken separately. However, they show the existence of a positive direct effect of inbound openness on firm's turnover growth, and a negative and significant interaction effect between the lean mover approach and the extent of openness. This relationship posits that firms should choose between a lean entry approach, based on time management and progressive improvement of firms' products or services based on customers' feedbacks, and the choice of integrating external assets, since they require consistent time and resources to integrate and thus delay entry timing.

The article in chapter 5 addresses the relationship between the adoption of inbound Open Innovation practices and firm performance. We investigate this question since a number of studies in Open Innovation literature has already focused on such relationship. However, we argue extant literature suffers from two main limitations: at first, there is still no homogeneity in the proposition of what "firm performance" is, according to extant literature. In addition, we see a heterogeneity of implications for the relationship between openness and performance, since there is still no consensus among authors on whether the relationship between openness and firm performance has a positive, negative or non-linear relationship. We address this relationship through an empirical analysis of a cross-national unbalanced panel data of European firms listed in the five major European markets in the years 2008-2013. We seek to sort the impact of the level of openness, derived by the amount invested in internal development versus the external acquisition of intangible assets and the identification of which types of intangible assets – among patents, trademarks, concessions, etc. – on firm performance, measured as the amount of firm turnover. Findings show that the effects of both internal development and external acquisition are positive and significant across different dimensions, but their output varies in terms in magnitude and distribution: in our preferred specification in column (3), we see that both variables are positively and significantly correlated with firm turnover, and that their effect on the latter is almost equal. In addition, we find that only internal development is positively and significantly correlated with the other two dimensions of performance, once we control for firm-specific time trends. Once we control for relative size of firms in the sample, we see that the effect of openness is more spread out across different class sizes, while the effect of internal development of intangibles influences the economic performance only for larger firms, and increases employment only for relatively smaller firms, while it has no effect on the financial side of performance.

3. Paper 1: *"Open"* lab? Studying the implementation of Open Innovation practices in a university laboratory

3.1 Introduction

Innovation has been extensively studied in management literature, particularly in the last decade. Yet, since the introduction of the term "Open Innovation", scholars have mostly devoted their attention towards Research & Development and knowledge generation dynamics occurring inside multinationals or very large firms (Svensson et al., 2010). Innovation can arise in every context, particularly in knowledge intensive environments like research centers. In this view, university laboratories represent an ideal environment for innovation. However - despite a handful of contributions (Miller, Mcadam, Moffett, Alexander, & Puthusserry, 2016; Ramos, Cardoso, Carvalho, & Graça, 2009) - Open Innovation and Technology Transfer are still considered as separate literature streams, as the former limits the role of universities as a potential source of externally-generated innovation, while the latter does not consider the potential of Open Innovation practices to favor commercialization of university inventions and provide benefits to academic research. Indeed, Technology Transfer literature has mainly deployed around principles of innovation as internal R&D and subsequent externalization of technologies through licensing. The aim of the paper is to explore the adoption of Open Innovation practices in a non-corporate environment, specifically in the context of university laboratories. The interaction between firms and academia has received little attention in the Open Innovation literature. In addition, extant contributions have so far looked at the phenomenon from the corporate perspective, thus failing to address the implications of openness from the researchers' perspective. This paper seeks to address the following research question: *to what extent do university laboratories implement open innovation practices?*

To do so, we developed a single case study through semi-structured interviews with researchers of a biomedical engineering laboratory of an American university.

We argue the topic is relevant for both researchers and practitioners, since – for scholars – it represents a first attempt in creating a connection between separate streams of technology transfer and open innovation. In addition, we argue that our study provides a contribution for professionals in the technology transfer field by offering insight on yet untapped channels for commercializing university research. Indeed, increasing the degree of openness of universities creates incentives for both academics and partnering firms (Wood, 2011). For universities and researchers, commercialization creates multiple benefits, since it provides a contribution to

business, it generates income through sales or royalty payments, it increases the university recognition, it secures financial support for research and helps disseminating knowledge (Decter, Bennett, & Leseure, 2007; J. Kim & Daim, 2013). For firms, engaging in collaboration with universities guarantees access to excellent sources of entrepreneurial ideas and (potentially) unique available intellectual property, and may generate additional financial returns (Wood, 2011).

In addition, we complement extant literature on Open Innovation by adding a contribution at the individual level of analysis. This echoes the need outlined by various scholars (including Salter et al., 2015; West & Bogers, 2017) of exploring the phenomenon at multiple levels, thus overcoming the firm-centric approach of early Open Innovation studies.

Section two contains a theoretical review of the literature framework addressing this study, Open Innovation. Section three introduces the case study. Section four presents the research design. Section five presents the main findings. Section six discusses the conclusions, the main limitations and some insights for future studies in the field.

3.2 Research framework

3.2.1 Open Innovation

The concept of Open Innovation is recent, since first studies assessing the phenomenon were only introduced in 2003 (Henry W. Chesbrough, 2003; Svensson et al., 2010). In the original formulation, Open Innovation was presented in opposition to Closed Innovation model (Almirall & Casadesus-Masanell, 2010; Felin & Zenger, 2014), which represented the standard research and development (R&D) management practice throughout the 20th century. Closed innovation model stressed the importance of control over key resources and internal organization of activities in order to secure competitive advantage against competitors. Closed companies are required to be efficient and self-reliant. In contrast, Open Innovation adopters put little emphasis on control, and perform limited or no research on their own (Verlag, 2013), leveraging instead on external as well as internal sources of innovation, and exploiting internal and external paths to market as well as external channels for commercialization of internal research (Bianchi et al., 2014; Ili et al., 2010; Svensson et al., 2010). Despite the two models were presented as alternatives in early studies (Svensson et al., 2010; Verlag, 2013), practice shows that closed and Open Innovation lie on a continuum (H. Chesbrough & Crowther, 2006;

Huizingh, 2011; Lichtenthaler, 2013), embracing different combinations based on the context in which companies operate.

At its core, the concept of Open Innovation redefines the boundaries of the firm in the innovation process, which become porous (H. Chesbrough & Crowther, 2006; Henry W. Chesbrough, 2003), allowing flows of ideas between the innovative firm and a variety of actors in the external environment, which may include organizations within the firm's supply chain, such as customers (Piller & Walcher, 2006), suppliers (Perols, Zimmermann, & Kortmann, 2013; Svensson et al., 2010) and competing firms (West & Gallagher, 2006), as well as specialist knowledge providers, such as research centers, universities, and consultancy agencies (Tether & Tajar, 2008).

Open Innovation process follows three directions: "*outside-in*" (inbound), "*inside-out*" (outbound) and "*coupled*" (Enkel et al., 2009). The inbound process aims at enriching the company knowledge capital by internalizing externally developed technologies. In this view, companies search for valuable sources of knowledge in their environment, leveraging on potential sources of ideas arising from other players, like: suppliers, customers, competitors, research centers, universities. Outbound innovation represents a way companies use to earn profits by transferring internally developed ideas to the market through a variety of mechanisms, such as licensing agreements, partnerships, and sale of intellectual property. Finally, the coupled process includes all the situations where two - or more - partners engage in collaboration, partnership, joint ventures or co-creation agreements, matching outside-in and inside-out activities of the partnering companies.

Innovative companies should find a balance between the exploration of new opportunities and exploitation of existing ones. To do so, they should effectively allocate R&D resources between internal and external activities (Bercovitz & Feldman, 2007).

In the inbound context, firms may leverage from abundancy of external knowledge to be acquired and converted into profitable business opportunities. Inbound Open Innovation provides multiple advantages to innovative firms, including: cost reduction in product development, faster time-to-market, product quality improvement, access to expertise outside the organization, i.e. customers and suppliers knowledge (Wallin & Von Krogh, 2010). However, external knowledge does not flow directly to innovative firms. Companies need to be able to identify knowledge sources, and build mechanisms to absorb and integrate external knowledge into internal activities. Thus, firms need to rely on their absorptive capacity to gain value from external knowledge (Spithoven et al., 2011). Absorptive capacity represents *''the ability of a firm to recognise the value of new, external information, assimilate it, and apply it*

to commercial ends" (W. M. Cohen & Levinthal, 1990). The concept of absorptive capacity has been widely adopted in Open Innovation literature, as a consistent number of Open Innovation studies, most of them related to inbound Open Innovation, cite it (including Aslesen & Freel, 2012; Harison & Koski, 2010; Hooge & Le Du, 2016; Remneland-Wikhamn & Wikhamn, 2011; Von Hippel & Von Krogh, 2006; Wikhamn, 2013).

When managing distributed innovation, companies face three main challenges: identifying the appropriate source of external innovation, securing a continuous supply flow, and adopt coherent strategies to extract value from distributed innovation (Bogers & West, 2012). To generate positive outcomes from the open approach, firms must successfully manage all the three inbound phases: knowledge acquisition, accumulation and exploitation (Lichtenthaler & Ernst, 2006).

Early contributions mainly focused on the process of inbound Open Innovation (Vrande, Vanhaverbeke, & Gassmann, 2010) organized inside multinational companies (van de Vrande et al., 2009). However, the spectrum of Open Innovation comprises also the process of commercialization of in-house innovation through external channels, i.e. outbound Open Innovation, as well as formal and informal relationships with different stakeholders, which represent various forms of coupled open innovation practices.

To exploit outbound possibilities, firms may adopt five strategic approaches (Henry W. Chesbrough & Garman, 2012): companies may decide to spin-off separate entities to develop previously internal projects, and become customer or supplier of their own spinoffs. Alternatively, companies may decide to create separate spin-offs for the development of non-strategic projects, and selling their equity – all or in part - to external investors. Additional moves include the exploitation of unused proprietary IP assets through out-licensing, the investment in the development of a company innovative ecosystem, or the creation of open domains on proprietary IP, in order to attract participation of developers and enlarging the community around firm projects.

Firms' ability in outward Technology Transfer relies on the potential volume of the firm's technology portfolio. The potential level is given by the firm's desorptive capacity (Lichtenthaler & Lichtenthaler, 2010) or multiplicative capacity (Hughes & Wareham, 2010). Desorptive capacity is – ideally - the opposite of a firm's absorptive capacity, and it represents the ability of the firm to successfully identify among internal sources of knowledge that are apt to potential external commercialization and the ability to transfer such knowledge to external actors.

So far, the majority of Open Innovation studies focus on the firm level of analysis, even though some contributions analyze the phenomenon at the industry-level (Bianchi, Cavaliere, et al., 2011; Christensen, Olesen, & Kjær, 2005; Michelino et al., 2015) or at regional level (Cooke, 2005; Porto Gómez, Otegi Olaso, & Zabala-Iturriagagoitia, 2016b), whereas Open Innovation studies at the individual level are - to our knowledge – still largely missing.

In the last years, the concept of Open Innovation has been applied in not-for-profit oriented contests, as in the case of open source communities (Fleming & Waguespack, 2007; Müller-Seitz & Reger, 2009). University laboratories represent an ideal environment for Open Innovation. In this context, Open Innovation *"can be particularly useful in moving technology off the shelf, where the potential user community is small, fragmented or not well connected to university research sources"* (Hall, Matos, Bachor, & Downey, 2014, p.27). However - despite some contributions – the interaction between firms and academia has received little attention in Open Innovation literature. In the next paragraph, we briefly revise the works which addressed university-business Technology Transfer through the lens of Open Innovation.

3.2.2 "Open" Tech Transfer

In parallel to Open Innovation's firm-centric perspective, a separate literature stream tried to apply the concept in non-profit oriented contests, mainly thanks to the emergence of online communities (Chou et al., 2015) designed to serve various applications – such as open source (West & Lakhani, 2008), crowdsourcing (Ye et al., 2012) and crowdfunding (Belleflamme et al., 2014) communities. Universities have received some attention in this sense, particularly when considered as sources of knowledge for innovating firms (Brunswicker & Vanhaverbeke, 2015; Love et al., 2011) or operating as innovation intermediaries (Katzy, Turgut, Holzmann, & Sailer, 2013; Lichtenthaler, 2013). Moreover, some authors focused on university-business collaboration (Asakawa, Nakamura, & Sawada, 2010; Bodas Freitas, Geuna, & Rossi, 2013; Ramos et al., 2009), technology and knowledge transactions (Bianchi et al., 2010; Hall et al., 2014; Lichtenthaler, 2008d; Miller et al., 2016), and the role played by absorptive and desorptive capacity in such contexts (Lichtenthaler & Lichtenthaler, 2010; Spithoven et al., 2011).

In the context of Open Innovation adoption in SMEs, Brunswicker and Vanhaverbeke (2015) argue that universities represent a relevant source of knowledge, since they are repositories of knowledge, whose evolution can alter the search for inventions. In an empirical

study on openness, knowledge and innovation in the UK service sector, Love et al (Love et al., 2011) found that firms' exploratory links with universities have a positive – although non-significant - effect on firm's innovativeness – expressed as the share of sales from innovative products.

Collaborative interactions between firms and universities provide positive results. For example, Asakawa et al (2010) – in a study on the performance of R&D laboratories in Japan – found that Open Innovation policies enhance the extent of collaborations between R&D laboratories and universities, which in turn positively influence – although not extensively - R&D laboratories' performance. Freitas et al (Bodas Freitas et al., 2013), in an empirical study on governance mode of university-industry links in Piedmont, Italy, demonstrated that while most Technology Transfer literature addresses the mediated knowledge transfer - i.e. through Technology Transfer Offices (TTOs), university-industry collaboration also occurs through personal arrangements between individual academics and industrial counterparts. In addition, they found that large firms engage in more institutional – mediated -contractual agreements, while more open companies tend to focus on personal agreements with single researchers. Ramos et al (2009), in their work on collaborative research projects in Portugal, identified two major drivers favor the adoption of Open Innovation systems in university-industry collaborative projects. Most SMEs cannot afford the costs of traditional brokering services. At the same time, as most universities are public (especially in Europe), there is a general consensus that the outcome of publicly funded research should create benefits to largest contributors, namely individuals and firms.

Universities can complement or substitute some corporate R&D functions. In a study on knowledge transactions, Bianchi et al (2010) found that while large firms tend to be self-sufficient, small and medium size firms rely on the involvement of university researchers to reduce uncertainty around viable applications of negotiated technologies.

Miller et al (Miller et al., 2016) developed a framework to study the mechanisms of knowledge transfer (KT) under absorptive capacity perspective in Open Innovation contexts, following a quadruple helix ecosystem. The framework comprises interactions among universities, industries, local government and end users. According to their framework, five factors influence the effectiveness of knowledge transfer: human centric factors; organizational factors (presence of dedicated knowledge transfer offices); knowledge characteristics; power relationships and network characteristics.

Other studies (Hall et al., 2014; Lichtenthaler, 2008d) briefly address the perception of universities towards Open Innovation practices and the potential outcomes of their adoption.

For example, Lichtenthaler (2008d) argues that universities are organizations which have a rather closed approach towards technology acquisition, while they are rather open in technology exploitation. In addition, Hall et al (2014) argue that Open Innovation may enhance the performance of universities' technology commercialization. However, such potential is currently limited by the focus of the TTO in implementing standard IP management contracts.

In sum, we argue that the framework of Open Innovation overcomes current limitations of extant frameworks that analyze university – industry transactions, since it covers all formal transactions addressed by Technology Transfer literature (Bozeman, 2000; Hudson, Henry, & Cornwell, 2011; Siegel et al., 2007), as well as informal interactions addressed by university – industry collaboration (Bercovitz & Feldman, 2007; Burnside & Witkin, 2008; D'Este & Patel, 2007). However, to our knowledge, Open Innovation literature has so far addressed the dyadic interaction between firms and academia only from the corporate perspective, whereas the point of view of university researchers has not been studied. Open Innovation literature has so far neglected the case of university laboratories as the locus of Open Innovation, while limiting their role to external providers of knowledge and technology to innovative firms, or as part of transaction-based analysis. To address this gap, we propose a case study analysis to explore the adoption of Open Innovation practices in a university-based context, according to the three dimensions of Open Innovation – inbound, outbound and coupled. Specifically, we include both informal practices of "university – industry" collaboration (Burnside & Witkin, 2008), as well as formalized "technology transfer" practices (Decter et al., 2007) which – combined – provide the entire spectrum of coupled Open Innovation practices. In addition to dyadic interactions, we consider community-based Open Innovation practices, which comprise "one-to-many" relationships between an innovative entity and communities of unrelated stakeholders. In particular, we address the existence of relationships between university researchers and online crowd-based communities.

The focus of the study are researchers operating in a biomedical research lab (from here, the Lab) of an American university in the Boston, Massachusetts area. The case is presented in the following paragraph. Due to confidentiality agreements, respondents and institutions name have not been disclosed.

3.3 Case study description

The Lab was established in 2006, after the arrival of the Principal Investigator (PI) to the school of engineering at the hosting institution. The Lab was created with the aim of conjugating the study of technological applications and biological materials, combining optical and photonic research with biomedical applications. In just a decade, the lab acquired a prominent role in research, with over 150 publications in top journals in the field (i.e. *Nature, Science, Advanced Materials, Biomaterials, Advanced Functional Materials*, *Journal of Materials Chemistry, etc.*).

The case was selected since the Lab shows prominent results in research and entrepreneurial activities, as presented in the next paragraph. Moreover, the choice was favored by environment-specific factors – such as the presence of a consolidated legal framework which stimulates academic entrepreneurship and transfer of university-based technologies (Jelinek & Markham, 2007; Mowery, Nelson, Sampat, & Ziedonis, 2001; Sampat, 2006; Swamidass & Vulasa, 2009), as well as the location in perhaps the largest biotech cluster in the world - the greater Boston area (Acworth, 2008; Breznitz, O'Shea, & Allen, 2008; Swamidass, 2013).

At the time of the study, the Lab involved 13 people, plus 2 visiting students. Coherently with the cross-functional nature of the lab, researchers have various field of expertise, such as: biomaterial functional architectures, inkjet printing, bio photonics, coated implants, nano- and opto- technologies, structural interfaces and technology, protein nano-devices and sensors.

3.4 Research design

Due to the exploratory nature of our research, we chose a single case study methodology (Mariotto, Zanni, & Moraes, 2014; Murale & Preetha, 2014). The research, conducted between May and June 2016, was carried out in the form of personal interviews with the PI, the University Technology Transfer deputy for the School of Engineering – in charge of managing the Lab technology portfolio – and the 13 researchers present in the lab at the time of the investigation. Each interview lasted between 30 - 60 minutes. Respondents' profile is presented in **Errore. L'origine riferimento non è stata trovata.**. Each of the interviewees was presented a semi-structured questionnaire, which was used as the base for the interview. The survey included questions on the following topics: (i) general respondents' information and ongoing research projects, (ii) Technology Transfer and university-industry collaboration, and (iii) Community-based Open Innovation practices. To ensure reliability of the findings, we

triangulated interviews' findings with the analysis of archival data provided by the TTO, as well as publicly available data.

Table 11: Respondents' profile

Respondent	Academic position	Years in the lab
1	Undergraduate	2
2	Graduate Student	4
3	Graduate Student	2
4	Graduate Student	4
5	Post Doc	0
6	Graduate Student	2
7	Undergraduate	0
8	Post Doc	1
9	Post Doc	0
10	Graduate Student	1
11	Graduate Student	2
12	Graduate Student	0
13	Graduate Student	3
14	Principal Investigator	10
15	Technology Transfer Officer	10

In the first section, interviewees were asked general information about their project, including: the number of current projects, whether they were individual or group-based, how many people worked on them, the status, the idea source and the purpose of the projects, and the potential for commercialization. Moreover, for "commercially viable" projects, we asked which were the potential sectors of application, the main benefits of the projects compared with current technologies available and the main issues related to commercialization. In the second section, we asked researchers to evaluate the importance of Technology Transfer and university – industry collaboration, and their involvement in any of these activities. Finally, in the last section, we asked interviewees about their propensity towards online community-based platforms – both open source of crowd-based. We complemented the section by asking interviewees about their previous involvement in any of these practices and the potential for implementation into the lab's activities.

Each section included questions that required open (descriptive) answers, as well as closed answers in the form of binomial (dummy) or Likert-scale measures. Open questions included descriptions of ongoing projects and assessment of potential industrial applications, i.e. the expected sector of application, the main challenges to industrialization and expected benefits compared to current technologies on the market. Moreover, we asked researchers the perceived importance of Technology Transfer, university-industry collaboration and community-based platforms.

Closed questions comprised researchers' perception of the abovementioned factors and their participation in those activities. To evaluate the first, we used a 1-5 scale, with 1 being the minimum value (*not important*) and 5 being the maximum value (*extremely important*). For participation, we used dummy variables 0-1, with 1 indicating *participation* and 0 indicating *non-participation*. The main findings are reported in the following section. Survey questions are adapted from the works of Decter et al (Decter et al., 2007)**,** who studied university-industry transactions in the UK and US market, and of Chesbrough and Brunswicker (2015) who studied the implementation of Open Innovation practices in large US- and European-based companies. The use of Likert-scale measures is widely adopted in Open Innovation literature (Bengtsson et al., 2015; Grote et al., 2012; Henkel et al., 2014; Hung & Chou, 2013; Laursen & Salter, 2006), hence ensuring reliability for our study. A list of the questions and their operationalization is presented in Table 12.

Table 12: Survey questions

Dimension	Relationship type	Question type	Question category	Question
Outbound	Analysis of archival data retrieved from the lab's Principal Investigator and Technology Transfer Officer			
Inbound		Open	Descriptive	1. Can you briefly describe the projects you are currently working on?
		Open	Descriptive	2. How many people are working on the same project besides you?
		Open	Descriptive	3. How long have you been working on the project?
		Closed	Categorical	4. What is the current status of the project?
		Closed	Categorical	5. What is the intended purpose of the project?
		Closed	Binomial	6. Do you think the project has the potential for commercial application?
		Open	Descriptive	6.1. What are the potential sectors of application?
		Open	Descriptive	6.2. What are the potential challenges/obstacles to commercialization?
		Open	Descriptive	7. Who was the source for the project?
Coupled	Dyadic	Closed	Scale	8. What is the importance of the following factors in determining the role played by the University?
		Closed	Scale	9. How important are the following factors in determining the propensity of the University to collaborate with industrial partners?
		Closed	Binomial	10. Have you ever been involved in any of these activities?
		Closed	Scale	11. How important are the following channels for technology transfer and university - industry collaboration?
		Open	Descriptive	12. What is your opinion on technology transfer and university - industry collaboration?
		Open	Descriptive	12.1. Which are the main advantages and disadvantages?
	Community	Closed	Scale	13. What is the importance of the following open innovation communities?
		Closed	Binomial	14. Have you ever been involved in any of these communities?
		Open	Descriptive	15. What is your opinion on open innovation communities?
		Open	Descriptive	15.1 Which are the main advantages and disadvantages?

Following Schilling (2006) we performed a content analysis to assess the results of the interviews. Specifically, we took extensive field notes during the interview process, reporting responses in the form of raw data on separate digital documents for each respondent. We then grouped all the responses in a single file by coding the questions as presented in Table 12. We then used paraphrasing technique to reduce all the answers to summary sentences. Finally, we reduced and grouped summary sentences to generalize findings. Results of the study are presented in the following section.

3.5 Findings

We grouped findings in accordance to the three dimensions of the Open Innovation framework, namely inbound practices, outbound, and coupled practices (Enkel et al., 2009). They are presented in the following sections.

3.5.1 Outbound and inbound practices

To address the extent of outbound Open Innovation practices, we analyzed archival data provided by the TTO, and we complemented the study with early interviews with the deputy Technology Transfer Officer and the lab's Principal Investigator to ensure internal validity of the survey. To assess the extent of inbound activities, we sorted information about researchers' ongoing projects, their status and commercial potential, and whether the idea source for the project was internal or external to the lab.

3.5.1.1 Outbound

Analysis of archival data shows that despite the prominent role played in the research field, the lab has pursued - since its establishment - a commercialization-oriented strategy, with a constant growth in the number of disclosures and patent applications over the years, and the creation of two corporate spinoffs – established in 2012 and 2015 - with the aim of commercially exploiting directly lab technology base. At the time of the investigation, the Lab product portfolio included 106 projects that have been disclosed to the TTO. Of these, 93 resulted in at least a patent application, while the remaining 13 were still in the disclosure phase. A textual analysis of patents' abstract helped the categorization of the projects according to various dimensions, as reported in Table 13.

Table 13: Lab's project pipeline - Textual analysis

Product type	Number
Manufacturing process	65
Structure/Coating	6
Device encapsulation	4
Agent delivery	20
Therapeutics	13
Printing	5
Total	*113*
Project categorization include multiple selections, therefore the total number exceeds the number of ongoing projects	

Coherently with the Lab specialization on cross-functional applications, the majority of Lab patents protect manufacturing processes. Agent delivery and therapeutic devices follow the biomedical orientation of the lab, while structure and printing products embrace the general spectrum of industrial applications. On aggregate, those 93 projects generated 342 patent applications in various regions, with an average value of almost 3.7 applications per project. These applications resulted in 61 patents guaranteed at the time of the study. Regional distribution of patents and patent applications is listed in Table 14.

Table 14: Lab's patent application and patent portfolio - Geographical distribution

	N. of Patent Applications	% Distribution	% of applications over projects	N. of Patents Granted	% Distribution	% Conversion Rate (Patents Granted / Pat. App.)
United States	93	27,19	100,00	28	45,90	30,11
Canada	28	8,19	30,11	6	9,84	21,43
Mexico	8	2,34	8,60	2	3,28	25,00
Brazil	9	2,63	9,68	0	0,00	0,00
European Union	46	13,45	49,46	8	13,11	17,39
Israel	3	0,88	3,23	2	3,28	66,67
India	7	2,05	7,53	0	0,00	0,00
China	13	3,80	13,98	3	4,92	23,08
Hong Kong	7	2,05	7,53	0	0,00	0,00
Japan	27	7,89	29,03	10	16,39	37,04
Korea	7	2,05	7,53	1	1,64	14,29
Australia	12	3,51	12,90	1	1,64	8,33
Worldwide	82	23,98	88,17	0	0,00	0,00
Total	342	100,00	100,00	61	100,00	17,84
"Worldwide" category includes all patent applications at the global level						

The TTO applied for patent protection in the domestic market for all the discoveries, with 93 applications in the US, which represent 27% of total applications. The result is consistent with the work of Fisch et al (2015), who demonstrated that universities tend to file more patents domestically.

Whenever a discovery shows commercial potential, the TTO seeks to secure local protection as a first step. The Lab had a portfolio of 61 patents, with a conversion rate – the ratio between the number of patents and the number of applications - of 18%. Lab Portfolio projects usually receive patents after 6 years (2318 days) – on average, with 4 years' minimum (1448 days) and 11 years' maximum (3938 days). The Technology Transfer Officer reported the adoption of a "*stretching*" policy adopted by the TTO. This measure aims at expanding the frame of patent filing, in order to minimize costs. This approach leaves more time to the TTO in order to search for industrial counterparts and amortizes patenting costs. However, this result in a longer patenting time frame.

3.5.1.2 Inbound

On aggregate, the 13 researchers reported 27 projects at the time of investigation. 21 of them are group-based, while only 6 were individual projects. We asked researchers to list the current phase of their project, according to the following categories: *research phase, design phase, prototyping* and *small-scale production phase*. Researchers indicated that the majority of projects – 16 - are still in the research phase. Five projects are currently in the design/optimization phase, while 6 have completed either prototype (3) or small-scale production (3).

As regards the purpose of the projects, interviewees responded the main cause was publication. In only two cases they reported the possibility of patent application. None indicated participation to industrial conferences or workshops or industrialization as a scope. Propensity towards commercialization is not clear. In 13 cases, researchers indicated that the projects have potential for commercial application. In 5 cases, they show some doubts about possible applications. This mainly occurred for projects in the early research phase. In 9 cases, researchers see no market potential. Again, the main cause is related to the stage of project development, and the nature of the project itself. For projects with commercial potential, we asked researchers what would be the potential sector of application and the main issues to tackle on the commercialization path. "*Biomedical*" was the most cited sector of application, with a

variety of products, including: sensors, implantable devices, ocular bandages, fillers and tubes. Other sectors included electrical engineering, textile and wearable electronics. Main problems for commercialization addressed were the necessity to scale up production, the labor-intensive fabrication process which requires process engineering, and the need to receive FDA approval for medical applications.

To assess the extent of inbound activities, we asked researchers to indicate whether the idea source for the project – themselves, coworkers, supervisors - and whether the source was internal or external[6]. Results are presented in Table 15. Researchers listed themselves as the main idea source 14 times, and that the idea emerged from the activity of a co-worker 7 times. In 9 cases, they indicated the PI as the main source for the project. and. In 6 cases, researchers reported that the idea generated from a contribution of an external actor. For 2 projects, respondents. indicated the PI of an affiliate lab, working in the same department. In 4 other cases, they indicated industrial companies working with the lab on joint research projects.

Table 15: Idea sources for lab projects

Source	Detail	Responses	Ratio
Internal	Self	14	38,89
	Principal investigator	9	25,00
	Co-worker	7	19,44
External	Principal investigator of partner lab	2	5,56
	Partner firm	4	11,11
	Total	*36*	*100,00*

Ratio column values are presented as percentages
"Other" categories - for both internal and external sources - have been eliminated, due to lack of observations

Results indicate that the lab typically follows a linear approach (Etzkowitz, 1998) in managing Technology Transfer: ideas for research projects are mostly generated within the lab boundaries. Outside-in processes, conversely, are only of limited importance for starting research projects, since ideas come from proximal sources, i.e. from researchers of different labs in the same department, and from firms with which the lab has ongoing relationships. Findings are aligned with the work of Lichtenthaler (2008a), who outlines that universities are rather open for knowledge exploitation, but still closed as regards external knowledge acquisition in the spectrum of Open Innovation.

[6] Researchers were allowed to report multiple sources for each project. Therefore, the number of observations exceeds the total number of active projects

3.5.2 Coupled Open Innovation practices

We complemented the previous section by analyzing the lab dyadic cooperation with industrial counterparts through a variety of indicators to measure: researchers' perception of the role of the university, motivation for collaboration with industrial counterparts, channels of Technology Transfer, researchers' experience in the Technology Transfer and collaboration activities, and the implication of such interactions for the lab. In addition, we evaluated the degree of interaction with community-based platforms, the experience of researchers with such instruments and the implications of such practices for the lab's activities.

3.5.2.1 Dyadic interactions

Results presented in Table 16 show general consensus of interviewees towards the importance of doing research – both fundamental and applied – and publishing results. For applied research and publishing interviewees, consensus is almost equally shared. Basic research shows slightly lower values. The importance of publishing is underlined by the previous question, as the majority of interviewees where it resulted as the main reason for lab projects. The importance of research, conversely, reflects the nature of the lab, where both fundamental and applied research is conducted. Interviewees consider teaching and Technology Transfer as equally important, although they are considered to be slightly less important than research-related activities. We believe that the positive consensus towards Technology Transfer activities derives from the lab culture, strongly influenced by the view of the PI, who actively promotes lab activities and engages in collaboration with industrial counterparts. Researchers do not consider commercialization and local economic development to be important tasks for universities.

Table 16: Interviewees' perception about the role of university

Activity	Mean
Applied research	4,46
Publishing	4,46
Basic research	4,23
Teaching	3,76
Technology Transfer	3,76
Local economic development	2,92
Knowledge/technology commercialization	2,84

As reported in Table 17 and Table 18, promotion of research is the most important reason for researchers to involve in Technology Transfer activities. Monetary compensation shows mixed result: while on the one hand researchers indicate that access to private research funds has a moderate importance, on the other hand royalties received from licensing agreements seems to have a limited impact in researchers' choice to pursue commercialization activities. The same with access to industry capabilities: while access to industrial knowledge has a limited impact, the access to technology shows higher levels. The possibility to obtain job opportunities is an important driver for researchers to start industrial relationships. Table 5, however, shows that respondents experience in Technology Transfer is quite limited. Only two respondents reported previous experiences in disclosing information to university TTO, and only one reported involvement in patenting and licensing procedures.

Table 17: Motivation for industrial collaboration and Technology Transfer

Activity	Mean
Promotion of research	4,00
Access to industrial technology	4,00
Job opportunities	3,85
Access to industrial knowledge	3,77
Access to private research funds	3,69
Royalties to department	3,15
Royalties to university	3,07
Royalties to inventors	3,00

Table 18: Respondents' experience with Technology Transfer activities

Activity	Respondents with experience	Ratio
Disclosures	2	15,38
Patents	1	7,69
Licenses	1	7,69
Startups	0	0

As university – industry relationships involve multiple channels in addition to Technology Transfer, we complemented this section by asking researchers the relative importance of each of these channels, and to report personal involvement in any of these. Results are presented in Table 19.

Table 19: Channels of Technology Transfer

Channel	Mean	Respondents with experience	Ratio
Applied research	4,23	4	30,77
Informal contacts	4,15	7	53,85
Cooperative work / Joint research	3,92	6	46,15
Industrial workshops and training programs	3,54	2	15,38
Contract industrial research	3,00	2	15,38
Consulting	2,92	1	7,69

Again, applied research is highly valued by researchers. Applied science seems to be the natural connection between university and industry. The result is consistent with what reported in the previous sections. Informal contacts and joint research represent valid alternatives. Participation to industrial workshops and training are a viable channel to get contacts, but their importance is not fundamental. Consulting and contract research, in contrast, seem to be not appealing to interviewees.

Interviewees reported a good level of involvement in Technology Transfer activities. On aggregate, at least 8 interviewees have been involved in any of the abovementioned processes, as reported in Table 5. Researchers were allowed to choose more than one option; therefore, the reported values exceed the number of interviewees.

Informal contacts and joint research are the most used channels of communication with the industry, as at least 6 researchers reported involvement in both activities. Both activities are in the lower spectrum of university – industry collaboration channels, and are not rigidly regulated by contractual relationships. Moving up the scale, we find the participation to industrial workshops and training programs (2). Applied research is another appealing channel, with 4 students involved. Researchers reported involvement also in more structured relationships with the industry, such as contract research (2) and consulting activities (1).

We then asked interviewees to state their opinion on university-industry collaboration, together with perceived advantages and disadvantages of these relationships. Almost all the interviewees declared to be *in favor* of partnerships with industry. Only respondent 1 reported to have "*mixed feelings"*, due to the nature of her previous experiences in joint research projects, which were not optimal due to excessive *"work unbalance"* and lack of financial rewards *"no compensation"*.

When asked about the advantages provided by university-industry collaboration, all respondents pointed out to three main categories: increasing research quality (Respondent 1, 4,

5, 8, 13), gaining access to industrial resources (Respondent 7, 8, 10, 13), and getting university technology "off the shelf" to generate value for society (Respondent 3, 6, 9, 11). Specifically, respondent 4 and 5 both stated that *"the quality of research can improve"* from industry involvement, and that students may benefit from potential career opportunities, as they *"can be better prepared to join and work for a non-academic environment"* (Respondent 4).

Collaboration with industrial counterparts allows university researchers to gain access to multiple resources, such as strategic guidance and financing. Industry guidance in commercialization can *"provide better directions for research"* (Respondent 9 and 11), *"so that studies can fit more to real life (needs)"* (Respondent 9). Moreover, interviewees outlined that collaborating with industry grants *"access to (larger) funding"* (Respondent 7 and 9), since *"industry has money, academia has ideas"* (Respondent 10). In addition, since *"the purpose of doing research is to apply (results) in real life"* (Respondent 9), university-industry cooperation allows researchers to access better channels to *"spread out knowledge"* (Respondent 11), so that *"the outcome of research does not stay in the lab, but creates value to society"* (Respondent 3).

Despite university-industry collaboration presents multiple advantages, many interviewees reported that such relationships bear some hidden costs. Particularly, they fear that university laboratories *"may lose independence*" (Respondent 3), since industry involvement *"confines the possibilities of research topics"* (Respondent 7), leading to *"focusing too much on industry"* (Respondent 12) and on *"profits"* (Respondent 4), *"taking away from important fundamental research"* (Respondent 10 and 12), with *"(excessive) control on costs"* (Respondent 6), since *"businessmen are always more interested in making profits in the short term, limiting ideas and research fields"* (Respondent 9). In addition, Respondent 8 addressed some concerns about *"how patent revenues are assigned, and who gets the profit"* out of co-research and development activities. However, they still view favorably the possibility to collaborate with industrial partners, since *"university and industry have different backgrounds"* (Respondent 3) and *"[…] skill sets, which may help in solving complex problems in an applicable manner"* (Respondent 1), and *"matching them may provide interesting research results"* (Respondent 3).

In short, the lab appears to be oriented towards cooperating with industrial partners. The majority of respondents reported previous (or current) collaboration with industrial counterparts, and almost all of them have a positive view of such relationships. Researchers mainly engage in such relationships to promote their research, gaining access to industry knowledge and technology, and creating financial returns for their department. For many of

them, cooperation with the industry may be seen as a potential career opportunity. Preferred channels are keeping informal contacts with industrial counterparts, conducting applied research on behalf of a company, or jointly working on a research project. More formalized channels, such as technological consulting or industrial contract research, received lower consensus among interviewees. Additionally, respondents highlighted that university-industry relationships bring multiple advantages, mainly improving quality of research, gaining access to additional industrial resources – e.g. technology and funds - and helping in bringing university technology to the market.

From the analysis, two main university-industry relationship modes emerge: an informal and personal channel of cooperation between researchers and industrial counterparts, working on a common project which may lead to future career opportunities for single researchers; and a mediated Technology Transfer channel, with formal exchange of intellectual property rights from the university to the industrial partner, usually supervised by the Technology Transfer Officer, where researchers have limited - or null - participation.

Despite the positive tendency and active efforts of the lab towards Technology Transfer and commercialization, the PI outlined that publishing remains the major determinant for collaboration with industrial counterparts. In the majority of cases, companies' interest follows the publication of research results on scientific journals or newspapers. Once results are published, potential partners contact the lab to start collaboration projects or to negotiate the terms to acquire technology. To overcome this gap, the PI proposes that the lab should adopt a more open approach to attract the interest of industrial and academic partners alike, without relying on "traditional" publication as the sole driver of attention. In this view, the adoption of Open Innovation practices – both physical or virtual – may represent interesting tools for promotion of lab activities. We address this aspect in the following section.

3.5.2.2 Community-based practices

As reported in Table 20, respondents show a rather neutral judgement towards the importance of community-based Open Innovation instruments. They report that their role is limited in conducting basic research and for the current status of activities of the lab. Only a minority of the interviewees have experience with such platforms: three of them are members of open source software communities, four have been involved in crowdsourcing activities and only two have participated in crowdfunding projects.

Table 20: Community-based Open Innovation actors

Community type	Mean	Respondents with Experience	Ratio
Open source	3,23	4	30,77
Crowdsourcing	2,92	3	23,08
Crowdfunding	2,92	2	15,38

However, when asked the perception of the potential of these applications, all researchers responded to be in favor. The argument supporting this view is mainly inspired by collaboration and the "wisdom-of-the-crowd" view (Ebner et al., 2009; Hutter et al., 2011). Respondent 1 stated that online communities are *"a think tank without physical boundaries"* which *"provide a wealth of innovation usually untapped sources"* and thus may help academics *"open their mind"* (Respondent 5). Such communities, according to Respondent 4 help *"building a better society where we live"*. Open collaboration model is seen as a "*medium risk, high reward strategy*" (Respondent 1), which brings advantages at different levels. For once, it leverages from a "*much larger community to draw information from*" (Respondent 8 and 9), thus multiplying the sources of innovation. In addition, it promotes the "*exchange of ideas and creation of contacts*" (Respondent 12), which in turn help building "*shared knowledge and expertise*" (Respondent 3), ultimately "*reducing costs and risks*" (Respondent 6) associated to research and development.

This model, however, does not come without limitations. Researchers noted that multiplying the sources of information may lead to "*increased complexity*" (Respondent 6), generating "*information overload and waste of time*" (Respondent 1 and 13), thus resulting in "*disorganization and lack of leadership*" (Respondent 10) which ultimately leads to tension in the appropriation of result, as "*people (firms) can take credit for something they did not completely developed*" (Respondent 12).

3.5.2.3 Summary

In sum, we argue the study highlights that – indeed – university laboratories are a potential locus (Powell et al., 1996) for Open Innovation, thus answering to the emerging question of whether the Open Innovation paradigm may be applied to non-corporate and not-for-profit contexts (Müller-Seitz & Reger, 2009; West & Bogers, 2017).

Increasing openness in academia may help researchers move technologies off the shelf (Hall et al., 2014) and generate new insights from the industrial word for new projects, as well

as generating additional revenue streams from the commercialization of university research (Decter et al., 2007; Wood, 2011), helping universities overcoming the "ivory tower" approach towards commercialization activities (Gassmann et al., 2010; Nelson, 2014).

Specifically, the lab's current situation shows contrasting trends. On one side, the lab has a prominent role in basic research - consistent with the number of publications - and it follows a commercially-oriented vision, as shown by the number of patents and patent applications. On the other hand, however, interviewees seem to have a positive view towards Technology Transfer and Open Innovation activities, although their current propensity and experience remain somehow limited. Findings show that respondents have some practice with commercialization activities, and open collaboration platforms. Despite the favorable view of these phenomena, however, interviewees agree that their relevance is still scarce. Respondents' focus – in contrast – leans towards classical approach of Mertonian science, i.e. fundamental research and publishing.

We believe the outcome is mostly dependent on the Lab's organization: knowledge and Technology Transfer is mainly carried out through mediated transactions involving the TTO (Bodas Freitas et al., 2013), which follows a rather linear approach towards Technology Transfer (Etzkowitz, 1998), and personal contacts with industrial counterparts are kept by the PI (Bodas Freitas et al., 2013). Thus, respondents' involvement in such activities remains limited – which in turn influences their judgement. We believe that more inclusive measures inside the Lab would increase the degree of "openness" of researchers.

3.6 Discussion and Conclusions

The article - to our knowledge - is the first attempt to explore the degree of implementation of Open Innovation practices in a non-corporate environment, specifically in the context of university laboratories, and at the individual level. In doing so, the paper investigates a single case study about an American-based biomedical research lab, which shows positive propensity towards such mechanisms. Results highlight that the lab follows a rather open approach towards outbound activities, proxied by the number of patents and patent applications presented. This aligns with the view of Lichtenthaler (2008d), who posits that academic organizations are rather open in technology exploitation. Additionally, the lab shows a positive tendency towards dyadic interactions with industrial counterparts. Specifically, the lab engages in dyadic interactions with the industry through two main channels of communication: the former based on informal

contacts between researchers and partner firms for the development of joint projects, while the latter based on the formal transfer of patented technology from the lab to the industry, superseded by the Technology Transfer Officer, where lab researchers have limited involvement. This echoes the results of Freitas et al. (Bodas Freitas et al., 2013) who posit the existence of two almost distinct channels of university-industry collaboration: an informal one, based on personal networks of researchers, and a formal one, involving technology transfer agreements superseded by a deputy Technology Transfer Officer. Instead, researchers' perception towards open collaboration models based on digital platforms is more neutral, although they all recognize the value these platforms may have to boost lab's activities.

The extent of inbound activities – as shown by the number of projects started from external ideas – is still limited, and interviewees tend to focus on traditional outcomes of the academic world, namely publishing and promotion of research. Publishing still represents the main driver for attracting industrial partners, and other channels of promotion – like online communities – are still in the early implementation phase. In this view, the academic world is a late-comer in the implementation of Open Innovation practices, although we believe that such measures will progressively complement traditional promotion channels.

Indeed, we argue the implementation of Open Innovation practices in university laboratories may enhance the results of technology commercialization – as echoed by Hall et al (2014), by granting access to external sources of knowledge, not just in the form of corporate counterparts, but by leveraging on online communities for research ideas. This, in turn, should reduce research costs (Ramos et al., 2009) and help university laboratories overcome the limitations of classical Technology Transfer mechanisms (Hall et al., 2014) by reducing the degree of formalization of knowledge transfer relationships. In this sense, the introduction of policies aimed at promoting Open Innovation activities inside universities – as studied by Asakawa et al (2010) – may enhance R&D outcomes of university laboratories.

Of course, the implementation of Open Innovation practices does not come without downsides. Increased efforts towards commercialization of university research may generate tension between two contrasting objectives of academia: the creation and dissemination of knowledge through research versus the commercial exploitation of such ideas (Etzkowitz, 2003). Additionally, the exploitation of external sources of knowledge for university research under an Open Innovation framework may create unwanted knowledge spillovers (Arora et al., 2016). In the same way, it may hinder the opportunity to reclaim intellectual property rights (Henry W. Chesbrough, 2003) on university inventions.

We believe the contribution is relevant for both scholars and practitioners in the field.

For management literature, this study contributes by matching the extant literature streams of Technology Transfer and Open Innovation, by verifying that university laboratories rather follow an outbound-oriented approach, while inbound activities are yet to be developed (Lichtenthaler, 2008d). The result gives room to the quantitative analysis of Open Innovation practices in university-based contexts. For university managers, conversely, the study outlines that online communities are still an untapped channel of communication, thus leaving room for enormous growth in their use to promote university research results. Moreover, a change in the policy in which academics are evaluated – mostly based on teaching and publishing activities (i.e. number of published papers) – with complementary measures to calculate researchers' propensity towards commercialization (i.e. the number patents/licensing agreements generated and the amount of revenues arising from these activities) will accelerate the shift towards more active commercialization efforts.

The study has two main limitations: first, it only "partially" supports openness. This may be due to the Lab focus on biomedical applications, which may be distant from the adoption of inbound Open Innovation practices. In addition, the use of patenting as a proxy of outbound Open Innovation expresses the potential of outbound effectiveness, which results from the revenues generated by licensing agreements. We believe more objective measures will provide better explanatory results, and leave room for comparison between multiple case studies.

Future studies may help by assessing the implementation of Open Innovation practices in university laboratories using larger samples of the analysis, thus overcoming sample and sector-related limitations. Moreover, future research may focus on addressing the determinants of openness in research laboratories. Finally, it may shed some light on the characteristics of the various categories of counterparts holding relationships with university laboratories.

4. Paper 2: Lean or Open? How Inbound Openness and Time-to-Market Affect Firm Performance

4.1 Introduction

In addition to classical management arguments on corporate and business strategy, which define the *where* firms should compete and *how* they should do it (Grant, 2002), also the concept of *when* to enter a sector, market or industry has attracted scholars for a long time. Entry timing has been extensively debated over the last decades by management scholars. Much of the literature in time-to-market revolves around the concept of the first mover advantage, although some scholars posited that different strategic choices – such as the second/follower entrance, early or late entrance – may yield superior results.

Despite extensive argument on which approach would yield better results, scholars are yet to find a consensus. While market-entry has been extensively studied in the previous decades, there is still a general – unresolved – debate upon which strategic approaches company may adopt, since scholars argue that entry timing strategies are influenced by contingent factors, including industry demand levels (Makadok, 1998), market development costs and sales volumes (Langerak, Hultink, & Griffin, 2008), distribution channels (S. Wang, Cavusoglu, & Deng, 2016), and therefore the level of profitability generated by the adoption of one strategy rather than another is moderated by exogenous variables.

Open innovation concept leverages on the rapid access and use of information, whether developed inside the organization or in external markets (H. Chesbrough, 2004; Svensson et al., 2010). The concept of Open Innovation, in its original formulation, has been opposed to the frame of closed innovation, a renowned approach adopted by the majority of innovative firms in the past decades, based on self-reliance and protection of firm's knowledge, usually via trade secrets and intellectual property rights (H. Chesbrough, 2004). Protection of firm's knowledge eliminates – or at least reduces - risks associated with unwanted knowledge spillovers (Cappelli, Czarnitzki, & Kraft, 2014; Svensson et al., 2010), which favor imitation by competitors and thus reduce firm's profitability. By keeping information secret, firms can pre-empty competition and have privileged access to new markets. The opposite argument, brought forward by Open Innovation, argues that collaboration in innovation activities grants better access to information and knowledge allows companies to reduce times related to research and development, therefore allowing for faster product and service development, and marketing

times (Wallin & Von Krogh, 2010). In this light, we believe that the advantages of adopting an Open Innovation approach in terms of faster development and marketing times exceed the downsides of potentially attracting competitors through information spillovers.

Despite the potential consensus, the relationship between firms' openness and entry-timing has mainly been overlooked by extant literature, as only a handful of recent studies (Cappelli et al., 2014; Hochleitner, Arbussà, & Coenders, 2017) addressed the issue, thus leaving room for empirical testing of such relationship.

Based on extant contributions on time-to-market and Open Innovation, we seek to answer to the following questions: how are inbound openness and time-to-market choices related to firm performance? Does the level of firm inbound openness moderate the impact between firm entry-timing strategy and its performance?

We believe the argument is relevant for both scholars and practitioners, since academics in the Open Innovation field highlighted the growing need the Open Innovation paradigm to larger and more traditional management theories (Gassmann et al., 2010; Huizingh, 2011). In this view, as Open Innovation is considered as a strategic approach in managing innovation activities (Denicolai, Zucchella, & Moretti, 2017), we seek to link the paradigm to market-entry theory (Lieberman & Montgomery, 1988). Moreover, in a recent review on entry-timing, Zachary *et al* (2015) stressed the need for more studies in the field, in order to overcome contingency-related issues. For practitioners, the definition of the interconnection between openness and market entry can highlight the need to develop strategies based upon developing fruitful collaborations with partners in the competitive environment, coupled with clear entry timing strategies, which in turn may boost firm productivity and revenues.

The remainder of this paper is organized as follows: in the next section, we will briefly review extant literature on time-to-market strategic choices in the frame of Open Innovation. After, we will outline the research design and the methodology adopted in the study. Then, we will present the descriptive and regression results of the study. Finally, we will describe the contributions of the study, the implications for researchers and professionals in the field, the main limitations of our work and some proposals for further studies in the field.

4.2 Literature review

4.2.1 Time-to-market

Among strategic choices undertaken by firms, the decisional process underneath the choice of the right time to enter in a market is perhaps one of the most discussed topics in management literature.

Timing to market is defined as *"the order of entry into a new or existing space (e.g., market, industry, or geographic region), relative to competitors, technology development, product life cycle, or other contextual referents"* (Zachary et al., 2015, p.1389). In the context of our study, we refer to entrance in existing or new markets for new or significantly improved products or services offered by the company.

The choice of when to enter a market strategic for innovating firms, since they all pursue the proficient market-entry timing (Langerak et al., 2008), i.e. the right time on when to enter a specific market with their product/service. Much of the literature in time-to-market revolves around the concept of the first mover advantage, although some scholars posited that different strategic choices – such as the second/follower entrance, lean or late entrance – may yield superior results.

First mover advantage is perhaps the most known effect of entry-timing strategy in management literature. Being first on the market represents a source of competitive advantage, since it provides advantages in terms of pricing (Makadok, 1998) and increased resource efficiency (Eisenhardt & Tabrizi, 1995; Perols et al., 2013). In addition, first movers may generate a "lock in" effect, since the company develops a social identity which stimulates customer loyalty towards the brand (Barnett, Feng, & Luo, 2013). First-moving firms may also influence changes in consumer behavior (Hochleitner et al., 2017). All these advantages increase market and industry shares of the pioneer firm and increasing profit margins, although they both decrease in accordance to the age of the reference market (W. C. Patterson, 1993).

The first-mover advantage paradigm has raised some questions in later studies (Lieberman & Montgomery, 1998), leading the way to the proposition of first- versus second-mover advantages analysis (Chevalier-Roignant, Flath, Huchzermeier, & Trigeorgis, 2011), mainly through duopoly market models (Alcácer, Dezs, & Zhao, 2013; Huisman & Kort, 2003; Morgan & Várdy, 2013), which highlight the existence of second-mover advantages under certain conditions. Second-mover advantages emerge in the context of high research and

development costs (Hoppe & Lehmann-Grube, 2001), since second movers/followers they face lower costs of research and development, as imitation costs are lower than innovation costs. In addition, second movers are favored by the clear definition of the boundaries of the market given by first-mover entrance (Hochleitner et al., 2017).

In addition to first- or second-mover advantage, we outline the presence of lean entrance. This is partially derived by the effects of early entry advantages, highlighted by extant entry-timing literature (B. Kim, Kim, Miller, & Mahoney, 2016; Makadok, 1998). Makadok (Makadok, 1998), for example, argues that in markets with low barriers to entry, first and early movers enjoy consistent pricing and market share advantages over later entrants. Early entrance is favored also in contexts characterized by low technical and market uncertainty (B. Kim et al., 2016). In addition, Wang et al (2016) found that in the context of online commerce, early entrance advantage is reinforced by the firm's customer relationship management capabilities. The strategic choice of lean entrance is derived from Eric Ries' *"lean startup"* concept (Ries, 2011), where the author proposes that in order for startups to be successful, they should focus on creating a minimum viable product (MVP) and launching it on the market as soon as possible, and then collect feedback from consumers to subsequently improve the launched product or service through iterative upgrades. While the lean startup paradigm suggests reducing time-to-market, it does not address the strategic choice in terms of competitors' timing. Rather, the benchmark is the company itself.

Finally, another stream of literature posits the emergence of late entrance. The argument for late entrance is mainly associated with the exploitation of the so-called "windows of opportunity" (Palmer, Linde, & Pons, 2004). Windows of opportunity emerge from the evolution of technology markets, since their development is discontinuous (Tyre & Orlikowski, 1994). Suarez et al argue that windows of opportunity start with emergence of the market dominant category, and they end when the dominant design emerges (Palmer et al., 2004). The choice of optimal market-entry timing is based upon a number of exogenous factors, including the length of the windows of opportunity, which varies from market to market (M. A. Cohen, Eliashberg, & Ho, 1996). Calantone and Di Benedetto (2000) posit the existence of tradeoffs between product performance and the time-to-market choice, and argue that when market windows are long, firms benefit from prolonging the product development phase, and postponing market-entry.

Surmising existing contributions, we can see that while market-entry has been extensively studied in the previous decades, there is still no general consensus upon which strategic approaches company may adopt, since scholars argue that entry timing strategies are influenced by contingent factors, including industry demand levels (Makadok, 1998), market development costs and sales volumes (Langerak et al., 2008), distribution channels (S. Wang et al., 2016), and therefore the level of profitability generated by the adoption of one strategy rather than another is moderated by exogenous variables. This calls for further studies in the field.

4.2.2 Inbound Open Innovation

In the Open Innovation contest, firms may leverage from abundancy of external knowledge to be acquired and converted into profitable business opportunities. Sourcing external innovation is quickly becoming one of the drivers in current R&D techniques. Drivers of external sourcing include lower cost of development, lower risks and faster time-to-market (Wallin & Von Krogh, 2010). In the Open Innovation system, external technology sourcing and implementation represents a complement, rather than a substitute, for internally-developed technology (H. Chesbrough & Crowther, 2006; Dahlander & Gann, 2010; Lichtenthaler & Ernst, 2008, 2009).

Firms can acquire knowledge from a variety of sources, including customers (Piller & Walcher, 2006), suppliers (Spaeth, Stuermer, & Krogh, 2010), competitors (Mention, 2011), but also specialist knowledge providers, such as research centers, universities, and consultancy agencies (Tether & Tajar, 2008)

Despite the seemingly easy access to external knowledge, however, this rarely flows directly to innovative firms. To leverage upon such knowledge, companies need to be able to identify the right knowledge sources, and build mechanisms to absorb and integrate external knowledge into internal activities. Thus, firms need to rely on their Absorptive Capacity, i.e. *'the ability of a firm to recognise the value of new, external information, assimilate it, and apply it to commercial ends'* (W. M. Cohen & Levinthal, 1990), to gain value from external knowledge (Spithoven et al., 2011). In addition, firms trying to leverage on external knowledge should possess adequate connective capacity, i.e. the ability to maintain knowledge outside the firm boundaries, through alliances or partnerships; and desorptive capacity, i.e. the ability to externally exploit knowledge (Lichtenthaler & Lichtenthaler, 2010).

An additional challenge in inbound Open Innovation practices is posed by the "not-invented-here" syndrome (H. Chesbrough & Crowther, 2006; Katz & Allen, 1982; Lichtenthaler, 2008c; Svensson et al., 2010; West & Gallagher, 2006). According to this approach, firms tend to adopt a negative attitude towards externally generated knowledge. This choice may arise as companies lack previous experience with a specific technology, or because of resistances played by key individuals inside the firm, such as R&D scientists or executives.

In essence, while inbound Open Innovation approach seems a useful mechanism for innovative companies, this approach requires attentive supervision in managing the following challenges: *maximization* of activities to maximize returns on internal innovation; *incorporation,* since external knowledge provides no benefit to the firm if the latter not able or to identify the potential of such through adequate scanning activities and absorptive capacity; and *motivation* to secure the continuous stream of knowledge (West & Gallagher, 2006). This includes creating an ex-ante framework to link innovation sourcing to corporate strategy, clearly define the boundaries of what external assets the firm wants to access, and managing the cultural change emerging within the organization once the external assets are getting implemented (Slowinski, Hummel, Gupta, & Gilmont, 2009).

4.2.3 Open innovation and market entry

Despite the emergence of the Open Innovation literature since the last decade, only a handful of contributions have so far linked the paradigm to the choice of market entrance. Extant Open Innovation literature has mainly focused on the involvement of various categories of stakeholders in the innovation process, at different points in time. As an example, firms can use brand community members (Füller et al., 2008) at early stages of development to create identity and sense of belonging, thus developing the brand value. Alternatively, at later stages, firms can involve cohorts of laggards (Jahanmir & Lages, 2015) to extract information spillovers (Cappelli et al., 2014) and insights about potential development of their products and processes.

In the Open Innovation context, technological functionality development is enhanced through substitution between the innovating firm – leader - and the imitating one - follower (Watanabe, Shin, Heikkinen, Zhao, & Griffy-Brown, 2011). Innovation leaders have higher productivity and yield better results in innovation-related investments (Likar, Kopač, & Fatur, 2014).

Perols et al (2013) investigate the relationship between supplier integration and time to market, finding that external technology adoption operates as a positive mediator between supplier product and process integration and time-to-market. Firms integrating suppliers consistently reduce time to market, and more increasingly so if they invest in both internal development and external technology acquisition. Similarly, Denicolai *et al* (2016) argue that the acquisition of externally-generated knowledge – contrary to expectations – increases firm performance more quickly than internal development of knowledge, although the results yielded by internally-generated knowledge last longer.

Perhaps the closest contribution to our study is the recent study of Hochleitner *et al* (2017), who studied the relationship between inbound Open Innovation activities, innovation outcomes and entry timing, finding that inbound Open Innovation activities have a positive effect on the open development of new products and services, that cooperation with customers, acquisition of information from consultants, universities and research institutions, and the acquisition of external machinery all have positive and significant effects on innovation outcomes. In addition, they found that all innovation activities but acquisition of information from consultants reduce market-entry times.

Based on extant contributions on Open Innovation, we seek to answer to the following questions: how are inbound openness and time-to-market choices related to firm performance? Does the level of firm inbound openness moderate the impact between firm entry-timing strategy and its performance?

To do so, we propose an empirical analysis of the relationship between the level of openness, the choice of entry timing and the performance by analyzing a sample of 100 Italian-based manufacturing and service firms, for years 2014 to 2016. The research design is described in the following section.

4.3 Research design

4.3.1 Sample

The research was conducted between February and June 2017. The collection process combined the proposition of a survey through semi-structured interviews, conducted with employees in key managerial positions within the interviewed companies.

Specifically, respondents (CEOs, presidents, members of the board of department managers, executives, etc.) with the collection of financial indicators through a separate survey, involving the same companies. As regards the interviews, the majority of them were audio recorded and then separately transcribed in a report. The role of the respondents is reported in Table 21.

Table 21: Respondents' role in the organization

Role	N. of respondents	Distribution
Board member	2	2%
CEO	35	35%
Department Manager	42	42%
Managing partner	3	3%
Member of management team	5	5%
Owner	9	9%
President	3	3%
Vice President	1	1%
Tot	100	100%

The data used in this study was collected from 106 manufacturing and service companies, for years 2014 to 2016. The selected sample refers to Italian companies. The choice of the context was driven by two characteristics: Italy's rooted entrepreneurial culture and the emergence of the fierce crisis that begun in 2008, which has emphasized - more than in other European countries - the distinction between conservative and breakthrough companies[7]. These circumstances facilitate the observation of clear-cut orientations. The selected sample constitutes a decent approximation of Italian companies in terms of sector distribution, according to latest ISTAT report[8]. From them, we eliminated observations missing relevant data for the analysis. This left us with a sample of 100 companies.

[7] See RIIR Report 2010

[8] See ISTAT Statistics Report 2014: https://www.istat.it/it/files/2016/10/Report-Risultati-economici-imprese-2014.pdf?title=Risultati+economici+delle+imprese+-+26%2Fott%2F2016+-+Testo+integrale+e+nota+metodologica.pdf

4.3.2 Measures

4.3.2.1 Dependent variable

As dependent variable, we selected the firm's turnover for year 2014, 2015 and 2016, and we calculated the growth rate among years. We used the compound average growth rate for years 2014 to 2016. The indicator represents the compound annual growth rate (CAGR) of firm's turnover over the selected period. Turnover data was controlled through the use of equivalent data downloaded from Bureau Van Dijk's ORBIS software.

4.3.2.2 Independent variables

Two main explanatory variables are used in this study: the level of firm's inbound openness and the time-to-market strategy. Based on Laursen and Salter's (2006) contribution, we operationalized openness by asking respondents to report the level of importance of externally acquired or non-directly controlled resources in their activity. The level was sorted 1 to 5 Likert scales, with 1 being the lowest value (not important/relevant at all) to 5 being the maximum value (extremely important/relevant). The value indicates the firm's propensity to appropriation of relevant external resources, and it is used as the Inbound Open Innovation indicator in this study.

As the time-to-market indicator, we asked the respondents to indicate which approach the company would follow in terms of market entry. Possible responses are listed in Table 22. We coded responses in accordance to the following categories: 1) "First mover", indicating companies which actively pursue being the first in a new market; 2) "Follower", those who prefer to follow a read-and-react approach in accordance to first movers; 3) "Lean mover", for those who actively try to reduce time-to-market irrespective of other companies' moves (i.e. being first or second); 4) "Window of opportunity", for those not trying to reduce market-entry times but rather waiting for the right window of opportunity to come by; 5) "No strategy", for companies who do not follow a specific strategy in terms of market entry. All variables are coded through dummies.

Table 22: Entry timing strategy - operationalization of variables

Question	Possible answers	Code
Which of the following sentences best describes the firm's approach?	Reducing time-to-market and being the first on the market is fundamental	First mover
	We would rather study what competitors do, and being the "second" on the market	Follower
	Shoot first, then aim	Lean mover
	You should patiently wait for the right "window of opportunity"	Window of opportunity
	We do not follow a specific approach	No strategy

4.3.2.3 Control variables

We controlled for a number of variables, including firm type, sector, age, size, research and development (R&D) expenditure.

In terms of firm types, we asked respondents to indicate the legal status of the company, whether it was a limited liability company, a public or a listed company, or a startup. For all indicators, we used dummy variables to code answers, with "1" being used to categorize the reference group, and "0" otherwise.

For firm sector, we asked respondents to indicate the firm sector of activities. To calculate firm's age, we subtracted the firm current year minus the self-reported year of establishment. For firm size, we used the average number of firm's employees and full-time equivalents in years 2014, 2015 and 2016, in logarithmic form. For firm R&D expenditure, we used firm's average expenditure in R&D for years 2014, 2015 and 2016, in logarithmic form. A summary of the variables used in the analysis is presented in Table 23. Such variables were triangulated with equivalent public data downloaded from Bureau Van Dijk's ORBIS software.

Table 23: Research model: definitions of dependent and explanatory variables

Group	Variable	Description	Type	Operationalization
Control	Firm type	Legal form of the firms in the sample	Dummies	LLC = Limited Liability Company Public = Public company Listed = Listed company Startup = Startup
	Industry	Reference industry for firms in the sample	Dummies	AUTO = Automobiles and parts CHEM = Chemicals CG = Consumer goods FB = Food and beverages HC = Healthcare IND = Industrial goods MEDIA = Media TECH = Technology TELCO = Telecommunications TRANS = Transportation OTH = Other
	R&D	Average Research and Development expenditure for years 2014 to 2016	Continuous	Log (R&D Expenditure)
	Age	Firm age	Continuous	Log (Age)
	Size	Average number of full-time employees for years 2014 to 2016	Continuous	Log (Size)
Independent	Entry timing	Entry timing strategies	Dummies	FM = First Mover FL = Follower EM = Early Mover W = Window of Opportunity NS = No Strategy
	Inbound Openness	Measure of the extent of firm's external resource acquisition	Ordinal	Inbound OI
Dependent	Growth	Compound average growth rate for years 2014 to 2016	Continuous	CAGR = Compound Annual Growth Rate

4.4 Findings

4.4.1 Descriptive results

Table 24 presents the summary statistics of the variables used in the analysis, whereas correlation coefficients are presented in Table 25. For better comprehension, we only report quantitative variables, thus excluding control dummy variables. Complete tables for both summary statistics and correlation matrix are reported in the appendix section. Average growth is pretty sustained for the companies in the sample, with an average 10.1% increase in turnover over the period 2014-2016.

For firm age and firm size, we calculated the logarithmic value of the indicators. On average, the sample includes consolidated firms, with an average age of 50.82 years. In terms of size, firms in the sample engage 5590 employees or full-time equivalents. In terms of research and development propensity, selected firms invest on average 46 million Euros per year in the reference years.

Table 24: Descriptive statistics

Summary statistics

N,	Variable	Count	Mean	St. Dev,	Min	Max
1	CAGR	92	0.100758	0.253949	-0.477778	1.349624
2	Age	100	3.485002	1.174608	0	5.252274
3	Size	100	2.045497	1.064297	0.30103	5.204123
4	R&D Expenditure	100	0.411199	0.723486	0	3.255514
5	Inbound OI	100	2.42	1.334696	1	5
6	First mover	100	0.55	0.5	0	1
7	Follower	100	0.07	0.256432	0	1
8	Lean mover	100	0.08	0.272660	0	1
9	Window of opportunity	100	0.16	0.368453	0	1
10	No strategy	100	0.13	0.337998	0	1

Variables Age, Size and R&D Expenditure are in logarithmic form

On average, companies report 2.42 relevance on externally acquired resources or assets on a scale from 1 to 5. Thus, we argue that companies follow a rather closed approach in terms of inbound openness. As regards entry timing strategies, the majority of companies reported the strategic intent of being first-mover on the market (55%). The picture is consistent with extant management theories, which posit the existence of a first-mover advantage, which allow companies to open new – uncontested - markets and profit from monopoly rents (W. C. Kim & Mauborgne, 2004). Only 7% report preferring being the second-mover and only 8% decide to adopt a lean mover approach. 16% report choosing to wait for the right window of opportunity, and 13% of the firms in the sample reported their company does not actively pursue a specific strategy in terms of market entry, but they rather prefer deciding on a case-by-case scenario.

Table 25: Pearson's correlation matrix

Correlation Matrix

N	Variable	1	2	3	4	5	6	7	8	9	10
1	CAGR	1									
2	Age	-0.309***	1								
3	Size	-0.265**	0.389***	1							
4	R&D Expenditure	-0.150	0.213**	0.666***	1						
5	Inbound OI	0.171	0.0248	0.118	0.107	1					
6	First mover	0.0554	0.104	0.191*	0.137	0.0352	1				
7	Follower	-0.104	-0.00138	-0.0684	0.00701	0.0941	-0.342***	1			
8	Lean mover	0.0719	-0.119	-0.125	-0.0900	-0.0769	-0.286***	-0.0688	1		
9	Window of opportunity	0.0378	-0.126	-0.0964	-0.102	-0.0526	-0.526***	-0.127	-0.106	1	
10	No strategy	-0.0921	0.0693	-0.0365	-0.0338	-0.0168	-0.439***	-0.106	-0.0883	-0.163	1

Variables Age, Size and R&D Expenditure are in logarithmic form

*** p<0.01, ** p<0.05, * p<0.1

4.4.2 Regression results

We run a regression analysis using OLS model to determine the effects of the aforementioned factors on the dependent variables, the firm's compound annual growth rate in turnover (CAGR), using 7 different models. Table 26 presents the results of the regression analysis. Models from 1 to 3 represent the effects of the control (Model 1) and explanatory variables of entry timing (Model 2) and inbound openness (Model 3). Models 4 to 7 highlight the interactions between the level of firm's inbound openness associated with each entry timing strategy, whether first mover (Model 4), follower (Model 5), lean mover (Model 6) or window of opportunity (Model 7). Since the models contain different dummy variables, we used limited liability companies as the base group for firm type, other sector as the base group for sectors, and no strategy as the base group for entry-timing strategy.

Table 26: Regression analysis

VARIABLES	1 Control	2 Timing	3 Openness	4 Interaction First mover	5 Interaction Follower	6 Interaction Lean mover	7 Interaction Window of opportunity
Public	0.00993	0.0331	-0.0106	0.00139	-0.00736	-0.0102	-0.00785
	(0.0631)	(0.0653)	(0.0620)	(0.0633)	(0.0629)	(0.0582)	(0.0622)
Listed	0.278*	0.283*	0.230	0.228	0.244	0.235*	0.246*
	(0.148)	(0.150)	(0.145)	(0.150)	(0.149)	(0.135)	(0.146)
Startup	0.873***	0.893***	0.843***	0.844***	0.842***	1.105***	0.825***
	(0.147)	(0.150)	(0.143)	(0.146)	(0.145)	(0.151)	(0.144)
Automobiles and parts	-0.0541	-0.0727	-0.127	-0.1000	-0.134	-0.167	-0.138
	(0.151)	(0.161)	(0.150)	(0.153)	(0.158)	(0.140)	(0.155)
Banking and Finance	-0.170	-0.195	-0.255*	-0.239	-0.256	-0.270*	-0.267*
	(0.151)	(0.159)	(0.151)	(0.153)	(0.157)	(0.141)	(0.154)
Chemicals	0.0220	-0.000749	-0.0167	-0.0231	-0.0169	-0.0345	-0.0107
	(0.121)	(0.124)	(0.119)	(0.121)	(0.120)	(0.112)	(0.120)
Consumer Goods	0.0512	0.0167	0.0457	0.0351	0.0471	0.0164	0.0520
	(0.102)	(0.105)	(0.0992)	(0.100)	(0.0999)	(0.0936)	(0.0997)
Food and Beverages	0.119	0.121	0.119	0.119	0.125	0.0479	0.125
	(0.107)	(0.108)	(0.104)	(0.105)	(0.105)	(0.0988)	(0.105)
Healthcare	0.0512	0.0197	0.0180	0.0174	0.0336	-0.00637	0.0203
	(0.152)	(0.159)	(0.149)	(0.150)	(0.153)	(0.140)	(0.149)
Industrial Goods	0.0504	0.0288	0.0369	0.0491	0.0430	0.0179	0.0308
	(0.0974)	(0.102)	(0.0949)	(0.0963)	(0.0959)	(0.0896)	(0.0980)
Technology	0.0167	-0.0267	-0.0291	-0.0231	-0.0258	0.0124	-0.0513
	(0.124)	(0.131)	(0.122)	(0.123)	(0.124)	(0.116)	(0.127)
Telecommunications	0.0540	0.00857	0.0204	0.0143	0.0296	0.0144	0.0136
	(0.181)	(0.185)	(0.177)	(0.178)	(0.179)	(0.165)	(0.178)
Transportation	0.00383	-0.0477	-0.0351	-0.0584	-0.0368	-0.0706	-0.0243
	(0.173)	(0.177)	(0.169)	(0.172)	(0.171)	(0.159)	(0.170)
Age	0.0111	0.00328	0.00248	0.00228	0.00473	0.0289	0.00300
	(0.0360)	(0.0367)	(0.0353)	(0.0357)	(0.0359)	(0.0339)	(0.0357)
Size	-0.0183	-0.0270	-0.00728	-0.0162	-0.0123	-0.0363	-0.00478
	(0.0380)	(0.0390)	(0.0373)	(0.0383)	(0.0379)	(0.0355)	(0.0376)
R&D Expenditure	-0.0291	-0.0275	-0.0287	-0.0317	-0.0301	-0.00352	-0.0241
	(0.0453)	(0.0460)	(0.0441)	(0.0445)	(0.0445)	(0.0416)	(0.0445)
First Mover		0.0872		0.0684			
		(0.0734)		(0.0979)			
Follower		0.0301			-0.189		
		(0.110)			(0.212)		
Lean Lover		-0.0533				0.562***	
		(0.118)				(0.210)	
Window of Opportunity		0.0827					-0.0807
		(0.0931)					(0.126)
Inbound OI			0.0411**	0.0438	0.0391**	0.0475***	0.0343*
			(0.0180)	(0.0288)	(0.0185)	(0.0169)	(0.0196)
First Mover x Inbound OI				-0.00698			
				(0.0362)			
Follower x Inbound OI					0.0505		
					(0.0712)		
Lean Mover x Inbound OI						-0.343***	
						(0.0971)	
Window of Opportunity x Inbound OI							0.0550
							(0.0479)
Constant	0.0321	0.0283	-0.0281	-0.0500	-0.0218	-0.0701	-0.0273
	(0.168)	(0.178)	(0.165)	(0.179)	(0.167)	(0.158)	(0.165)
Observations	92	92	92	92	92	92	92
R-squared	0.448	0.471	0.484	0.493	0.491	0.567	0.497

Model 1 presents the effects of control variables on the dependent variable, the firm's compound annual growth rate. Results show that in terms of firm type, there is a positive and consistent relationship between startups and the dependent variable (0.873, p-value < 0.01) and a marginally positive and consistent relationship between listed firms and the turnover growth rate (0.278, p-value < 0.1). Startups and listed firms show marginally positive results in firm's turnover growth compared to the base group, limited liability companies. In particular, the correlation for startups is consistent across all models, therefore we argue that startups show higher growth rates. This, we believe, is mainly due to their limited size and age, which allows for sudden growth rates compared to traditional, established businesses. All other control variables – firm sector, age, size, and research and development propensity – do not yield significant correlations with the dependent variable

Model 2 shows the results of entry timing decisions on firm growth. Quite surprisingly, we do not find any significant correlations between the predictors and the dependent variable. Apparently, entry timing strategies do not yield marginally different results compared to not having a strategy at all, the reference group for our analysis. Results are in contrast with previous entry-timing studies, who posit the existence of strategic entry-timing effects, such as first-mover (Lieberman & Montgomery, 1988; W. C. Patterson, 1993).

Model 3 presents the effects of inbound openness on firm growth. Results show a positive and consistent correlation between the extent of acquisition of externally developed assets and the firm's turnover growth. The choice of relying on external resources yields significant results in terms of firm growth. The results are in contrast with multiple Open Innovation studies, who posit a linear (Y. Chen et al., 2016; Egbetokun, 2015; Gesing et al., 2015; Pullen et al., 2012; Rass, Dumbach, Danzinger, Bullinger, & Moeslein, 2013) effect of openness on firm performance.

In terms of interactions between the main explanatory variables (Model 4 to Model 7), results show that there is a negative and significant interaction effect between the lean mover approach and the extent of openness (-0.343, p-value <0.01). Other combinations, in contrast, are not significant.

From the results, we argue that the extent of inbound openness – the acquisition of external resources – negatively influences the choice of a lean strategic approach to market entry. The choice of following a strategy based on fast launch and progressive improvement of the minimum viable product – based on customers' feedback - does not enhance firm growth

when the firm relies on externally developed resources, but rather it reduces its positive impact on firm growth. The results are in contrast with those of Hochleitner *et al* (2017), who found that inbound Open Innovation activities have a positive effect on the open development of new products and services, and that the acquisition of external machinery have positive and significant effects on innovation outcomes. We believe this is due to the nature of acquired assets, which help reducing development and marketing times (Wallin & Von Krogh, 2010), but they need consistent time to be properly integrated and exploited by the acquiring firm. This highlights the importance of firm's absorptive capacity (W. M. Cohen & Levinthal, 1990), echoed by multiple Open Innovation studies (Ferreras-Méndez, Fernández-Mesa, & Alegre, 2016; Lichtenthaler, 2016; W. Patterson & Ambrosini, 2015; Xia, 2013).

4.5 Discussion and conclusions

4.5.1 Contributions

The paper contributes to extant Open Innovation literature. First, to our knowledge, it is a first attempt to empirically test the relationship between entry timing strategies, firm openness, and firm performance. Results show the existence of a negative moderating effect of the level of inbound openness on the strategic choice following a lean entry strategy, and the growth of the firm's turnover. In managerial terms, this relationship posits that firms should choose between a lean entry approach, based on time management and progressive improvement of firms' products or services based on customers' feedbacks, and the choice of integrating external assets, since they require consistent time and resources to integrate; thus, delaying entry timing. This, in addition, echoes the need of recent studies in the field to link the Open Innovation paradigm to traditional management theories (Gassmann et al., 2010; Huizingh, 2011; West & Bogers, 2017). In this view, we argue that when choosing a lean entry strategy, firms should focus on leveraging upon internal resources rather than acquiring assets, since they require time to integrate, which causes delay in market entry times.

4.5.2 Implications

The work contributes to both scholars and practitioners in the field of Open Innovation. For scholars, the link between the two research streams of entry timing and Open Innovation calls

for further studies in the field. In addition, we argue that the article may be a first attempt to integrate Open Innovation in Strategic Management literature, although this only represents a preliminary study.

For managers, the study confirms the positive effect of inbound openness on firm performance, while it partially contrasts entry-timing literature, by finding that strategic choices regarding when to enter in a market do not generate consistent results in terms of market growth, if taken separately. In addition, we find that openness negatively moderates the effect of lean entry on firm growth. Thus, we argue that firms, when deciding entry strategies, should choose between being "lean" or being "open", by either minimizing development times to launch the minimum viable product on the market, or acquiring external assets and postpone entry to secure that external technology is properly absorbed and integrated into firm routines.

4.5.3 Limitations and future research

The study presents multiple limitations. First, and foremost, in the current form, the paper is still preliminary; therefore, subject to implementation. In addition, the sample is cross-sectional, and largely refers to Italian companies. Therefore, it is subject to both time- and country-related bias. Finally, explanatory variables are self-reported used in this paper are company self-reported measures, for both entry timing strategy and inbound openness measures. More objective measures could better serve to isolate the effects of such variables on firm performance.

We suggest that future research needs to deepen the understanding of the relationship between openness and firm strategy, such as entry timing. In particular, scholars should focus on determining whether collaboration with different categories of stakeholders yield different strategic entry-timing choices, and, in turn, to different results. Moreover, cross-country comparison or panel data samples may help overcome current limitations.

5. Paper 3: Inbound Open Innovation and Firm Performance

5.1 Introduction

Open Innovation (OI) is one of the hottest topics in management literature in the past decade. According to Scopus dataset, ever since the introduction of the term in 2003, over 3600 articles have been published on the topic. Following the original definition, OI represents a new model to pursue activities where "*[...] firms commercialize external (as well as internal) ideas by deploying outside (as well as in-house) pathways to the market".* (Svensson et al., 2010). Enkel, Gassmann and Chesbrough (Enkel et al., 2009), distinguish three dimensions of Open Innovation: "*outside-in*", "*inside-out*" and "*coupled*". In particular, the outside-in (inbound) process aims at enriching the company knowledge capital by internalizing externally-developed technologies. Firms search for valuable sources of knowledge in their environment, leveraging on potential sources of ideas arising from other players, i.e. suppliers, customers, competitors or universities. Drivers of acquisition of external assets include lower cost of development, lower risks and faster time-to-market (Wallin & Von Krogh, 2010). Building on the resource-based view of the firm (Barney, 1991), We join the current debate in OI literature by seeking to answer to the following question: *How is inbound openness related with firm performance?*

So far, a number of studies focused on the effects of OI on firm performance (Chiang & Hung, 2010; Hung & Chou, 2013; Lichtenthaler, 2009). However, OI literature is yet to find consensus in defining the determinants of openness, as well as in sorting its effect on performance. Extant studies present three main limitations in determining such relationship: first, we believe there is a bias in the measurement of firm level of openness in extant studies, since they mostly rely on self-reported measures of openness derived from secondary data. In addition, there is no consensus in the definition of what "firm performance" is in Open Innovation studies. Finally, results of extant studies on the relationship between inbound openness and performance are heterogeneous: multiple authors argue the presence of a positive relationship between openness and performance (Nitzsche et al., 2016; Rass et al., 2013), while others argue there is a negative or non-linear relation between such variables (Laursen & Salter, 2006; Love et al., 2011; Suh & Kim, 2012).

We seek to contribute to extant literature by proposing an empirical analysis of the effects of openness - focusing on the nature of acquired intangible assets versus internally developed assets - on firm performance, measured according to three dimensions: 1) Economic performance – through the value of turnover; 2) Financial performance – the value of firm stock

prices; and 3) Human capital performance – the level of firm employment. To do so, we use an unbalanced panel data of 329 European companies listed in the five major markets – United Kingdom, Germany, France, Italy and Spain, over the period 2008-2013.

Results show that the effects of both internal development and external acquisition are positive and significant across different dimensions, but their output varies in terms in magnitude and distribution: both variables are positively and significantly correlated with turnover, and their effect is almost equal. In addition, we find that only development is positively and significantly correlated with the other two dimensions of performance, once we control for firm-specific time trends. Once we control for relative size of firms in the sample, we see that the effect of openness is more spread out across different class sizes, while the effect of development of intangibles influences the economic performance only for larger firms, and increases employment only for relatively smaller firms, while it has no effect on the financial side of performance.

The structure of the paper is the following: in the next paragraph, we will briefly review the OI literature to sort out how performance is measured by extant contributions and the direction of the relationship between openness and performance proposed by scholars. Then, we introduce the research design and methodology used in our study. In the findings section, we present the results of the econometric analysis. Finally, we list the article's contributions and implications for academics and professionals in the field, we address the limitations of the study and include suggestions for further research.

5.2 Literature review

5.2.1 Open Innovation and performance measurement

5.2.1.1 How is Open Innovation measured?

Ever since the introduction of the term "Open Innovation" (Svensson et al., 2010), a number of studies focused on the effects of "openness" on firm performance. The seminal contribution in this OI topic is Laursen and Salter's (2006) article, where the authors address the role of openness in determining firm's innovation performance. They introduce two variables: *search breadth* – the number of external sources the firm relies on in conducting innovation – and *search depth* – the extent on which firms deeply rely on each of these sources. They operationalize the two measures by analyzing the level of interaction firms have with various

categories of external actors, including: market sources, institutional sources, specialized sources, or other sources. They find that both indicators have a curvilinear relationship with innovation performance. The same indicators have been widely adopted by subsequent studies (Bogers & Lhuillery, 2011; Chiang & Hung, 2010; Vahter, Love, & Roper, 2014), becoming the *de facto* standard measures to evaluate openness.

These indicators bring an effective and comparable measure to evaluate the firm level of openness, i.e. the organizational propensity towards the external environment. However, they are self-reported and subjective, thus failing to consider the actual investments in external assets conducted by the firm. So far, extant literature has focused on the propensity to cooperate with various stakeholders, without measuring the value of such transactions. In our view, more objective measures are required to evaluate the impact of acquired assets over performance. Since the choice of development of assets or their acquisition represents alternative choices, such measures should allow for comparisons between the effects of externally acquired and internally developed assets on performance.

5.2.1.2 How is performance measured?

Starting from Laursen and Salter's (2006) contribution, a number of studies have tried to address the relationship between openness and performance. However, various authors have so far used the same label – performance – to measure different dimensions such as: firm's performance (De Zubielqui et al., 2016; Rass et al., 2013), Research & Development (R&D) performance (Suh & Kim, 2012), firm's success (Nitzsche et al., 2016), firm growth (Love et al. 2011), innovativeness/innovation performance (J. Chen, Chen, & Vanhaverbeke, 2011; Egbetokun, 2015; Spithoven et al., 2010) and product/NPD performance (Gesing et al., 2015; Praest Knudsen & Bøtker Mortensen, 2011).

We list the number of extant quantitative studies which address the relationship between openness and performance - with particular attention to the variables used in the analysis - in Table 35 (in the Appendix section). We argue that extant contributions present two main limitations: sample specific restrictions and the definition of the output "performance" variable.

As regards the first issue, all the contributions presented in Table 35 use country or sector-specific samples. While this choice favors the recognition of specific patterns of openness, it does not allow confrontation of results across various contexts, thus failing to address the existence of cross-national or cross-sectoral patterns over time. In addition, much

literature focuses on various "innovation-related" measures as the performance output, including scale measures for innovation performance (Cruz-González et al., 2015; Pullen et al., 2012), continuous measures of innovation outputs, such as the number of new or significantly improved products (Hwang et al., 2009; Mention, 2011), or percentage measures, such as the share of sales from innovative products/services (Y. Chen et al., 2016; Gesing et al., 2015). While these measures provide objective indicators of the output of innovation efforts put through by companies, they do not directly address the effect on firm overall performance: using ratios of innovation over firm revenues does not guarantee that the firm will experience an increase in the latter, since the increasing incidence of innovation may come at expenditure of overall sales results. To avoid distortion of results, we rely on objective and comparable performance measures of firm performance, namely firm sales, shares value and employment levels.

5.2.2 Open Innovation and performance

OI literature is yet to find consensus on the openness – performance relationship. In the next paragraphs, we review significant extant contributions in the field.

5.2.2.1 Positive effects

Chen et al (2011) show that both scope and depth of openness have a positive effect on the company's innovation performance. Similarly, Pullen et al (2012), study the effects of firm network characteristics on innovation performance and find that goal complementarity is positively related to innovation performance. Rass et al (2013) posit a positive relationship between the implementation of OI instruments and performance, and a positive relationship between the former and firm social capital. Results show that firm social capital acts as a positive moderator, positively influencing firm performance in the implementation of OI practices. Gesing et al (2015) address the effects of governance modes and collaboration types on firm NPD performance, measured as the share of revenues from products that are new to the firm and the share of revenues from products that are new to the market. They find that formal collaborations with both market-based and science-based partners show a stronger positive and significant effect on revenue shares from new-to-the-firm and new-to-the-market products compared to informal collaborations. Egbetokun (2015) finds that the breadth of firms' network portfolio – the number of external knowledge sources – has a positive effect on both the firms'

overall innovation and product innovation performance. In addition, the variety of informal collaboration has a positive impact on firms' innovativeness, while the variety of formal arrangements has a minor impact, as it only partially increases the overall innovation performance. Nitzsche et al (Nitzsche et al., 2016) show that absorptive capacity, open culture, connectivity, strategic and structural flexibility all have a positive and significant effect on firm's innovation success.

5.2.2.2 Negative and non-linear effects

Suh & Kim (2012) study the effects of four different type of collaboration activities – in-house R&D, technology acquisition or licensing, R&D collaboration and networking - on firm R&D performance, measured in terms of product/service innovation, process innovation and patents produced by firms, find that non-collaboration (in-house R&D) is an efficient strategy, while networking is the most inefficient strategy when considering all innovation outputs.

Again, Laursen & Salter (2006) find that both search breadth and depth have an inverted U-shaped relationship with innovation performance. Similarly, Garcia Martinez et al (2017) find an inverted U-shape correlation between the impact of alliance portfolio diversity on firm incremental and radical innovation performance. Love et al (Love et al., 2011) find that firms' internal organization, the presence of external public support and increasing competition, and the creation of ties with commercial laboratories have a positive effect on the firm innovative performance – innovative sales – while increasing openness is positively but non-significantly related with innovation.

5.2.2.3 Summary

In short, extant OI literature has so far focused on defining the level of openness of the company – measured through the extent of relationships with external counterpart, failing to consider the value of the acquired assets, and their effects of performance in comparison with the development of the same products on performance. In addition, while the use of "innovation" related indicators as the output of the innovation process provides a useful indicator on the success of innovation-related activities, it does not tell us how such output influences firm's overall performance, i.e. revenue growth. Finally, we see heterogeneous views in defining the relationship between openness and performance, since the multiple works show that openness

has beneficial effects on performance, while other studies argue that the relationship is negative, or rather non-linear.

Hence, we seek to contribute to extant literature by proposing an empirical analysis of the effects of openness - focusing on the nature of acquired intangible assets versus internally developed assets - on performance, measured in terms of overall sales, firm shares value, and the level of employment. To do so, we use an unbalanced panel data of 329 European companies listed in the five major markets – United Kingdom, Germany, France, Italy and Spain, over the period 2008-2013. Details about the research design are presented in the following section.

5.3 Research design

5.3.1 Sample

The empirical analysis relies on a panel regression analysis. The data collection process consisted of two main steps. First, a preliminary analysis was conducted on all companies listed on stock market exchanges (London, Frankfurt, Paris, Milan and Madrid) of the five largest European countries. All these countries have adopted IFRS (International Financial Reporting Standards) provisions, hence the data is assumed to be comparable.

The data collection process started with the collection of all 2178 companies listed on the abovementioned Stock Exchange markets for fiscal year 2008. From this first group, we excluded all the companies that did not provide financial information using IAS/IFRS principles. Then we continued excluding firms that did not meet our selection criteria: *identifiability, control and the existence of future economic benefits.* Moreover, all the companies involved in financial services were excluded from the sample[9],. The same collection procedures have been accepted in previous studies (Denicolai, Cotta Ramusino, & Sotti, 2015; Denicolai, Ramirez, & Tidd, 2014; Denicolai et al., 2016)

From the initial sample, we were able to select 328 companies following all the eligibility criteria. We extended the original sample by including the following years, up to 2013. The final sample consists of 328 companies over 2008-2013, thus 1968 firm-year observations. From this value, we subtracted a number of companies which have been removed from listing or acquired in the reference period. The final sample is an unbalanced panel data

[9] Because of the composition of their intangible assets, almost entirely externally generated and not providing any value added in terms of innovation

consisting of 1896 firm-year observations. Country and industry distribution of the sample are presented in Table 27 and Table 28. We complemented the data with the extraction of the same dataset using Bureau van Dijk's ORBIS Software.

Table 27: Sample distribution by country and year

	2008	2009	2010	2011	2012	2013	Total	Distribution
UK	153	153	153	150	135	135	879	46,36
France	53	53	53	53	53	50	315	16,61
Germany	80	80	80	79	69	63	451	23,79
Italy	22	22	22	22	22	22	132	6,96
Spain	20	20	20	20	20	19	119	6,28
Total	*328*	*328*	*328*	*324*	*299*	*289*	*1896*	*100,00*
Distribution column is expressed in percentages								

Table 28: Sample distribution by industry and year

	2008	2009	2010	2011	2012	2013	Total	Distribution
Automobiles and parts	14	14	14	13	13	12	80	4,22
Chemicals	7	7	7	7	7	7	42	2,22
Consumer goods	14	14	14	14	14	12	82	4,32
Healthcare	38	38	38	38	36	36	224	11,81
Industrial goods	114	114	114	114	104	104	664	35,02
Media	21	21	21	21	20	19	123	6,49
Technology	94	94	94	92	82	77	533	28,11
Telecommunications	18	18	18	18	16	15	103	5,43
Other	8	8	8	7	7	7	45	2,37
Total	*328*	*328*	*328*	*324*	*299*	*289*	*1896*	*100,00*
Distribution column is expressed in percentages								

5.3.2 Measures

5.3.2.1 Dependent variables

We adopted three different indicators to express performance: 1) economic performance, measured through firm turnover, in logarithmic form (TURN); 2) financial performance, measured through the value of shares at the end of each year included in the sample (SHARES); and 3) human capital performance, measured through the number of employees and full-time equivalents reported at the end of each year included in the sample (EMPL).

5.3.2.2 Independent variables

Independent variables considered in the model include internally generated intangible assets, externally acquired intangible assets and dummy variables to indicate the specific types of assets the company invested into.

Internally developed intangible assets (INT IA), include intangibles that arose from internal activities during the fiscal year considered, besides goodwill. Externally acquired intangible assets (EXT IA), conversely, include all externally generated intangible assets, both singularly acquired and or acquired as part of a business combination. For both variables, we use the logarithmic value of the amount spent by the firm, in Euros.

5.3.2.2 Control variables

Finally, we included control variables, namely industry effects and country effects through, using dummy variables. In addition, we controlled for innovation propensity of firms, expressed as the logarithmic value of amount of R&D expenditure reported at the end of each year included in the sample, in Euros. A summary of the variables used is presented in Table 29.

Table 29: Operationalization of variables

Group	Variable	Description	Type	Operationalization
Control	Country	Country of the listed firm	Dummies	UK = United Kingdom FR = France GE = Germany IT = Italy SP = Spain
	Industry	Reference industry for the listed firm	Dummies	AUTO = Automobiles and parts CHEM = Chemicals CG = Consumer goods HC = Healthcare IND = Industrial goods MEDIA = Media TECH = Technology TELCO = Telecommunications OTH = Other
	Year	Reference year	Dummies	Y8 = Year 2008 Y9 = Year 2009 Y10 = Year 2010 Y11= Year 2011 Y12 = Year 2012 Y13 = Year 2013
	R&D	Research and Development expenditure at the end of each reference year	Continuous	Log (R&D)
Independent	INT IA	Value of Internally generated intangible assets at the end of each reference year	Continuous	Log (INT IA)
	EXT IA	Value of Externally acquired intangible assets at the end of each reference year	Continuous	Log (EXT IA)
Dependent	TURN	Firm turnover at the end of each reference year	Continuous	Log (TURN)
	SHARES	Value of firm shares at the end of each reference year	Continuous	Log (SHARES)
	EMPL	Number of firm's employees and full-time equivalens at the end of each reference year	Continuous	Log (EMPL)

5.3.3 Empirical strategy

The identification strategy is based on panel data regression where we are able to control for firm-level fixed effects and firm-specific linear time trend and on a GMM-system estimator (Blundell & Bond, 1998).

Our baseline empirical specification is the following:

$$Perf_{ijkt} = \beta_{0jkt} D_{kjt} + \beta_1 OI_{it} + \beta_2 X_{it} + \varepsilon_{it} \qquad (1)$$

where D_{kjt} are sector (j) - country (k) - year (t) dummies, i.e. triple interactions of these variables; OI_{it} is our variable of interest, that is the amount of money invested in OI practices by firm i in year t and X_{it} is a vector of time-variant firm-specific controls

In our baseline specification (1) we are not able to control for firm level time-invariant heterogeneity that could affect performance and OI practices at the same time. In order to include these factors, we rely on a second specification where we add firm-specific Fixed Effects (FEs) and year dummies:

$$Perf_{it} = \alpha_{1i} D_i + \tau_t + \beta_1 OI_{it} + \varepsilon_{it} \qquad (2)$$

In this specification, the identification of our parameter of interest β_1 relies on within-firm variation in OI over time (i.e. firms are allowed to start from different intercepts). FEs allow us to control for time-invariant unobserved heterogeneity which might affect performance.

We also estimate a more demanding specification including both firm specific intercepts and firm specific time trends, allowing them to follow different trends in the outcome variables, which is:

$$Perf_{it} = \alpha_{1i} D_i + \tau_t + \beta_1 OI_{it} + \beta_2 (D_i * t) + \varepsilon_{it} \qquad (3)$$

where the β_{3i}s are the firm-specific linear time trends.

This may address the concern that firms who saw an improvement in performance associated to an increase in OI activities may have been already on an increasing trend before the investments in OI practices.

Finally, we include a quantile regression analysis in order to check for differences in the effect of OI at different percentiles of the outcome variables.

5.4 Findings

5.4.1 Descriptive results

Table 30 shows the summary statistics of the variables used in the econometric analysis. In particular, firms in the sample spend, on average, 36 million Euros per year in development of intangible assets and 52 million Euros per year in acquisition of intangible assets over the 2008-2013 period. As regards dependent variables, firms in the sample have an average turnover of 3.9 Billion Euros on average, employ 16.800 full-time personnel per year and have an average stock price of 17.77 Euros over the selected period.

Table 30: Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
TURN	1581	3920000000	14700000000	1	203000000000
EMPL	1576	16802,50	60776	0	648254
SHARES	1291	17,77	45,76	0	641
INT IA	1781	36200000	202000000	-656000	4020000000
EXT IA	1771	52300000	260000000	-1038885	3540000000

5.4.2 Econometric results

The following tables (Table 31 - Table 33) show the results of the econometric models used in the study. All tables consist of two panels. Panel A reports the results using the expenditure in internally generated intangible assets and panel B those using expenditure in externally acquired intangible assets. Column (1) presents the estimates of the specification with triple interactions (equation 1), column (2) shows the estimated values from the equation with firm-specific FEs, in column (3) firm-specific time-trends are added to the specification in column (2). Finally, in columns (4) - (6) we present estimates for the quantile regressions at the 50^{th}, 80^{th} and 20^{th} percentiles. Table 31 investigates the effect of expenditure on intangible assets on firms' (log) turnover.

Table 31: Effect of expenditure of Intangible Assets on firms' log (Turnover)

	Eq. (1)	Eq. (2)	Eq. (3)	P50	P80	P20
Panel A. Internal IA						
log(internalIA)	0.095***	0.069***	0.025*	0.037***	0.032**	0.018
	(0.028)	(0.022)	(0.014)	(0.014)	(0.013)	(0.016)
Number of obs	1150	1154	1154	1154	1154	1154
R^2	0.948	0.990	0.998	0.934	0.943	0.937
Panel B. External IA						
log(externalIA)	0.127***	0.047***	0.026*	0.024***	0.014***	0.017***
	(0.019)	(0.012)	(0.014)	(0.004)	(0.004)	(0.006)
Number of obs	1193	1200	1200	1200	1200	1200
R^2	0.944	0.990	0.996	0.932	0.941	0.932
control variables (both panels):						
SectorXcountryXyear	Yes	No	No	No	No	No
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Firm time trends	No	No	Yes	No	No	No
Year dummies	No	Yes	Yes	Yes	Yes	Yes
Other firm-level controls	Yes	No	No	No	No	No

*, **, *** statistically significant at the 10, 5 and 1% level. Standard errors are clustered at the firm level.

Results in Column (1) show that both development and acquisition of intangible assets is significantly correlated with turnover (0.095, p-value < 0.001 and 0.127, p-value < 0.001, respectively). If we assume firms are homogeneous, it seems that intangible assets generate positive results on turnover, irrespective of their source. Specifically, the acquisition of external intangible assets generates a *vis-à-vis* greater effect on the dependent variable. The argument is aligned with the finding of positive effects of openness – measured as the extent of acquisition of external intangible assets (i.e. J. Chen et al., 2011; Rass et al., 2013).

Adding controls for firm fixed effects and year dummies in column (2), results still show a positive and significant correlation for both asset development and acquisition with turnover (0.069, p-value < 0.001 and 0.047, p-value < 0.001, respectively). By controlling for firm heterogeneity, results show that both development and acquisition of intangibles have a positive effect on turnover, and that the effect of the former exceeds the latter: a 1% increase in expenditure for development generates a 0.069% increase in turnover, while a 1% increase in expenditure for acquisition generates a 0.043% increase. While the argument is still aligned with the positive effect on turnover generated by inbound openness, results in this specification show that the degree of incidence is *vis-à-vis* lower than the one generated by development.

To address this issue, we control for the presence of firm-specific time trends in column (3). Again, results return a positive and significant correlation with turnover for both development (0.025) and acquisition (0.026), both significant at the 10% level. By isolating the effects of firm-specific time trend, we see that external assets have a marginally greater effect on turnover than internally-developed assets: a 1% increase in the former leads to a 0.025% increase in turnover, while a 1% increase in the latter leads to a 0.026% increase in turnover. Results show that positive effects are consistent throughout the specifications, and their influence on the dependent variable, once we add controls, is almost equal.

For further specification, we added quantile regressions to verify whether there are differences in magnitude when compared to firm size. Results in column (4) – (6) show that the effects of development are positive and consistent for larger firms – in the 50th and 80th percentile of the sample – while for relatively smaller firms they are not. In contrast, the positive relationship between acquisition of intangibles and turnover is consistent throughout size classes, with a marginally greater effect for firms in the 50th percentile (0.024, p-value 0.001) than in the 20th and 80th percentile (0.017, p-value 0.001 and 0.0014, p-value 0.01, respectively).

In this light, we argue that asset acquisition (i.e. increasing inbound openness) generates positive results on firm performances, irrespective of their size, while development generates positive results (an increase in sales) only when companies are sufficiently large to exploit the outcomes of internal R&D. This, we believe, confirms that internal and external intangible assets are complements, rather than substitutes (Denicolai et al., 2016).

In Table 32 we repeat the same analysis of Table 31 for a different dependent variable, stock prices.

Table 32: Effect of expenditure of Intangible Assets on firms' log (Share price)

	Eq. (1)	Eq. (2)	Eq. (3)	P50	P80	P20
Panel A. Internal IA						
log(internalIA)	0.057	0.067**	0.066**	0.033	0.038	0.046
	(0.053)	(0.026)	(0.028)	(0.027)	(0.028)	(0.036)
Number of obs	922	922	922	922	922	922
R^2	0.685	0.950	0.987	0.813	0.835	0.837
Panel B. External IA						
log(externalIA)	0.075*	0.045**	-0.007	0.031***	0.037***	0.011
	(0.044)	(0.020)	(0.014)	(0.009)	(0.007)	(0.010)
Number of obs	997	997	997	997	997	997
R^2	0.608	0.939	0.982	0.796	0.822	0.814
control variables (both panels):						
SectorXcountryXyear	Yes	No	No	No	No	No
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Firm time trends	No	No	Yes	No	No	No
Year dummies	No	Yes	Yes	Yes	Yes	Yes
Other firm-level controls	Yes	No	No	No	No	No

*, **, *** statistically significant at the 10, 5 and 1% level. Standard errors are clustered at the firm level.

Results in column (1) show a non-significant relationship between development of intangible assets and financial performance (shares value), and a positive relationship between acquisition and the dependent variable (0.075, p-value < 0.1). By isolating the effects of sector, country and year specification, the expenditure on development of internal intangible assets does not appear to be correlated with financial performance, while expenditure on acquisition seems to be positively correlated with an increase in stock prices.

In column (2), results for both variables are both positive and consistent (0.067 and 0.045, respectively). Both results are consistent at the 5% level.

When controlling for firm-specific time trends in column (3), results show contrasting results to column (1): development is positively associated with firm stock price (0.066), and the relationship is consistent at the 5% level. In contrast, the effect of acquisition is negative (-0.007), although close to zero and non-significant.

Quantiles in column (4) – (6) show that development is not-significantly related with share values across all groups, while asset acquisition has a positive and significant effect for relatively larger firms in the 50th and 80th percentile (0.031 and 0.037, respectively), and such effects are significant at the 1% level, while for relatively smaller firms – in the 20th percentile – the relationship is positive but non-significant.

Here, we argue that results are consistent with the resource-based view of the firm (Barney, 1991) since firms' proprietary technologies may represent the source of competitive advantage on the market, hence they reflect a positive effect on investors' expectations which in turn increases the stock value. In contrast, acquisition of external technology does not influence financial performance, since purchased technology is seldom unique, and therefore easily replicable by competitors.

As in Table 31 and Table 32, in Table 33 we repeat the same analysis, using the level of employment – measured as the logarithmic form of the number of firm employees – as the dependent variable.

Table 33: Effect of expenditure of Intangible Assets on firms' log (Employment)

	Eq. (1)	Eq. (2)	Eq. (3)	P50	P80	P20
Panel A. Internal IA						
log(internalIA)	0.044**	0.052***	0.035**	0.031***	0.027	0.027***
	(0.022)	(0.015)	(0.016)	(0.010)	(0.016)	(0.006)
Number of obs	1150	1150	1150	1150	1150	1150
R^2	0.945	0.989	0.994	0.940	0.949	0.942
Panel B. External IA						
log(externalIA)	- 0.007	0.027***	0.007	0.021***	0.014***	0.012***
	(0.018)	(0.008)	(0.007)	(0.004)	(0.003)	(0.004)
Number of obs	1193	1193	1193	1193	1193	1193
R^2	0.935	0.988	0.993	0.937	0.947	0.936
control variables (both panels):						
SectorXcountryXyear	Yes	No	No	No	No	No
Firm FE	No	Yes	Yes	Yes	Yes	Yes
Firm time trends	No	No	Yes	No	No	No
Year dummies	No	Yes	Yes	Yes	Yes	Yes
Other firm-level controls	Yes	No	No	No	No	No

*, **, *** statistically significant at the 10, 5 and 1% level. Standard errors are clustered at the firm level.

Results in column (1) show the presence of a positive and significant relationship between development of intangible assets and the level of employment (0.044, p-value <0.05). A 1% increase in firm's expenditure for development of intangibles creates a 0.044% increase in the number of employees. In contrast, acquisition of intangible assets is not significantly correlated with employment.

In column (2), both explanatory variables are positively and significantly related with the dependent variable at the 1% level, and the effect of development (0.052) is higher than the

effect of acquisition (0.027): while both actions increase firm employment, the impact of the former is *vis-à-vis* greater than the latter.

Results in column (3) show that – however - only development appears to be positively and significantly related with the level of employment (0.035, p-value < 0.05). Acquisition, in contrast, has a positive effect on the dependent variable, although it is close to zero (0.007) and non-significant.

Quantile distribution shows that the effects of development for relatively smaller groups of firms - 20th and 50th percentile – are positive and significant at the 1% level (0.027 and 0.031, respectively), while for firms in the 80th percentile the effect on employment is non-significant. Acquisition of intangible assets, in contrast, generates positive and significant results on employment across all size classes.

We argue that – in terms of employment – development of resources generates higher returns: when investing creating new technology, companies tend to bring in additional employees to conduct R&D. Instead, when they leverage on the acquisition of technology, they tend not to increase the number of employees, but rather rely on the firm's absorptive capacity (W. M. Cohen & Levinthal, 1990; Denicolai et al., 2016) to integrate the acquired assets.

5.4.3 Summary

Summarizing the results, we see that when controlling for sector-, country-, and year-specific effects, development and acquisition of intangible assets generate different results: both affect the economic side of performance of a firm, measured in terms of turnover. Their effects on the financial and human capital side of performance, however, is different: development of intangible assets generate a positive effect on the level of employment, while acquisition of external intangible assets has a marginally positive effect on financial performance – measured as the value of firm stocks.

Controlling for firm-specific fixed effects, we find a positive and significant effect of both internally-developed and external intangible assets. Results are consistent across all models: both variables generate positive results in terms of economic, financial and human capital performance. For all three dimensions, the effect of development is marginally greater than acquisition.

In column (3), we find that both explanatory variables are positively related with firms' economic performance, and that the effects of both variables on turnover is almost equal: a 1%

increase in development of intangibles generate a 0.025% increase in turnover, while the same increase in acquisition generates a 0.026% increase. In addition, we find that development of intangible assets is correlated with the other two performance dimensions, while acquisition is not.

Quantile distributions show that acquisition has a positive and consistent correlation among all class sizes with the economic and human capital dimension of performance, while in terms of financial performance the effect is significant only for relatively larger-sized firms (in the 50th and 80th percentile of the sample). Differently, development of assets generates a positive result on economic performance only for relatively larger firms, and a positive effect on the level of employment only for relatively smaller firms, while we find no significant correlation with financial performance.

5.5 Discussion and conclusions

The article builds on OI literature to measure the relationship between the level of openness and firm performance, measured through various dimensions. Results show that the effects of both development and acquisition are positive and significant across different dimensions, but their output varies in terms in magnitude and distribution: both variables are positively and significantly correlated with turnover, and that their effect on the latter is almost equal. In addition, we find that only development is positively and significantly correlated with the other two dimensions of performance, once we control for firm-specific time trends. Once we control for relative size of firms in the sample, we see that the effect of openness is more spread out across different class sizes, while the effect of development of intangibles influences the economic performance only for larger firms, and increases employment only for relatively smaller firms, while it has no effect on the financial side of performance.

5.5.1 Contributions

We argue that the article provides many contributions to existing literature: first, it clarifies the dimensions considered to evaluate the level of openness, the level of performance and the relationship between the two dimensions. Then, it builds on extant literature to overcome existing limitations, proposing the measurement of inbound openness through the use of objective indicators, the amount invested in the acquisition of externally-developed intangible

assets and the amount invested by the firm in the development of intangible assets. Such variables provide more reliable indicators of firm propensity to openness than scale measures adopted so far by OI literature (Egbetokun, 2015; Ferreras-Méndez, Newell, Fernández-Mesa, & Alegre, 2015; Laursen & Salter, 2006). In addition, the paper proposes the study of the effects of development versus acquisition on three different dimensions for performance: 1) economic; 2) financial; and 3) human capital.

5.5.2 Limitations

We argue that in this form the paper suffers from three main limitations: first, since it studies the effects of openness versus development using a sample of European companies, it misses out on the behavior of firms from different regions. In addition, since the sample only refers to listed company, we cannot control for smaller-sized firms. Finally, we did not control for the types of intangible assets – whether internal or external – the firms in the sample invest into, therefore missing on sorting out differences among various categories (patents, trademarks, concessions, etc.).

5.5.3 Implications

We believe the article is of interest for both scholars and practitioners. For researchers, the paper provides the basis for overcoming current limitations of OI studies in evaluating the relationship between openness and performance. The inclusion of objective measures of firm propensity for openness – i.e. the level of investment in external intangible assets – provides a more reliable indicator than scale measures derived from secondary data. In addition, the definition of multiple dimensions of performance help in highlighting the presence of different effects of development versus acquisition across the dimensions.

For managers, we argue that the choice in investing on development of intangibles versus acquisition leads to similar positive results in terms of economic performance, although it seems that the latter is marginally more effective than the former. In contrast, such investments do not directly affect other dimensions such as financial and human capital performance, although we see a marginally significant lagged effect of development on employment.

5.5.4 Further studies

For scholars, the work leaves room for the proposition of similar quantitative studies in different regions, provided that financial data are exhaustive and adopt the same accounting standards across countries. In addition, the inclusion of small- or medium-sized firms could highlight the presence of differences of behavior across size-classes, as posited by previous works (van de Vrande et al., 2009). Finally, the inclusion of indicators for the amount invested by each company in different intangible asset classes could provide more suitable implications for professionals in the innovation field.

6. General conclusions

We believe this work helps extending the comprehension of Open Innovation and its diffusion by verifying the adoption of Open Innovation practices outside the corporate-based environment; by linking Open Innovation with the market-entry theory, and provides a fruitful contribution to the ongoing debate on the relationship between openness and firm performance.

As regards the first issue, the paper in Chapter 3 highlights that Open Innovation practices – inbound, outbound and coupled practices - may be adopted outside the spectrum of a business environment. Specifically, the proposed case study highlights that the chosen lab indeed does that, although the degree of implementation of outbound and coupled practices is higher than the degree of inbound-related activities. Respondents seem to be more prone to engage in collaborations with industrial counterparts and seek ways to externalize and promote their own research, but rather rely on internal resources when conducting innovation-related activities.

The paper in Chapter 4 shows a first attempt to empirically test the relationship between entry timing strategies, firm openness, and firm performance. Results highlight that while the degree of inbound openness is associated with the growth of firm turnover, there exists a negative effect on firm turnover when firms try leveraging on the acquisition of externally-generated assets and adopt a lean market entry strategy at the same time. We believe that fast entrance and openness reflect alternative approaches to market-entry, although extant Open Innovation literature posits the existence of a positive correlation between the degree of openness and the pace to market commercialization.

The paper in Chapter 5 tries overcoming the limitations of extant contributions that link inbound Open Innovation with firm performance. To do so, it proposes the measurement of inbound openness through the use of objective indicators, i.e. the amount invested in the acquisition of externally-developed intangible assets, together with the amount invested by the firm in the internal development of intangible assets on: 1) economic; 2) financial; 3) and human capital performance. Results show that the effects of both internal development and external acquisition are positive and significant across different dimensions, but their output varies in terms in magnitude and distribution. Specifically, only internal development is positively and significantly correlated all the three dimensions of performance, once we control for firm-specific time trends, and when we add controls for relative firm size we find that the

effect of internal development of intangible assets influences the economic performance of large firms, increases employment only for relatively smaller firms, while it has no effect on the financial side of performance. External acquisition, conversely, has a positive effect throughout the three dimensions and across various class sizes.

We argue that the contributions of the three essays are of interest for both scholars and practitioners. Specifically, for scholars, the article in Chapter 3 provides a link between Technology Transfer and Open Innovation literature, and analyzes the adoption of Open Innovation practices in a non-corporate environment. In addition, it shows that university laboratories rather follow an outbound-oriented approach, while inbound activities are not yet developed, thus leaving room to subsequent quantitative studies of Open Innovation practices in university laboratories. Similarly, the paper in Chapter 4 matches the research stream of entry timing with Open Innovation. Results are partially in contrast entry-timing literature, since they show that strategic choices regarding when to enter are not marginally different from the approach of not having a strategy at all, since they do not increase firms' turnover growth. The results, again, leave room for subsequent empirical studies to verify such relationships. The article in Chapter 5 provides the basis for overcoming current limitations of open innovation studies in evaluating the relationship between openness and firm performance. The inclusion of objective measures of firm propensity for openness – i.e. the level of investment in external intangible assets – provides a more reliable indicator than scale measures derived from secondary data. In addition, the definition of multiple dimensions of performance help in highlighting the presence of different effects of internal development versus external acquisition across the dimensions.

For practitioners, we believe that the article in Chapter 3 may be helpful for university managers and for national policies regarding faculty evaluation: for the former, the study highlights that outlines that online communities are a valuable – yet untapped – resource to promote the results of university basic and applied research. Thus, we argue that investing in such activities may generate enormous results in overcoming the ivory tower (Nelson, 2014; Thursby & Thursby, 2002) and generating value for society. For the latter, we believe a shift in the evaluation policy for faculty towards with the inclusion of measures for technology transfer activities will accelerate the path to the discovery of breakthrough innovations and more active commercialization efforts. The paper in Chapter 4 can be useful for business managers, since 1) it confirms the existence of a positive relationship between the extent of inbound openness and firm performance, and 2) it shows that in the planning phase, the choice between openness

and a lean market-entry are alternatives, and the combined use of the two generates sub-optimal results. In this light, we argue, startups adopting a lean approach should rely on internally-generated assets, or decide to acquire technologies and delay their market entrance until those technologies are adequately integrated into firm routines. The article in Chapter 5 shows that the choice in investing on internal development of intangibles versus external acquisition lead to similar positive results in terms of economic performance, although it seems that the latter is marginally more effective than the former. In contrast, such investments do not directly affect other dimensions such as financial and human capital performance, although we see a marginally significant lagged effect on internal development on employment.

Overall, we this thesis work provides contributions for researchers and practitioners alike. Specifically, for scholars, our work extends literature on Open Innovation by linking it to other research frameworks – namely technology transfer and entry-timing strategy – and provides a contribution for the ongoing debate regarding the relationship between Open Innovation and firm performance. We believe the contributions, especially those in Chapter 3 and Chapter 4 may fuel further scholar debate on related topics. While we argue that such contributions are far from building new theory, still we believe that may be of interest for future studies to go beyond the bulk of extant studies regarding Open Innovation, thus expanding the study of the phenomenon for multiple types of organizations – business-driven or non-profit alike. In addition, we argue that the thesis can provide a contribution – albeit small – for strategic and managerial use of Open Innovation. In terms of strategy formulation, we posit that the adoption of an "Open" business model can be useful for any type of organization. Specifically, organizations may profit from the use of online communities, which are still rarely involved in innovation-related activities. However, executives should be aware of the temporal dimensions – i.e. when to allow openness. Specifically, we have seen that the presence of a negative interaction between increasing openness and the adoption of a lean market-entry strategic approach. Therefore, we suggest that openness works better at later stages of the firm life cycle – when its organization and market position is more consolidated.

References

Acworth, E. B. (2008). University-industry engagement: The formation of the Knowledge Integration Community (KIC) model at the Cambridge-MIT Institute. *Research Policy*, *37*(8), 1241–1254.

Alcácer, J., Dezs, C. L., & Zhao, M. (2013). Firm rivalry, knowledge accumulation, and MNE location choices. *Journal of International Business Studies*, *44*(5), 504–520.

Almirall, E., & Casadesus-Masanell, R. (2010). Open versus closed innovation: A model of discovery and divergence. *Academy of Management Review*, *35*(1), 27–47.

Andries, P., & Thorwarth, S. (2014). Should firms outsource their basic research? The impact of firm size on in-house versus outsourced R & D productivity. *Creativity and Innovation Management*, *23*(3), 303–317.

Arora, A., Athreye, S., & Huang, C. (2016). The paradox of openness revisited: Collaborative innovation and patenting by UK innovators. *Research Policy*, *45*(7), 1352–1361.

Asakawa, K., Nakamura, H., & Sawada, N. (2010). Firms' open innovation policies, laboratories' external collaborations, and laboratories' R&D performance. *R & D Management*, *40*(2), 109–123.

Aslesen, H. W., & Freel, M. (2012). Industrial Knowledge Bases as Drivers of Open Innovation? *Industry and Innovation*, *19*(7), 563–584.

Aylen, J. (2010). Open versus closed innovation: Development of the wide strip mill for steel in the United States during the 1920s. *R and D Management*, *40*(1), 67–80.

Balka, K., Raasch, C., & Herstatt, C. (2014). The effect of selective openness on value creation in user innovation communities. *Journal of Product Innovation Management*, *31*(2), 392–407.

Barge-Gil, A. (2010). Open, semi-open and closed innovators: Towards an explanation of degree of openness. *Industry and Innovation*, *17*(6), 577–607.

Barge-Gil, A. (2013). Open Strategies and Innovation Performance. *Industry and Innovation*, *20*(7), 585–610.

Barnett, W. P., Feng, M., & Luo, X. (2013). Social identity, market memory, and first-mover advantage. *Industrial and Corporate Change*, *22*(3), 585–615.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management*.

Belderbos, R., Cassiman, B., Faems, D., Leten, B., & Van Looy, B. (2014). Co-ownership of intellectual property: Exploring the value-appropriation and value-creation implications of co-patenting with different partners. *Research Policy*, *43*(5), 841–852.

Belleflamme, P., Lambert, T., & Schwienbacher, A. (2014). Crowdfunding: Tapping the right crowd. *Journal of Business Venturing*, *29*(5), 585–609.

Bengtsson, L., Lakemond, N., Lazzarotti, V., Manzini, R., Pellegrini, L., & Tell, F. (2015). Open to a Select Few? Matching Partners and Knowledge Content for Open Innovation

Performance. *Creativity and Innovation Management*, *24*(1), 72–86.

Berchicci, L. (2013). Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance. *Research Policy*, *42*(1), 117–127.

Bercovitz, J. E. L., & Feldman, M. P. (2007). Fishing upstream: Firm innovation strategy and university research alliances. *Research Policy*, *36*(7), 930–948.

Bhutta, M. F. (2015). Evolution and Otitis Media: A Review, and a Model to Explain High Prevalence in Indigenous Populations. *Hum Biol*, *87*(2), 92–108.

Bianchi, M., Campodall'Orto, S., Frattini, F., & Vercesi, P. (2010). Enabling open innovation in small- and medium-sized enterprises: How to find alternative applications for your technologies. *R and D Management*, *40*(4), 414–431.

Bianchi, M., Cavaliere, A., Chiaroni, D., Frattini, F., & Chiesa, V. (2011). Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis. *Technovation*, *31*(1), 22–33.

Bianchi, M., Chiaroni, D., Chiesa, V., & Frattini, F. (2011). Organizing for external technology commercialization: evidence from a multiple case study in the pharmaceutical industry. *R&D Management*, *41*(2), 120–137.

Bianchi, M., Croce, A., Dell'Era, C., Di Benedetto, C. A., & Frattini, F. (2016). Organizing for Inbound Open Innovation: How External Consultants and a Dedicated R&D Unit Influence Product Innovation Performance. *Journal of Product Innovation Management*, *33*(4), 492–510.

Bianchi, M., Frattini, F., Lejarraga, J., & Di Minin, A. (2014). Technology exploitation paths: Combining technological and complementary resources in new product development and licensing. *Journal of Product Innovation Management*, *31*(S1), 146–169.

Bianchi, M., & Lejarraga, J. (2016). Learning to license technology: the role of experience and workforce' s skills in Spanish manufacturing firms. *R & D Management*, 691–705.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal For Econometrics*, *87*(I), 115–143.

Bodas Freitas, I. M., Geuna, A., & Rossi, F. (2013). Finding the right partners: Institutional and personal modes of governance of university-industry interactions. *Research Policy*, *42*(1), 50–62.

Bogers, M., & Lhuillery, S. (2011). A functional perspective on learning and innovation: Investigating the organization of absorptive capacity. *Industry and Innovation*, *18*(6), 581–610.

Bogers, M., & West, J. (2012). Managing distributed innovation: Strategic utilization of open and user innovation. *Creativity and Innovation Management*, *21*(1), 61–75.

Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. *Research Policy*, *29*(4–5), 627–655.

Breznitz, S. M., O'Shea, R. P., & Allen, T. J. (2008). University commercialization strategies in the development of regional bioclusters. *Journal of Product Innovation Management*,

25(2), 129–142.

Brunswicker, S., & Vanhaverbeke, W. (2015). Open Innovation in Small and Medium-Sized Enterprises (SMEs): External Knowledge Sourcing Strategies and Internal Organizational Facilitators. *Journal of Small Business Management*, *53*(4), 1241–1263.

Burcharth, A. L. D. A., Knudsen, M. P., & Søndergaard, H. A. (2014). Neither invented nor shared here: The impact and management of attitudes for the adoption of open innovation practices. *Technovation*, *34*(3), 149–161.

Burnside, B., & Witkin, L. (2008). Forging Successful University-Industry Collaborations. *Research Technology Management*, *51*(2), 26–30.

Calantone, R. J., & Anthony Di Benedetto, C. (2000). Performance and time to market: accelerating cycle time with overlapping stages. *IEEE Transactions on Engineering Management*, *47*(2), 232–244.

Caner, T., Sun, J., & Prescott, J. E. (2014). When a firm's centrality in R&D alliance network is (not) the answer for invention: The interaction of centrality, inward and outward knowledge transfer. *Journal of Engineering and Technology Management - JET-M*, *33*, 193–209.

Cappelli, R., Czarnitzki, D., & Kraft, K. (2014). Sources of spillovers for imitation and innovation. *Research Policy*, *43*(1), 115–120.

Chatenier, E. Du, Verstegen, J. A. A. M., Biemans, H. J. A., Mulder, M., & Omta, O. (2009). The challenges of collaborative knowledge creation in open innovation teams. *Human Resource Development Review*, *8*(3), 350–381.

Chen, J., Chen, Y., & Vanhaverbeke, W. (2011). The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. *Technovation*, *31*(8), 362–373.

Chen, J. W., Zhang, J. S., Wang, Z., & Wang, J. K. (2011). Research on Product Open Innovation Design Based on Knowledge. *Advanced Materials Research*, *230–232*, 819–823.

Chen, Y., Vanhaverbeke, W., & Du, J. (2016). The Interaction between Internal Capabilities and External Knowledge Sourcing: An Empirical Study of Chinese Firms. *R & D Management*, *S3*, 1006–1023.

Cheng, C. C. J., & Huizingh, E. K. R. E. (2014). When Is Open Innovation Beneficial? The Role of Strategic Orientation. *Journal of Product Innovation Management*, *31*(6), 1235–1253.

Cheng, C. C. J., Yang, C., & Sheu, C. (2016). Effects of open innovation and knowledge-based dynamic capabilities on radical innovation: An empirical study. *Journal of Engineering and Technology Management - JET-M*, *41*, 79–91.

Chesbrough, H. (2004). Managing open innovation. *IEEE Engineering Management Review*, *32*(2), 52–56.

Chesbrough, H., & Crowther, A. K. (2006). Beyond high tech: Early adopters of open innovation in other industries. *R and D Management*, *36*(3), 229–236.

Chesbrough, H. W. (2003). The Logic of Open Innovation: Managing Intellectual Property. *California Management Review*, *45*(3), 33–58.

Chesbrough, H. W. (2007). Why Companies Should Have Open Business Models. *MIT Sloan Management Review*, 21–28.

Chesbrough, H. W., & Garman, A. R. (2012). How open innovation can help you cope in lean times. *IEEE Engineering Management Review*, *40*(3), 58–66.

Chevalier-Roignant, B., Flath, C. M., Huchzermeier, A., & Trigeorgis, L. (2011). Strategic investment under uncertainty: A synthesis. *European Journal of Operational Research*, *215*(3), 639–650.

Chiang, Y. H., & Hung, K. P. (2010). Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows. *R and D Management*, *40*(3), 292–299.

Chiaroni, D., Chiesa, V., & Frattini, F. (2003). Platform leadership: how intel, microsoft, and cisco drive industry innovation [Book Review]. *IEEE Engineering Management Review*, *31*(4), 138–138.

Chiaroni, D., Chiesa, V., & Frattini, F. (2011). The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm. *Technovation*, *31*(1), 34–43.

Chou, C., Yang, K. P., & Jhan, J. (2015). Empowerment Strategies for Ideation through Online Communities. *Creativity and Innovation Management*, *24*(1), 169–181.

Christensen, J. F., Olesen, M. H., & Kjær, J. S. (2005). The industrial dynamics of Open Innovation - Evidence from the transformation of consumer electronics. *Research Policy*, *34*(10), 1533–1549.

Coase, R. H. (1937). The Nature of the Firm. *Economica*, *4*(16), 386–405.

Cohen, M. A., Eliashberg, J., & Ho, T. H. (1996). New product development: The performance and time-to-market tradeoff. *Management Science*, *42*(2), 173–186.

Cohen, W. M., & Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, *35*(1), 128.

Colombo, M. G., Franzoni, C., & Rossi-Lamastra, C. (2015). Internal social capital and the attraction of early contributions in crowdfunding. *Entrepreneurship: Theory and Practice*, *39*(1), 75–100.

Colyvas, J. A. (2007). From divergent meanings to common practices: The early institutionalization of technology transfer in the life sciences at Stanford University. *Research Policy*, *36*(4), 456–476.

Cooke, P. (2005). Regionally asymmetric knowledge capabilities and open innovation: Exploring “Globalisation 2” - A new model of industry organisation. *Research Policy*, *34*(8), 1128–1149.

Cruz-Cázares, C., Bayona-Sáez, C., & García-Marco, T. (2013). Make, buy or both? R&D strategy selection. *Journal of Engineering and Technology Management - JET-M*, *30*(3),

227–245.

Cruz-González, J., López-Sáez, P., Navas-López, J. E., & Delgado-Verde, M. (2015). Open search strategies and firm performance: The different moderating role of technological environmental dynamism. *Technovation*, *35*, 32–45.

D'Este, P., & Patel, P. (2007). University-industry linkages in the UK: What are the factors underlying the variety of interactions with industry? *Research Policy*, *36*(9), 1295–1313.

Dahlander, L., & Gann, D. M. (2010). How open is innovation? *Research Policy*, *39*(6), 699–709.

Dahlander, L., & Piezunka, H. (2014). Open to suggestions: How organizations elicit suggestions through proactive and reactive attention. *Research Policy*, *43*(5), 812–827.

Dandonoli, P. (2013). Open innovation as a new paradigm for global collaborations in health. *Globalization and Health*, *9*(1), 41.

De Zubielqui, G. C., Jones, J., & Lester, L. (2016). Knowledge Inflows from Market- and Science-based Actors, Innovation and Performance - a Study of SMEs. *International Journal of Innovation Management*, *20*(6), 1650055.

Decter, M., Bennett, D., & Leseure, M. (2007). University to business technology transfer-UK and USA comparisons. *Technovation*, *27*(3), 145–155.

Denicolai, S., Cotta Ramusino, E., & Sotti, F. (2015). The impact of intangibles on firm growth. *Technology Analysis and Strategic Management*, *27*(2), 219–236.

Denicolai, S., Ramirez, M., & Tidd, J. (2014). Creating and capturing value from external knowledge: The moderating role of knowledge intensity. *R and D Management*, *44*(3), 248–264.

Denicolai, S., Ramirez, M., & Tidd, J. (2016). Overcoming the false dichotomy between internal R&D and external knowledge acquisition: Absorptive capacity dynamics over time. *Technological Forecasting and Social Change*, *104*, 57–65.

Denicolai, S., Zucchella, A., & Moretti, F. (2017). Not So Similar After All: Exploring the Diversity of Strategic Orientations for Innovation. *International Journal of Innovation Management*, *22*(4), 1850036.

Dittrich, K., & Duysters, G. (2007). Networking as a means to strategy change: The case of open innovation in mobile telephony. *Journal of Product Innovation Management*, *24*(6), 510–521.

Dodgson, M., Gann, D., & Salter, A. (2006). The role of technology in the shift towards open innovation: The case of Procter & Gamble. *R and D Management*, *36*(3), 333–346.

Du, J., Leten, B., & Vanhaverbeke, W. (2014). Managing open innovation projects with science-based and market-based partners. *Research Policy*, *43*(5), 828–840.

Du, S., Yalcinkaya, G., & Bstieler, L. (2016). Sustainability, Social Media Driven Open Innovation, and New Product Development Performance*. *Journal of Product Innovation Management*, *33*, 55–71.

Ebner, W., Leimeister, J. M., & Krcmar, H. (2009). Community engineering for innovations:

The ideas competition as a method to nurture a virtual community for innovations. *R and D Management*, *39*(4), 342–356.

Egbetokun, A. A. (2015). The more the merrier? Network portfolio size and innovation performance in Nigerian firms. *Technovation*, *43–44*, 17–28.

Eisenhardt, K. M., & Tabrizi, B. N. (1995). Accelerating Adaptive Processes: Product Innovation in the Global Computer Industry. *Administrative Science Quarterly*, *40*(1), 84.

Enkel, E., Gassmann, O., & Chesbrough, H. (2009). Open R&D and open innovation: Exploring the phenomenon. *R and D Management*, *39*(4), 311–316.

Etzkowitz, H. (1998). The norms of entrepreneurial science: Cognitive effects of the new university-industry linkages. *Research Policy*, *27*(8), 823–833.

Etzkowitz, H. (2003). Research groups as "quasi- firms": the invention of the entrepreneurial university. *Research Policy*, *32*(1), 109–121.

Faems, D., De Visser, M., Andries, P., & Van Looy, B. (2010). Technology alliance portfolios and financial performance: Value-enhancing and cost-increasing effects of open innovation. *Journal of Product Innovation Management*, *27*(6), 785–796.

Felin, T., & Zenger, T. R. (2014). Closed or open innovation? Problem solving and the governance choice. *Research Policy*, *43*(5), 914–925.

Ferreras-Méndez, J. L., Fernández-Mesa, A., & Alegre, J. (2016). The relationship between knowledge search strategies and absorptive capacity: A deeper look. *Technovation*, *54*, 48–61.

Ferreras-Méndez, J. L., Newell, S., Fernández-Mesa, A., & Alegre, J. (2015). Depth and breadth of external knowledge search and performance: The mediating role of absorptive capacity. *Industrial Marketing Management*, *47*(SI), 86–97.

Fichter, K. (2009). Innovation communities: The role of networks of promotors in open innovation. *R and D Management*, *39*(4), 357–371.

Fisch, C. O., Hassel, T. M., Sandner, P. G., & Block, J. H. (2015). University patenting: a comparison of 300 leading universities worldwide. *Journal of Technology Transfer*, *40*(2), 318–345.

Fleming, L., & Waguespack, D. M. (2007). Brokerage, Boundary Spanning, and Leadership in Open Innovation Communities. *Organization Science*, *18*(2), 165–180.

Frishammar, J., Ericsson, K., & Patel, P. C. (2015). The dark side of knowledge transfer: Exploring knowledge leakage in joint R&D projects. *Technovation*, *41*, 75–88.

Frishammar, J., Lichtenthaler, U., & Rundquist, J. (2012). Identifying technology commercialization opportunities: The importance of integrating product development knowledge. *Journal of Product Innovation Management*, *29*(4), 573–589.

Fritsch, M. (2017). The theory of economic development – An inquiry into profits, capital, credit, interest, and the business cycle. *Regional Studies*.

Fu, X. (2012). How does openness affect the importance of incentives for innovation?

Research Policy, *41*(3), 512–523.

Füller, J., Hutter, K., & Faullant, R. (2011). Why co-creation experience matters? Creative experience and its impact on the quantity and quality of creative contributions. *R and D Management*, *41*(3), 259–273.

Füller, J., Matzler, K., & Hoppe, M. (2008). Brand community members as a source of innovation. *Journal of Product Innovation Management*, *25*(6), 608–619.

Füller, J., Matzler, K., Hutter, K., & Hautz, J. (2012). Consumers' Creative Talent: Which Characteristics Qualify Consumers for Open Innovation Projects? An Exploration of Asymmetrical Effects. *Creativity and Innovation Management*, *21*(3), 247–262.

Galán-Muros, V., & Plewa, C. (2016). What drives and inhibits university-business cooperation in Europe? A comprehensive assessement. *R and D Management*, *46*(2), 369–382.

Galati, F., Bigliardi, B., & Petroni, A. (2016). Open Innovation in Food Firms: Implementation Strategies, Drivers and Enabling Factors. *International Journal of Innovation Management*, *20*(3), 1650042.

Gambardella, A., & Panico, C. (2014). On the management of open innovation. *Research Policy*, *43*(5), 903–913.

Garcia Martinez, M., & Walton, B. (2014). The wisdom of crowds: The potential of online communities as a tool for data analysis. *Technovation*, *34*(4), 203–214.

Garcia Martinez, M., Zouaghi, F., & Sanchez Garcia, M. (2017). Capturing value from alliance portfolio diversity: The mediating role of R&D human capital in high and low tech industries. *Technovation*, *59*, 55–67.

Gassmann, O., Enkel, E., & Chesbrough, H. (2010). The future of open innovation. *R and D Management*, *40*(3), 213–221.

Gesing, J., Antons, D., Piening, E. P., Rese, M., & Salge, T. O. (2015). Joining forces or going it alone? On the interplay among external collaboration partner types, interfirm governance modes, and internal R&D. *Journal of Product Innovation Management*, *32*(3), 424–440.

Goduscheit, R. C., & Knudsen, M. P. (2015). How Barriers to Collaboration Prevent Progress in Demand for Knowledge: A Dyadic Study of Small and Medium-Sized Firms, Research and Technology Organizations and Universities. *Creativity and Innovation Management*, *24*(1), 29–54.

Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, *17*(S2), 109–122.

Grant, R. M. (2002). *Contemporary Strategy Analysis* (Fourth Edi). John Wiley and sons.

Grote, M., Herstatt, C., & Gemünden, H. G. (2012). Cross-Divisional Innovation in the Large Corporation: Thoughts and Evidence on Its Value and the Role of the Early Stages of Innovation. *Creativity and Innovation Management*, *21*(4), 361–375.

Gubitta, P., Tognazzo, A., & Destro, F. (2016). Signaling in academic ventures: the role of

technology transfer offices and university funds. *Journal of Technology Transfer*, *41*(2), 368–393.

Guimón, J., & Salazar-Elena, J. C. (2015). Collaboration in Innovation Between Foreign Subsidiaries and Local Universities: Evidence from Spain. *Industry and Innovation*, *22*(6), 445–466.

Hall, J., Matos, S., Bachor, V., & Downey, R. (2014). Commercializing University Research in Diverse Settings: Moving Beyond Standardized Intellectual Property Management. *Research-Technology Management*, *57*(5), 26–34.

Harison, E., & Koski, H. (2010). Applying open innovation in business strategies: Evidence from Finnish software firms. *Research Policy*, *39*(3), 351–359.

Henkel, J. (2006). Selective revealing in open innovation processes: The case of embedded Linux. *Research Policy*, *35*(7), 953–969.

Henkel, J., Schöberl, S., & Alexy, O. (2014). The emergence of openness: How and why firms adopt selective revealing in open innovation. *Research Policy*, *43*(5), 879–890.

Hippel, E. Von. (1976). The dominant role of users in the scientific instruments innovation process. *Research Policy*, *5*(3), 212–239.

Hochleitner, F. P., Arbussà, A., & Coenders, G. (2017). Inbound open innovation in SMEs: indicators, non-financial outcomes and entry-timing. *Technology Analysis and Strategic Management*, *29*(2), 204–218.

Holmes, S., & Smart, P. (2009). Exploring open innovation practice in firm-nonprofit engagements: A corporate social responsibility perspective. *R and D Management*, *39*(4), 394–409.

Hooge, S., & Le Du, L. (2016). Collaborative Organizations for Innovation: A Focus on the Management of Sociotechnical Imaginaries to Stimulate Industrial Ecosystems. *Creativity and Innovation Management*, *25*(3), 311–330.

Hoppe, H. C., & Lehmann-Grube, U. (2001). Second-Mover Advantages in Dynamic Quality Competition. *Journal of Economics & Management Strategy*, *10*(3), 419–433.

Howells, J., James, A., & Malik, K. (2003). The sourcing of technological knowledge: distributed innovation processes and dynamic change. *R&D Management*, *33*(4), 395–409.

Hu, Y., McNamara, P., & McLoughlin, D. (2015). Outbound open innovation in bio-pharmaceutical out-licensing. *Technovation*, *35*, 46–58.

Hudson, J. M. G., Henry, G. H. R., & Cornwell, W. K. (2011). Taller and larger: Shifts in Arctic tundra leaf traits after 16 years of experimental warming. *Global Change Biology*, *17*(2), 1013–1021.

Hughes, B., & Wareham, J. (2010). Knowledge arbitrage in global pharma: A synthetic view of absorptive capacity and open innovation. *R and D Management*, *40*(3), 324–343.

Huisman, K. J. M., & Kort, P. M. (2003). Strategic investment in technological innovations. *European Journal of Operational Research*, *144*(1), 209–223.

Huizingh, E. K. R. E. (2011). Open innovation: State of the art and future perspectives. *Technovation*, *31*(1), 2–9.

Hung, K. P., & Chou, C. (2013). The impact of open innovation on firm performance: The moderating effects of internal R&D and environmental turbulence. *Technovation*, *33*(10–11), 368–380.

Hurmelinna, P., Kyläheiko, K., & Jauhiainen, T. (2007). The Janus face of the appropriability regime in the protection of innovations: Theoretical re-appraisal and empirical analysis. *Technovation*, *27*(3), 133–144.

Hutter, K., Hautz, J., Füller, J., Mueller, J., & Matzler, K. (2011). Communitition: The tension between competition and collaboration in community-based design contests. *Creativity and Innovation Management*, *20*(1), 3–21.

Hwang, J., Kim, E., & Kim, S. (2009). Factors affecting open technological innovation in open source software companies in Korea. *Innovation: Management, Policy and Practice*, *11*(3), 279–290.

Ili, S., Albers, A., & Miller, S. (2010). Open innovation in the automotive industry. *R and D Management*, *40*(3), 246–255.

Jahanmir, S. F., & Lages, L. F. (2015). The Lag-User Method: Using laggards as a source of innovative ideas. *Journal of Engineering and Technology Management - JET-M*, *37*, 65–77.

Jelinek, M., & Markham, S. (2007). Industry-university IP relations: Integrating perspectives and policy solutions. *IEEE Transactions on Engineering Management*, *54*(2), 257–267.

Kathan, W., Hutter, K., Füller, J., & Hautz, J. (2015). Reciprocity vs. Free-Riding in Innovation Contest Communities. *Creativity and Innovation Management*, *24*(3), 537–549.

Katz, R., & Allen, T. J. (1982). Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D Project Groups. *R&D Management*, *12*(1), 7–20.

Katzy, B., Turgut, E., Holzmann, T., & Sailer, K. (2013). Innovation intermediaries: A process view on open innovation coordination. *Technology Analysis and Strategic Management*, *25*(3), 295–309.

Kim, B., Kim, E., Miller, D. J., & Mahoney, J. T. (2016). The impact of the timing of patents on innovation performance. *Research Policy*, *45*(4), 914–928.

Kim, J., & Daim, T. U. (2013). A new approach to measuring time-lags in technology licensing: Study of U.S. academic research institutions. *Journal of Technology Transfer*, *39*(5), 748–773.

Kim, N., Kim, D. J., & Lee, S. (2015). Antecedents of open innovation at the project level: Empirical analysis of Korean firms. *R and D Management*, *45*(5), 411–439.

Kim, W. C., & Mauborgne, R. (2004). Blue ocean strategy. *Harvard Business Review*, *82*(10), 76–84.

Kogut, B., & Zander, U. (1996). What Firsm Do? Coordination, Identity, and Learning. *Organisation Science*.

Kohler, T., Matzler, K., & Füller, J. (2009). Avatar-based innovation: Using virtual worlds for real-world innovation. *Technovation*, *29*(6–7), 395–407.

Langerak, F., Hultink, E. J., & Griffin, A. (2008). Exploring mediating and moderating influences on the links among cycle time, proficiency in entry timing, and new product profitability. *Journal of Product Innovation Management*, *25*(4), 370–385.

Laursen, K., & Salter, A. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal*, *27*(2), 131–150.

Laursen, K., & Salter, A. J. (2014). The paradox of openness: Appropriability, external search and collaboration. *Research Policy*, *43*(5), 867–878.

Lee, S., Park, G., Yoon, B., & Park, J. (2010). Open innovation in SMEs-An intermediated network model. *Research Policy*, *39*(2), 290–300.

Li, J., & Kozhikode, R. K. (2009). Developing new innovation models: Shifts in the innovation landscapes in emerging economies and implications for global R&D management. *Journal of International Management*, *15*(3), 328–339.

Li, Y. R. (2009). The technological roadmap of Cisco's business ecosystem. *Technovation*, *29*(5), 379–386.

Lichtenthaler, U. (2008a). External technology commercialisation projects: Objectives, processes and a typology. *Technology Analysis and Strategic Management*, *20*(4), 483–501.

Lichtenthaler, U. (2008b). Integrated Roadmaps for Open Innovation. *Research-Technology Management*, *51*(3), 45–49.

Lichtenthaler, U. (2008c). Open innovation in practice: An analysis of strategic approaches to technology transactions. *IEEE Transactions on Engineering Management*, *55*(1), 148–157.

Lichtenthaler, U. (2008d). Relative capacity: Retaining knowledge outside a firm's boundaries. *Journal of Engineering and Technology Management - JET-M*, *25*(3), 200–212.

Lichtenthaler, U. (2009). Outbound open innovation and its effect on firm performance: Examining environmental influences. *R and D Management*, *39*(4), 317–330.

Lichtenthaler, U. (2010). Technology exploitation in the context of open innovation: Finding the right "job" for your technology. *Technovation*, *30*(7–8), 429–435.

Lichtenthaler, U. (2011a). Implementation Steps for Successful Out-Licensing. *Research-Technology Management*, *54*(5), 47–53.

Lichtenthaler, U. (2011b). The evolution of technology licensing management: Identifying five strategic approaches. *R and D Management*, *41*(2), 173–189.

Lichtenthaler, U. (2013). The collaboration of innovation intermediaries and manufacturing

firms in the markets for technology. *Journal of Product Innovation Management*, *30*(SUPPL 1), 142–158.

Lichtenthaler, U. (2016). Absorptive capacity and firm performance: an integrative framework of benefits and downsides. *Technology Analysis and Strategic Management*, *28*(6), 664–676.

Lichtenthaler, U., & Ernst, H. (2006). Attitudes to externally organising knowledge management tasks: A review, reconsideration and extension of the NIH syndrome. *R and D Management*, *36*(4), 367–386.

Lichtenthaler, U., & Ernst, H. (2007). External technology commercialization in large firms: Results of a quantitative benchmarking study. *R and D Management*, *37*(5), 383–397.

Lichtenthaler, U., & Ernst, H. (2008). Intermediary services in the markets for technology: Organizational antecedents and performance consequences. *Organization Studies*, *29*(7), 1003–1035.

Lichtenthaler, U., & Ernst, H. (2009). Opening up the innovation process: the role of technology aggressiveness. *R&D Management*, *39*(1), 38–54.

Lichtenthaler, U., & Lichtenthaler, E. (2010). Technology Transfer across organizational boundaries: absorptive capacity and desorptive capacity. *California Management Review.*, *53*(1), 154–170.

Lieberman, M. B., & Montgomery, D. B. (1988). First- mover advantages. *Strategic Management Journal*, *9*(1 S), 41–58.

Lieberman, M. B., & Montgomery, D. B. (1998). First-mover (dis)advantages: Retrospective and link with the resource-based view. *Strategic Management Journal*, *19*(12), 1111–1125.

Likar, B., Kopač, J., & Fatur, P. (2014). Innovation investment and economic performance in transition economies: Evidence from Slovenia. *Innovation*, *16*(1), 53–66.

Lopez-Vega, H., Tell, F., & Vanhaverbeke, W. (2016). Where and how to search? Search paths in open innovation. *Research Policy*, *45*(1), 125–136.

Love, J. H., Roper, S., & Bryson, J. R. (2011). Openness, knowledge, innovation and growth in UK business services. *Research Policy*, *40*(10), 1438–1452.

Love, J. H., Roper, S., & Vahter, P. (2014). Dynamic complementarities in innovation strategies. *Research Policy*, *43*(10), 1774–1784.

Makadok, R. (1998). Can first-mover and early-mover advantages be sustained in an industry with low barriers to entry/imitation? *Strategic Management Journal*, *19*(7), 683–696.

Manzini, R., & Lazzarotti, V. (2016). Intellectual property protection mechanisms in collaborative new product development. *R&D Management*, *46*(S2), 579–595.

March, J. G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Scienceation Science*, *2*(1), 71–87.

Mariotto, F. L., Zanni, P. P., & Moraes, G. H. S. M. de. (2014). What Is the Use of a Single-Case Study in Management Research? *Revista de Administração de Empresas*, *54*(4),

358–369.

McGrath, R. G. (1996). Options and the Enterprise: Toward a Strategic Theory of Entrepreneurial Wealth Creation. *Academy of Management Proceedings*, *1996*(1), 101–105.

Mention, A. L. (2011). Co-operation and co-opetition as open innovation practices in the service sector: Which influence on innovation novelty? *Technovation*, *31*(1), 44–53.

Michelfelder, I., & Kratzer, J. (2013). Why and how combining strong and weak ties within a single interorganizational R&D collaboration outperforms other collaboration structures. *Journal of Product Innovation Management*, *30*(6), 1159–1177.

Michelino, F., Lamberti, E., Cammarano, A., & Caputo, M. (2015). Measuring Open Innovation in the Bio-Pharmaceutical Industry. *Creativity and Innovation Management*, *24*(1), 4–28.

Miller, K., Mcadam, R., Moffett, S., Alexander, A., & Puthusserry, P. (2016). Knowledge transfer in university quadruple helix ecosystems: An absorptive capacity perspective. *R and D Management*, *46*(2), 383–399.

Mina, A., Bascavusoglu-Moreau, E., & Hughes, A. (2014). Open service innovation and the firm's search for external knowledge. *Research Policy*, *43*(5), 853–866.

Miozzo, M., Desyllas, P., Lee, H. F., & Miles, I. (2016). Innovation collaboration and appropriability by knowledge-intensive business services firms. *Research Policy*, *45*(7), 1337–1351.

Mller-Seitz, G., & Reger, G. (2010). Networking beyond the software code? an explorative examination of the development of an open source car project. *Technovation*, *30*(11–12), 627–634.

Mollick, E. (2014). The dynamics of crowdfunding: An exploratory study. *Journal of Business Venturing*, *29*(1), 1–16.

Morgan, J., & Várdy, F. (2013). The Fragility of Commitment. *Management Science*, *59*(6), 1344–1353.

Mortara, L., & Minshall, T. (2011). How do large multinational companies implement open innovation? *Technovation*, *31*(10–11), 586–597.

Mowery, D. C., Nelson, R. R., Sampat, B. N., & Ziedonis, A. A. (2001). The growth of patenting and licensing by U.S. universities: An assessment of the effects of the Bayh-Dole act of 1980. *Research Policy*, *30*(1), 99–119.

Müller-Seitz, G. (2012). Absorptive and desorptive capacity-related practices at the network level - the case of SEMATECH. *R and D Management*, *42*(1), 90–99.

Müller-Seitz, G., & Reger, G. (2009). Is open source software living up to its promises? insights for open innovation management from two open source software-inspired projects. *R and D Management*, *39*(4), 372–381.

Murale, V., & Preetha, R. (2014). An Integrated Approach towards Legitimization of Single Case Design-working Paper. *Procedia Economics and Finance*, *11*(1997), 812–818.

Nelson, A. J. (2014). From the ivory tower to the startup garage: Organizational context and commercialization processes. *Research Policy*, *43*(7), 1144–1156.

Nitzsche, P., Wirtz, B. W., & Goettel, V. (2016). Innovation Success in the Context of Inbound Open Innovation. *International Journal of Innovation Management*, *20*(2), 1650025.

Núñez-Sánchez, R., Barge-Gil, A., & Modrego-Rico, A. (2012). Performance of knowledge interactions between public research centres and industrial firms in Spain: A project-level analysis. *Journal of Technology Transfer*, *37*(3), 330–354.

Ojasalo, J., & Tähtinen, L. (2016). Integrating Open Innovation Platforms in Public Sector Decision Making : Empirical Results from Smart City Research. *Technology Innovation Management Review*, *6*(12), 38–48.

Ollila, S., & Elmquist, M. (2011). Managing open innovation: Exploring challenges at the interfaces of an open innovation arena. *Creativity and Innovation Management*, *20*(4), 273–283.

Ollila, S., & Yström, A. (2016). Exploring Design Principles of Organizing for Collaborative Innovation: The Case of an Open Innovation Initiative. *Creativity and Innovation Management*, *25*(3), 363–377.

Onofrei, M., Hunt, J., Siemienczuk, J., Touchette, D. R., & Middleton, B. (2004). A first step towards translating evidence into practice: Heart failure in a community practice-based research network. *Informatics in Primary Care*, *12*(3), 139–145.

Ooms, W., Bell, J., & Kok, R. A. W. (2015). Use of Social Media in Inbound Open Innovation: Building Capabilities for Absorptive Capacity. *Creativity and Innovation Management*, *24*(1), 136–150.

Palmer, M., Linde, M., & Pons, G. X. (2004). Correlational patterns between invertebrate species composition and the presence of an invasive plant. *Acta Oecologica*, *26*(3), 219–226.

Parjanen, S., Hennala, L., & Konsti-Laakso, S. (2012). Brokerage functions in a virtual idea generation platform: Possibilities for collective creativity? *Innovation: Management, Policy and Practice*, *14*(3), 363–374.

Parmentier, G. (2015). How to innovate with a brand community. *Journal of Engineering and Technology Management - JET-M*, *37*, 78–89.

Patterson, W., & Ambrosini, V. (2015). Configuring absorptive capacity as a key process for research intensive firms. *Technovation*, *36*, 77–89.

Patterson, W. C. (1993). First- Mover Advantage: the Opportunity Curve. *Journal of Management Studies*, *30*(5), 759–777.

Penrose, E. (1995). *The Theory of the Growth of the Firm*. Oxford University Press.

Perkmann, M., & Schildt, H. (2015). Open data partnerships between firms and universities: The role of boundary organizations. *Research Policy*, *44*(5), 1133–1143.

Perols, J., Zimmermann, C., & Kortmann, S. (2013). On the relationship between supplier

integration and time-to-market. *Journal of Operations Management*, *31*(3), 153–167.

Piller, F. T., & Walcher, D. (2006). Toolkits for idea competitions: A novel method to integrate users in new product development. *R and D Management*, *36*(3), 307–318.

Porter, A. L., & Newman, N. C. (2011). Mining external R&D. *Technovation*, *31*(4), 171–176.

Porto Gómez, I., Otegi Olaso, J. R., & Zabala-Iturriagagoitia, J. M. (2016a). Trust builders as open Innovation intermediaries. *Innovation*, *18*(2), 145–163.

Porto Gómez, I., Otegi Olaso, J. R., & Zabala-Iturriagagoitia, J. M. (2016b). Trust builders as open Innovation intermediaries. *Innovation*, *18*(2), 145–163.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology. *Administrative Science Quarterly*, *41*(1), 116.

Praest Knudsen, M., & Bøtker Mortensen, T. (2011). Some immediate but negative effects of openness on product development performance. *Technovation*, *31*(1), 54–64.

Pullen, A. J. J., De Weerd-Nederhof, P. C., Groen, A. J., & Fisscher, O. A. M. (2012). Open innovation in practice: Goal complementarity and closed NPD networks to explain differences in innovation performance for SMEs in the medical devices sector. *Journal of Product Innovation Management*, *29*(6), 917–934.

Ramos, I., Cardoso, M., Carvalho, J. V., & Graça, J. I. (2009). An Action Research on Open Knowledge and Technology Transfer. *Information Systems - Creativity and Innovation in Small and Medium-Sized Enterprises*, *301*, 211–223.

Randhawa, K., Wilden, R., & Hohberger, J. (2016). A Bibliometric Review of Open Innovation: Setting a Research Agenda. *Journal of Product Innovation Management*, *33*(6), 750–772.

Rass, M., Dumbach, M., Danzinger, F., Bullinger, A. C., & Moeslein, K. M. (2013). Open innovation and firm performance: The mediating role of social capital. *Creativity and Innovation Management*, *22*(2), 177–194.

Remneland-Wikhamn, B., & Knights, D. (2012). Transaction Cost Economics and Open Innovation: Implications for Theory and Practice. *Creativity and Innovation Management*, *21*(3), 277–289.

Remneland-Wikhamn, B., & Wikhamn, W. (2011). Open innovation climate measure: The introduction of a validated scale. *Creativity and Innovation Management*, *20*(4), 284–295.

Ries, E. (2011). *The Lean Startup*. Crown Business.

Roberts, D. L., Piller, F. T., & Lüttgens, D. (2016). Mapping the Impact of Social Media for Innovation: The Role of Social Media in Explaining Innovation Performance in the PDMA Comparative Performance Assessment Study. *Journal of Product Innovation Management*, *33*, 117–135.

Robertson, P. L., Casali, G. L., & Jacobson, D. (2012). Managing open incremental process

innovation: Absorptive Capacity and distributed learning. *Research Policy*, *41*(5), 822–832.

Rohrbeck, R., Hölzle, K., & Gemünden, H. G. (2009). Opening up for competitive advantage - How Deutsche telekom creates an open innovation ecosystem. *R and D Management*, *39*(4), 420–430.

Rolandsson, B., Bergquist, M., & Ljungberg, J. (2011). Open source in the firm: Opening up professional practices of software development. *Research Policy*, *40*(4), 576–587.

Sabidussi, A., Lokshin, B., De Leeuw, T., Duysters, G., Bremmers, H., & Omta, O. (2014). A comparative perspective on external technology sourcing modalities: The role of synergies. *Journal of Engineering and Technology Management - JET-M*, *33*, 18–31.

Saguy, I. S., & Sirotinskaya, V. (2014). Challenges in exploiting open innovation's full potential in the food industry with a focus on small and medium enterprises (SMEs). *Trends in Food Science and Technology*, *38*(2), 136–148.

Salter, A., Ter Wal, A. L. J., Criscuolo, P., & Alexy, O. (2015). Open for ideation: Individual-level openness and idea generation in R&D. *Journal of Product Innovation Management*, *32*(4), 488–504.

Samadi, S. (2014). Open Innovation Business Model in the Food Industry: Exploring the Link with Academia and SMEs. *Journal of Economics, Business and Management*, *2*(3), 209–213.

Sampat, B. N. (2006). Patenting and US academic research in the 20th century: The world before and after Bayh-Dole. *Research Policy*, *35*(6), 772–789.

Schemmann, B., Herrmann, A. M., Chappin, M. M. H., & Heimeriks, G. J. (2016). Crowdsourcing ideas: Involving ordinary users in the ideation phase of new product development. *Research Policy*, *45*(6), 1145–1154.

Schiele, H. (2010). Early supplier integration: The dual role of purchasing in new product development. *R and D Management*, *40*(2), 138–153.

Schilling, J. (2006). On the pragmatics of qualitative assessment designing the process for content analysis. *European Journal of Psychological Assessment*, *22*(1), 28–37.

Segarra-Ciprés, M., Bou-Llusar, J. C., & Roca-Puig, V. (2012). Exploring and exploiting external knowledge: The effect of sector and firm technological intensity. *Innovation: Management, Policy and Practice*, *14*(2), 203–217.

Seldon, T. (2011). Beyond patents: Effective intellectual property strategy in biotechnology. *Innovation: Management, Policy and Practice*, *13*(1), 55–61.

Sieg, J. H., Wallin, M. W., & von Krogh, G. (2010). Managerial challenges in open innovation: A study of innovation intermediation in the chemical industry. *R and D Management*, *40*(3), 281–291.

Siegel, D. S., Veugelers, R., & Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: Performance and policy implications. *Oxford Review of Economic Policy*, *23*(4), 640–660.

Sikimic, U., Chiesa, V., Frattini, F., & Scalera, V. G. (2016). Investigating the Influence of Technology Inflows on Technology Outflows in Open Innovation Processes: A Longitudinal Analysis. *Journal of Product Innovation Management*, *33*(6), 652–669.

Slowinski, G., Hummel, E., Gupta, A., & Gilmont, E. R. (2009). Effective Practices for Sourcing Innovation. *Research Technology Management*, *52*(1), 27–34.

Snow, C. C., Fjeldstad, Ø. D., Lettl, C., & Miles, R. E. (2011). Organizing continuous product development and commercialization: The collaborative community of firms model. *Journal of Product Innovation Management*, *28*(1), 3–16.

Spaeth, S., Stuermer, M., & Krogh, G. Von. (2010). Enabling knowledge creation through outsiders: towards a push model of open innovation. *International Journal of Technology Management*, *52*(3/4), 411.

Spender, J.-C. (1996). Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal*, *17*(S2), 45–62.

Spithoven, A., Clarysse, B., & Knockaert, M. (2011). Building absorptive capacity to organise inbound open innovation in traditional industries. *Technovation*, *31*(1), 10–21.

Spithoven, A., Frantzen, D., & Clarysse, B. (2010). Heterogeneous firm-level effects of knowledge exchanges on product innovation: Differences between dynamic and lagging product innovators. *Journal of Product Innovation Management*, *27*(3), 362–381.

Stam, W. (2009). When does community participation enhance the performance of open source software companies? *Research Policy*, *38*(8), 1288–1299.

Su, C. Y., Lin, B. W., & Chen, C. J. (2015). Technological knowledge co-creation strategies in the world of open innovation. *Innovation: Management, Policy and Practice*, *17*(4), 485–507.

Suh, Y., & Kim, M. S. (2012). Effects of SME collaboration on R&D in the service sector in open innovation. *Innovation: Management, Policy and Practice*, *14*(3), 349–362.

Svensson, L., McDowall, A., Giles, K. M., Stanley, P., Feske, S., & Hogg, N. (2010). Calpain 2 controls turnover of LFA-1 adhesions on migrating T lymphocytes. *PLoS ONE*, *5*(11), 35–41.

Swamidass, P. M. (2013). University startups as a commercialization alternative: Lessons from three contrasting case studies. *Journal of Technology Transfer*, *38*(6), 788–808.

Swamidass, P. M., & Vulasa, V. (2009). Why university inventions rarely produce income? Bottlenecks in university technology transfer. *Journal of Technology Transfer*, *34*(4), 343–363.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal*, *18*(7), 509–533.

Teirlinck, P., & Spithoven, A. (2013). Research collaboration and R&D outsourcing: Different R&D personnel requirements in SMEs. *Technovation*, *33*(4–5), 142–153.

Tether, B. S., & Tajar, A. (2008). Beyond industry-university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base.

Research Policy, *37*(6–7), 1079–1095.

Thanasopon, B., Papadopoulos, T., & Vidgen, R. (2016). The role of openness in the fuzzy front-end of service innovation. *Technovation*, *47*, 32–46.

Thursby, J. G., & Thursby, M. C. (2002). Who Is Selling the Ivory Tower? Sources of Growth in University Licensing. *Management Science*, *48*(1), 90–104.

Toyoda, T. (2011). *Methods for open innovation on a genome-design platform associating scientific, commercial, and educational communities in synthetic biology*. *Methods in Enzymology* (1st ed., Vol. 498). Elsevier Inc.

Tran, A., Hasan, S. U., & Park, J.-Y. (2012). Crowd Participation Pattern in the Phases of a Product Development Process that Utilizes Crowdsourcing. *Industrial Engineering and Management Systems*, *11*(3), 266–275.

Tranekjer, T. L., & Knudsen, M. P. (2012). The (unknown) providers to other firms new product development: Whats in it for them? *Journal of Product Innovation Management*, *29*(6), 986–999.

Tyre, M. J., & Orlikowski, W. J. (1994). Windows of Opportunity: Temporal Patterns of Technological. *Organization Science*, *5*(1), 98–118.

Vahter, P., Love, J. H., & Roper, S. (2014). Openness and Innovation Performance: Are Small Firms Different? *Industry and Innovation*, *21*(7–8), 553–573.

Valentim, L., Lisboa, J. V., & Franco, M. (2016). Knowledge management practices and absorptive capacity in small and medium-sized enterprises: is there really a linkage? *R&D Management*, *46*(4), 711–725.

van de Vrande, V., de Jong, J. P. J., Vanhaverbeke, W., & de Rochemont, M. (2009). Open innovation in SMEs: Trends, motives and management challenges. *Technovation*, *29*(6–7), 423–437.

Veer, T., Lorenz, A., & Blind, K. (2016). How open is too open? The mitigating role of appropriation mechanisms in R&D cooperation settings. *R and D Management*, *46*, 1113–1128.

Verlag, F. (2013). Managing Open Innovation. *Research-Technology Management*, *47*(1), 23–26.

von Hippel, E. (1986). Lead Users: A Source of Novel Product Concepts. *Management Science*, *32*(7), 791–805.

von Hippel, E. (1988). *The sources of innovation*. Oxford University Press.

Von Hippel, E., & Von Krogh, G. (2006). Free revealing and the private-collective model for innovation incentives. *R and D Management*, *36*(3), 295–306.

Vrande, V. Van de, Vanhaverbeke, W., & Gassmann, O. (2010). Broadening the scope of open innovation: past research, current state and future directions. *International Journal of Technology Management*, *52*(3/4), 221.

Vrgovic, P., Vidicki, P., Glassman, B., & Walton, A. (2012). Open innovation for SMEs in developing countries - An intermediated communication network model for

collaboration beyond obstacles. *Innovation: Management, Policy and Practice*, *14*(3), 290–302.

Wallin, M. W., & Von Krogh, G. (2010). Organizing for open innovation: Focus on the integration of knowledge. *Organizational Dynamics*, *39*(2), 145–154.

Wang, S., Cavusoglu, H., & Deng, Z. (2016). Early mover advantage in e-commerce platforms with low entry barriers: The role of customer relationship management capabilities. *Information and Management*, *53*(2), 197–206.

Wang, Y., & Li-Ying, J. (2014). When does inward technology licensing facilitate firms' NPD performance? A contingency perspective. *Technovation*, *34*(1), 44–53.

Watanabe, C., Shin, J. H., Heikkinen, J., Zhao, W., & Griffy-Brown, C. (2011). New functionality development through follower substitution for a leader in open innovation. *Technological Forecasting and Social Change*, *78*(1), 116–131.

West, J., & Bogers, M. (2014). Leveraging external sources of innovation: A review of research on open innovation. *Journal of Product Innovation Management*, *31*(4), 814–831.

West, J., & Bogers, M. (2017). Open innovation: current status and research opportunities. *Innovation: Organization & Management*, *19*(1), 43–50.

West, J., & Gallagher, S. (2006). Challenges of open innovation: The paradox of firm investment in open-source software. *R and D Management*, *36*(3), 319–331.

West, J., & Lakhani, K. R. (2008). Getting clear about communities in open innovation. *Industry and Innovation*, *15*(2), 223–231.

West, J., & O'mahony, S. (2008). The role of participation architecture in growing sponsored open source communities. *Industry and Innovation*, *15*(2), 145–168.

West, J., Salter, A., Vanhaverbeke, W., & Chesbrough, H. (2014). Open innovation: The next decade. *Research Policy*, *43*(5), 805–811.

Wikhamn, B. R. (2013). Two different perspectives on open innovation - libre versus control. *Creativity and Innovation Management*, *22*(4), 375–389.

Williamson, O. (2012). The governance of contractual relations. *The Economic Nature of the Firm: A Reader, Third Edition*, *22*(2), 116–126.

Wincent, J., Anokhin, S., & Boter, H. (2009). Network board continuity and effectiveness of open innovation in Swedish strategic small-firm networks. *R and D Management*, *39*(1), 55–67.

Wood, M. S. (2011). A process model of academic entrepreneurship. *Business Horizons*, *54*(2), 153–161.

Xia, T. (2013). Absorptive capacity and openness of small biopharmaceutical firms - a European Union-United States comparison. *R and D Management*, *43*(4), 333–351.

Ye, W., Xu, P., Jia, Y., & Jiang, F. (2012). Crowdsourcing for open innovations. *Applied Mathematics and Information Sciences*, *6*(3 SUPPL.), 741–747.

Zachary, M. A., Gianiodis, P. T., Payne, G. T., & Markman, G. D. (2015). Entry Timing: Enduring Lessons and Future Directions. *Journal of Management*, *41*(5), 1388–1415.

Table 34: Selected papers - Review

Authors	Title	Journal	Year	Abstract
Dodgson, M; Gann, D; Salter, A	The role of technology in the shift towards open innovation: the case of Procter & Gamble	R & D MANAGEMENT	2006	As with all new ideas, the concept of Open Innovation requires extensive empirical investigation, testing and development. This paper analyzes Procter and Gamble's 'Connect and Develop' strategy as a case study of the major organizational and technological changes associated with open innovation. It argues that although some of the organizational changes accompanying open innovation are beginning to be described in the literature, more analysis is warranted into the ways technological changes have facilitated open innovation strategies, particularly related to new product development. Information and communications technologies enable the exchange of distributed sources of information in the open innovation process. The case study shows that furthermore a suite of new technologies for data mining, simulation, prototyping and visual representation, what we call 'innovation technology', help to support open innovation in Procter and Gamble. The paper concludes with a suggested research agenda for furthering understanding of the role played by and consequences of this technology.
Piller, FT; Walcher, D	Toolkits for idea competitions: a novel method to integrate users in new product development	R & D MANAGEMENT	2006	Research has shown that many innovations originate not in the manufacturer but the user domain. Internet-based toolkits for idea competitions (TIC) are a novel way for manufacturers to access innovative ideas and solutions from users. Idea competitions build on the nature of competition as a means to encourage users to participate at an open innovation process, to inspire their creativity, and to increase the quality of the submissions. When the contest ends, submissions are evaluated by an expert panel. Users whose submissions score highest receive an award from the manufacturer, which is often granted in exchange for the right to exploit the solution in its domain. Following the idea of evolutionary prototyping, we developed a TIC in cooperation with a manufacturer of sports goods. The TIC was launched as a pilot in one of the company's markets. Submissions were evaluated using the consensual assessment technique. The evaluation of this study provides suggestions for further research, but also implications for managers willing to explore TIC in their organization.
Chesbrough, H; Crowther, AK	Beyond high tech: early adopters of open innovation in other industries	R & D MANAGEMENT	2006	Companies have historically invested in large research and development departments to drive innovation and provide sustainable growth. This model, however, is eroding due to a number of factors. What is emerging is a more open model, where companies recognize that not all good ideas will come from inside the organization and not all good ideas created within the organization can be successfully marketed internally. To date, Open Innovation concepts have been regarded as relevant primarily to 'high-technology' industries, with examples that include Lucent, 3Com, IBM, Intel and Millenium Pharmaceuticals. In this article, we identify organizations in industries outside 'high technology' that are early adopters of the concept. Our findings demonstrate that many Open Innovation concepts are already in use in a wide range of industries. We document practices that appear to assist organizations adopting these concepts, and discover that Open Innovation is not ipso facto a recipe for outsourcing R&D. We conclude that Open Innovation has utility as a paradigm for industrial innovation beyond high tech to more traditional and mature industries.
West, J; Gallagher, S	Challenges of open innovation: the paradox of firm investment in open-source software	R & D MANAGEMENT	2006	Open innovation is a powerful framework encompassing the generation, capture, and employment of intellectual property at the firm level. We identify three fundamental challenges for firms in applying the concept of open innovation: finding creative ways to exploit internal innovation, incorporating external innovation into internal development, and motivating outsiders to supply an ongoing stream of external innovations. This latter challenge involves a paradox, why would firms spend money on R&D efforts if the results of these efforts are available to rival firms? To explore these challenges, we examine the activity of firms in open-source software to support their innovation strategies. Firms involved in open-source software often make investments that will be shared with real and potential rivals. We identify four strategies firms employ - pooled R&D/product development, spinouts, selling complements and attracting donated complements - and discuss how they address the three key challenges of open innovation. We conclude with suggestions for how similar strategies may apply in other industries and offer some possible avenues for future research on open innovation.
Henkel, J	Selective revealing in open innovation processes: The case of embedded Linux	RESEARCH POLICY	2006	This paper provides a quantitative study (N = 268) of patterns of free revealing of firm-developed innovations within embedded Linux, a type of open source software (OSS). I find that firms, without being obliged to do so, contribute many of their own developments back to public embedded Linux code, eliciting and indeed receiving informal development support from other firms. That is, they perform a part of their product development open to the public-an unthinkable idea for traditionally minded managers. Such openness obviously entails the challenge of protecting one's intellectual property. I find that firms address this issue by revealing selectively. They reveal, on average, about half of the code they have developed, while protecting the other half by various means. Revealing is strongly heterogeneous among firms. Multivariate analysis can partly explain this heterogeneity by firm characteristics and the firm's purpose behind revealing. An analysis of reasons for revealing and of the type of revealed code shows that different types of firms have different rationales for openness.

				Implications for management are that the conflict between downsides and benefits of openness appears manageable. Provided selective revealing is practiced deliberately, the opportunities of open development dominate. (c) 2006 Elsevier B.V. All rights reserved.
Lichtenthaler, U; Ernst, H	Attitudes to externally organising knowledge management tasks: a review, reconsideration and extension of the NIH syndrome	R & D MANAGEMENT	2006	Companies may carry out all major knowledge management tasks, i.e. knowledge acquisition, accumulation and exploitation, internally and externally. Therefore, we propose the integrate-or-relate decision in knowledge accumulation as a complement to the well-known make-or-buy and keep-or-sell decisions in knowledge acquisition and exploitation. A key factor for taking adequate decisions, for building up organisational capabilities and for realising a firm's knowledge potential are unbiased attitudes to the knowledge management tasks. While past research has focused on the 'not-invented-here' (NIH) syndrome as a negative attitude to acquiring external knowledge, a more holistic view is adopted in the present article by extending prior research on two dimensions. Firstly, we consider all major knowledge management tasks and do not limit our analysis to knowledge acquisition. Secondly, we take into account that, apart from overly negative attitudes, excessively positive attitudes may exist. Accordingly, we identify the following six syndromes: 'NIH' vs. 'buy-in' in knowledge acquisition, 'all-stored-here' vs. 'relate-out' in knowledge accumulation and 'only-used-here' vs. 'sell-out' in knowledge exploitation. After briefly reviewing research into NIH and developing a knowledge management framework, the syndromes are defined, and possible antecedents, consequences and managerial actions are described.
von Hippel, E; von Krogh, G	Free revealing and the private-collective model for innovation incentives	R & D MANAGEMENT	2006	A central tenant of open innovation is free revealing of the detailed workings of novel products and services, so that others may use them, learn from them, and perhaps improve them as well. We explain that innovators frequently do freely reveal proprietary information and knowledge regarding both information-based products and physical products they have developed. We explain why free revealing can make good economic sense for innovators and for society as well. The article develops the case for free revealing in terms of a 'private collective' model of innovation incentives.
Hurmelinna, P; Kylaheiko, K; Jauhiainen, T	The Janus face of the appropriability regime in the protection of innovations: Theoretical re-appraisal and empirical analysis	TECHNOVATION	2007	Profiting from rapid innovations plays a central role in the knowledge-based economy, and establishing an effective appropriability regime can crucially facilitate this endeavor. It is not an easy task for strategic management, however. The basic elements of appropriability, i.e., the very nature of knowledge (tacit vs. codified) as well as the legal means (such as patents, copyrights, trademarks) could be seen as a double-edged sword: they both increase the protection of intellectual capital, but on the other hand they also make learning and the utilization of intangibles more challenging by decreasing the transferability of knowledge within the company and the network to which it belongs. This also makes it hard to utilize knowledge-related positive externalities. Additionally, the difficulty of transferring knowledge diminishes the probability of creating profit-generating standards. In sum, managers' discretionary decisions to emphasize either protection or knowledge sharing affect the boundaries of the appropriability regime. The purpose of our study was to analyze the characteristics of the Janus-faced nature of the appropriability regime and to focus on issues that have been overlooked so far by reviewing previous research and providing empirical evidence from Finnish industry. The data collected among 299 companies reveals that the different mechanisms within the appropriability regime have different effects on knowledge flows within companies, on the benefits derived from positive network externalities, and on standardization. (C) 2005 Elsevier Ltd. All rights reserved.
Dittrich, K; Duysters, G	Networking as a means to strategy change: The case of open innovation in mobile telephony	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2007	The purpose of this article is to investigate how innovation networks can be used to deal with a changing technological environment. This study combines different concepts related to research and development (R&D) collaboration strategies of large firms and applies these concepts to R&D alliance projects undertaken by Nokia Corporation in the period 1985-2002. The research methodology is a combination of in-depth semistructured interviews and a large-scale quantitative analysis of alliance agreements. For the empirical analysis a distinction is made between exploration and exploitation in innovation networks in terms of three different measures. As a first measure, the difference between exploration and exploitation strategies by means of the observed capabilities of the partners of the contracting firms is investigated. The second measure is related to partner turnover. The present article argues that in exploration networks partner turnover will be higher than in exploitation networks. As a third measure, the type of alliance contract will be taken; exploration networks will make use of flexible legal organizational structures, whereas exploitation alliances are associated with legal structures that enable long-term collaboration. The case of Nokia has illustrated the importance of strategic technology networks for strategic repositioning under conditions of change. Nokia followed an exploitation strategy in the development of the first two generations of mobile telephony and an exploration strategy in the development of technologies for the third generation. Such interfirm networks seem to offer flexibility, speed, innovation, and the ability to adjust smoothly to changing market conditions and new strategic opportunities. These two different strategies have led to distinctly different international innovation networks, have helped the company in becoming a world leader in the mobile phone industry, and have enabled it to sustain that position in a radically changed technological environment. This study also illustrates that Nokia effectively uses an open innovation strategy in the development of new products and services and in setting technology standards for current and future use of mobile communication applications. This article presents one of the first longitudinal studies, which describes the

				use of innovation networks as a means to adapt swiftly to changing market conditions and strategic change. This study contributes to the emerging, but still inconsistent, literature on explorative and exploitative learning by means of strategic technology networks.
Lichtenthaler, U; Ernst, H	External technology commercialization in large firms: results of a quantitative benchmarking study	R & D MANAGEMENT	2007	External technology commercialization (ETC), i.e., the commercialization of technological knowledge exclusively or in addition to its application inside the firm, has recently become a broader trend. However, this increase in outward technology transfer, e.g., by means of technology licensing, has been insufficiently reflected by academic research. Thus, we lack a detailed understanding of the evolution and the current scope of ETC, which represents an important component of technology portfolio management. Moreover, our insights into the functions of ETC and into firms' strategies, processes, and structures for managing ETC are limited. To address these research deficits, we present the results of a questionnaire-based benchmarking study in 154 medium-sized and large European firms spanning multiple industries. Thus, this article is among the first studies that provide quantitative empirical evidence for the current scope and management of ETC. After an introduction and theoretical considerations, the research design is described. Subsequently, the results of the survey are presented. In the final section, theoretical and managerial implications are discussed, and opportunities for further research are pointed out.
West, J; O'Mahony, S	The Role of Participation Architecture in Growing Sponsored Open Source Communities	INDUSTRY AND INNOVATION	2008	Most research on open source software communities has focused on those that are community founded. More recently, firms have founded their own open source communities. How do sponsored open source communities differ from their autonomous counterparts? With comparative examination of 12 open source projects initiated by corporate sponsors, we identify three design parameters that together help form a participation architecture-the opportunity structure extended to potential external contributors. In exploring sponsors' community design decisions, we found that sponsored open source projects were more likely to offer transparency than they were accessibility and that this had implications for their communities' growth. We contribute theoretical constructs that offer a common basis of comparison for the future study of open source projects and illustrate how the tension between control and growth affects open source community design and creation.
Fuller, J; Matzler, K; Hoppe, M	Brand community members as a source of innovation	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2008	Brand community members have a strong interest in the product and in the brand. They usually have extensive product knowledge and engage in product-related discussions; they support each other in solving problems and generating new product ideas. Therefore, brand communities can be a valuable source of innovation. So far, little is known about the member's ability and willingness to participate in a company's innovation process. How does passion for the brand, affiliation to the brand community, and trust in the brand affect the willingness to engage in a company's innovation process? What is the effect of brand passion on brand knowledge and on domain-specific skills, which are considered important prerequisites for qualified and creative contributions to new product development? What is the effect of personality traits on the willingness and ability to engage in new product development? This research addresses these questions, which are interesting for managers who are thinking about opening up their innovation process and collaborating with brand communities and for academics exploring the opportunities of online communities for new product development and trying to develop promising new forms of open innovation networks. Drawing on brand community literature, relationship theory, creativity theory, and personality traits research, this paper introduces a comprehensive set of antecedents affecting brand community members' willingness to engage in new product development. It is argued that consumer creativity, identification with the brand community, and brand-specific emotions and attitudes (passion and trust) as well as brand knowledge are important determinants of consumers' willingness to share their knowledge with producers. The paper also identifies two personality traits (i.e., extraversion and openness) that have significant influence on brand passion, creativity, and identification with the community. The hypotheses are tested on a sample of 550 members of the Volkswagen Golf GTI car community. Structural equation modeling was used to test the relationship among the constructs. Though a positive disposition toward a brand may be advantageous for consumers that are willing to interact with producers during new product development, our results show that it is consumer interest in innovations and the innovative process that drives them to get involved. Further, brand community members with more knowledge and more innovative skills seem to be more willing to contribute than less qualified community members.
West, J; Lakhani, KR	Getting Clear About Communities in Open Innovation	INDUSTRY AND INNOVATION	2008	Research on open source software, user innovation and open innovation have increasingly emphasized the role of communities in creating, shaping and disseminating innovations. However, the comparability of such studies has been hampered by the lack of a precise definition of the community construct. In this paper we review prior definitions (implicit and explicit) of the community construct, and other suggestions for future research.
Lichtenthaler, U	Relative capacity: Retaining knowledge outside a firm's boundaries	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2008	Besides internalizing external knowledge, companies may maintain knowledge in interfirm relationships over time. Thus, interorganizational relations may be regarded as an extended knowledge base to which a firm has privileged access. We merge research into knowledge management, absorptive capacity, learning, and dynamic capabilities to analyze knowledge retention outside a firm's boundaries. Prior research into knowledge management has focused on internally storing knowledge, whereas research into knowledge transactions has primarily studied the internalization of external knowledge. The need to dynamically manage knowledge in interfirm relations over time - without necessarily internalizing this knowledge - has been relatively neglected. Therefore, we develop the

				foundations of the dynamic capability-based concept of relative capacity as a complement to absorptive capacity and transformative capacity in external knowledge retention. Relative capacity contributes to explaining interfirm differences in knowledge strategies, alliance strategies, organizational boundaries, open innovation, and performance. To guide further research, propositions are advanced regarding the antecedents and consequences of relative capacity. (C) 2008 Elsevier B.V. All rights reserved.
Tether, BS; Tajar, A	Beyond industry-university links: Sourcing knowledge for innovation from consultants, private research organisations and the public science-base	RESEARCH POLICY	2008	This paper explores the use of specialist knowledge providers as sources of information in the innovation activities of manufacturing and service firms. Specialist knowledge providers are consultancies, private research organisations and the public science-base (i.e., universities and the government research laboratories). These may be engaged by firms in co-operative arrangement for innovation or as informal sources of information. We find, as anticipated, that amongst other factors specialist knowledge Providers are more likely to be engaged by firms with more open approaches to innovation, those with high levels of absorptive capacity, those with greater social capital and networking capabilities, as well as by those with deeper commitments to innovation. Overall, the use of specialist knowledge providers tends to complement firms' own internal innovation activities and to complement other external sources of knowledge. Moreover, the individual types of specialist knowledge providers tend to complement rather than substitute for one another. Beyond this we find significant differences in the types of specialist knowledge providers used by manufacturing and service firms. Although service firms are more likely than manufacturers to use specialist knowledge providers, they are more likely to engage consultants, whilst their links with research-based organisations, including the public science-base, are weaker. We ask whether there is a case for increasing the extent to which the public science-base undertakes activities that are relevant to innovation in the services. (C) 2008 Elsevier B.V. All rights reserved.
Fichter, K	Innovation communities: the role of networks of promotors in Open Innovation	R & D MANAGEMENT	2009	Research on Open Innovation has increasingly emphasised the role of communities in creating, shaping and disseminating innovations. However, the comparability of many studies has been hampered by the lack of a precise definition of the community construct, and the research on Open Innovation has to date not been well connected to insights from research on the role of transformational leaders and the networking of champions and promotors across organisational boundaries. For this reason, this paper introduces a new construct of 'innovation communities' based on promotor theory, which it defines as 'networks of promotors'. It proposes a comprehensive concept of the quality of interaction in innovation communities, and presents findings of three case studies, which explore the role of promotors and networks of promotors in Open Innovation. The case studies reveal that such transformational leaders as promotors, and especially their close and informal co-operation across functional and organisational boundaries, play a key role in Open Innovation.
Rohrbeck, R; Holzle, K; Gemunden, HG	Opening up for competitive advantage - How Deutsche Telekom creates an open innovation ecosystem	R & D MANAGEMENT	2009	When, on 21st September 2006, 'The Economist' compared incumbent telecommunication operators with dinosaurs that could soon face extinction, most readers were ready to agree. The mixture of declining revenues and fierce competition was believed to shake the market and soon to dethrone former national champions. However, there are ways to fight that extinction and one way is to open up for competitive advantage. This paper reflects on a case study at Deutsche Telekom, the German national telecommunication operator. The aim of this study is to analyse to what extent the open innovation paradigm has been embraced inside this now multinational company. Using empirical evidence from 15 in-depth interviews, we identify 11 open innovation instruments and detail their value contribution. We can show that Deutsche Telekom has successfully enhanced its innovation capacity by opening up its traditional development process and embracing external creativity and knowledge resources.
Kohler, T; Matzler, K; Fuller, J	Avatar-based innovation: Using virtual worlds for real-world innovation	TECHNOVATION	2009	The purpose of this article is to explore the opportunities virtual worlds offer for real-world innovations. By integrating users of virtual worlds into in interactive new product development process, companies can tap customers innovative potential using the latest technology. Connecting the emerging technology of virtual Worlds With a customer-centric perspective of open innovation allows unique and inventive opportunities to capitalize oil users' innovative potential and knowledge. The concept of avatar-based innovation serves as a point of origin to reveal these possibilities and represents the first attempt to systematically take advantage of virtual worlds for innovation management. In doing so, this paper argues that latest advances of information and communication technologies enrich the interaction process and can improve new product development process. Further, characteristics are presented that suggest that the digital environment is especially conducive to innovation and creative tasks. Based oil theoretical insights, the analysis of eight cases (Coca-Cola, Steelcase, Osram, Alcatel-Lucent, Toyota Scion, Endemol, Aloft, and Mazda), participant observation directly within the virtual world and 23 interviews with both managers and customers, this paper demonstrates how virtual worlds allow producers and consumers to swarm together with like-minded individuals to create new products and permits companies to find an audience to test, use, and provide feedback on the content and products they create. We highlight the active roles avatars can play throughout the whole innovation process, and demonstrate the opportunities of how manufactures and Customers could collaborate to innovate from idea to launch. A few pathfinding companies experiment with avatars as a source of innovation. Specifically, the initiatives of Osram, Steelcase, Mazda, and Toyota truly link the concepts of open innovation and virtual worlds to employ the interactive technology for new product development. These efforts are critically analyzed to examine the

				hypothesized potential of avatar-based innovation. The cases pinpoint practical implications and reveal both preconditions and challenges of this new approach to interactive new product development. The results suggest that in order to fully realize the potential of avatar-based innovation, companies need to create a compelling open innovation experience and consider the peculiarities of Virtual worlds. (C) 2008 Elsevier Ltd. All rights reserved.
Ebner, W; Leimeister, JM; Krcmar, H	Community engineering for innovations: the ideas competition as a method to nurture a virtual community for innovations	R & D MANAGEMENT	2009	'Crowdsourcing' is currently one of the most discussed key words within the open innovation community. The major question for both research and business is how to find and lever the enormous potential of the 'collective brain' to broaden the scope of 'open R&D'. Based on a literature review in the fields of Community Building and Innovation Management, this work develops an integrated framework called 'Community Engineering for Innovations'. This framework is evaluated in an Action Research project - the case of an ideas competition for an ERP Software company. The case 'SAPiens' includes the design, implementation and evaluation of an IT-supported ideas competition within the SAP University Competence Center (UCC) User Group. This group consists of approximately 60,000 people (lecturers and students) using SAP Software for educational purposes. The current challenges are twofold: on the one hand, there is not much activity yet in this community. On the other, SAP has not attempted to systematically address this highly educated group for idea generation or innovation development so far. Therefore, the objective of this research is to develop a framework for a community-based innovation development that generates innovations, process and product ideas in general and for SAP Research, in particular, combining the concepts of idea competitions and virtual communities. Furthermore, the concept aims at providing an interface to SAP Human Resources processes in order to identify the most promising students in this virtual community. This paper is the first to present an integrated concept for IT-supported idea competitions in virtual communities for leveraging the potential of crowds that is evaluated in a real-world setting.
Li, YR	The technological roadmap of Cisco's business ecosystem	TECHNOVATION	2009	A business ecosystem provides a new perspective for repositioning a company's strategy in order to aggressively further its own interests and to promote its overall ecosystem health. Analyzing a business ecosystem is not an easy task, and therefore only a few studies have been made, even though some scholars and managers accept this concept from ecology since value creation is achieved by establishing a platform that other members of the ecosystem can use to enhance their performance. This paper presents a case study based on both qualitative and quantitative data, by explaining how Cisco Systems has been so successful in utilizing its strategy of mergers and acquisitions (M&A) for corporate growth based on a business ecosystem, especially from a technological perspective. We use US patent data from 1993 to 2005 to illustrate Cisco's technological roadmap. Finally, implications of symbiosis, platform, and co-evolution are provided for managers to challenge the contemporary business environment. (C) 2009 Elsevier Ltd. All rights reserved.
Muller-Seitz, G; Reger, G	Is open source software living up to its promises? Insights for open innovation management from two open source software-inspired projects(1)	R & D MANAGEMENT	2009	At present, several virtual initiatives claim to be acting according to the open source software (OSS) arena, which is often deemed a role model for open innovation. Against this background, this research focuses on a comparative case study of two non-profit project networks that attempt to operate in line with the OSS phenomenon: Wikipedia, the online encyclopedia, and the development of an automobile, Open Source car. We show that many parallels to the OSS arena can be drawn in both cases. However, this analysis must be performed cautiously, as several factors limit the applicability of OSS principles to non-software-related arenas. We conclude with a discussion of implications for open innovation research and managerial practice.
Hwang, J; Kim, E; Kim, S	Factors affecting open technological innovation in open source software companies in Korea	INNOVATION-MANAGEMENT POLICY & PRACTICE	2009	Open source software (OSS) is a rapidly growing method of collaborative technology development. Yet there has been little quantitative research into the specific innovativeness of the OSS industry that seeks to address the question of whether such collaborative processes are also correlated with increased innovative activity. Using survey data from Korean OSS firms, this paper seeks to analyze the decisive factors in the open technological innovation activity of the OSS industry. Building on this analysis, we discuss the policy significance of OSS in fostering capacity intensification of technological innovation.
van de Vrande, V; de Jong, JPJ; Vanhaverbeke, W; de Rochemont, M	Open innovation in SMEs: Trends, motives and management challenges	TECHNOVATION	2009	Open innovation has so far been studied mainly in high-tech, Multinational enterprises. This exploratory paper investigates if open innovation practices are also applied by small- and medium-sized enterprises (SMEs). Drawing oil I database collected from 605 innovative SMEs in the Netherlands, we explore the incidence of and apparent trend towards open innovation. The survey furthermore focuses oil the motives and perceived challenges when SMEs adopt open innovation practices. Within the survey, open innovation is measured with eight innovation practices reflecting technology exploration and exploitation in SMEs. We find that the responding SMEs engage in many open innovation practices and have increasingly adopted such practices during the past 7 years. In addition. we find no major differences

				between manufacturing and services industries, but medium-sized firms are oil average more heavily involved in open innovation than their smaller counterparts. We furthermore find that SMEs Pursue open innovation primarily for market-related motives such as meeting customer demands, or keeping LIP with competitors. Their most important challenges relate to organizational and Cultural issues as a consequence of dealing with increased external contacts. (C) 2008 Elsevier Ltd. All rights reserved.
Stam, W	When does community participation enhance the performance of open source software companies?	RESEARCH POLICY	2009	This study examined how participation in open innovation communities influences the innovative and financial performance of firms commercializing open source software. Using an original dataset of open Source companies in the Netherlands, I found that the community participation-performance relationship is curvilinear. In addition, results indicate that extensive technical participation in open source projects is more strongly related to performance for firms that also engage in social ("offline") community activities, for companies of larger size, and for firms with high R&D intensities. Overall, this research refines our understanding of the boundary conditions under which engagement in community-based innovation yields private returns to commercial actors. (C) 2009 Elsevier B.V. All rights reserved.
Lichtenthaler, U	Outbound open innovation and its effect on firm performance: examining environmental influences	R & D MANAGEMENT	2009	Firms may open up their innovation processes on two dimensions. While inbound open innovation refers to the acquisition of external technology in open exploration processes, outbound open innovation describes the outward transfer of technology in open exploitation processes. Prior open innovation research has focused on the inbound dimension, whereas the outbound dimension has been relatively neglected. Therefore, this article addresses the relationship between outbound open R&D strategies and firm performance. We use data from 136 industrial firms to test four hypotheses on the moderating effects of environmental factors in the relationship between open innovation strategies and firm performance. The results show that the degree of technological turbulence, the transaction rate in technology markets, and the competitive intensity in technology markets strengthen the positive effects of outbound open innovation on firm performance. By contrast, the degree of patent protection does not facilitate successful open innovation. The results are crucially important to managers because they show under what environmental conditions open innovation strategies enhance performance.
Wincent, J; Anokhin, S; Boter, H	Network board continuity and effectiveness of open innovation in Swedish strategic small-firm networks	R & D MANAGEMENT	2009	Increasing adoption of open innovation as an alternative route to research and development necessitates the development of new ways to organize innovation, as well as reassessment of existing ways. Much like traditional corporations that subscribe to the closed innovation paradigm, novel organizational arrangements targeting open innovation, such as small-firm networks, employ boards to effectively manage joint research-and-development activities. These boards are similar yet different from traditional corporate boards; as such, they may have different requirements for proper functioning. We use 5-year longitudinal data on 53 Swedish strategic small-firm networks to investigate how the boards should be organized to help improve the innovative status of network participants. We expand the set of tools available for effective organization of the boards' operations and emphasize the effects of network board continuity (rates of renewal) on network members' innovative performance. We argue that the relationship is curvilinear (U-shaped) and demonstrate that it is more pronounced in larger networks.
Enkel, E; Gassmann, O; Chesbrough, H	Open R&D and open innovation: exploring the phenomenon	R & D MANAGEMENT	2009	There is currently a broad awareness of open innovation and its relevance to corporate R&D. The implications and trends that underpin open innovation are actively discussed in terms of strategic, organizational, behavioral, knowledge, legal and business perspectives, and its economic implications. This special issue aims to advance the R&D, innovation, and technology management perspective by building on past and present studies in the field and providing future directions. Recent research, including the papers in this special issue, demonstrates an increasing range of situations where the concept is regarded as applicable. Most research to date has followed the outside-in process of open innovation, while the inside-out process remains less explored. A third coupled process of open innovation is also attracting significant research attention. These different processes show why it is necessary to have a full understanding of how and where open innovation can add value in knowledge-intensive processes. There may be a need for a creative interpretation and adaptation of the value propositions, or business models, in each situation. In other words, there are important implications for new and emerging methods of R&D management.
Holmes, S; Smart, P	Exploring open innovation practice in firm-nonprofit engagements: a corporate social responsibility perspective	R & D MANAGEMENT	2009	This paper examines the concept of open innovation within the context of corporate social responsibility. It demonstrates how the practice of open innovation unfolds in inter-organizational collaborations that involve the voluntary or charitable sector, outlining the findings of an explorative collective case study of eight voluntary dyadic partnerships between corporate and nonprofit organizations in the United Kingdom, which have resulted in innovation outcomes. Two generic approaches to open innovation were witnessed: firstly, a more exploratory approach to dyadic engagement activities that resulted in an emergent innovation process, and secondly, a focused and pre-determined search activity to exploit the resources of the nonprofit partner that demonstrated a more planned innovation process. Two distinct boundary-spanning roles were identified: in dyads exhibiting few organizational linkages, the role was associated with formal responsibilities from senior management to 'manage' innovation opportunities and outcomes. In dyads exhibiting high linkages, there was

				no such formality; the role was a 'conduit' to facilitate search and exploration to locate opportunities for innovation through idea exchange. Overall, this research demonstrates the value of an open innovation approach driven by the need to address societal and social issues (rather than those purely economic). Such practice broadens a firm's 'search' activities and delivers innovations in exchange for enhanced social legitimacy - acting innovation capital for future enterprising activities and market advantage.
Keupp, MM; Gassmann, O	Determinants and archetype users of open innovation	R & D MANAGEMENT	2009	Extant research on open innovation (OI) offers no systematic insight of how and why firms differ regarding the extent to which they conduct OI activities. Whereas past theoretical contributions have focused on explaining the externalisation of R&D activities as a result of firm-external factors, we focus on explaining this externalisation as a result of firm-internal weaknesses, specifically, impediments to innovation. Using the exploration-exploitation dichotomy as our theoretical framework, we develop hypotheses on how impediments to innovation influence the breadth and depth of OI. We then test these hypotheses by using an exceptionally large and detailed data set to estimate population-averaged panel models. Our results provide support for most of the hypothesised relationships. Further, they allow to identify four 'archetypes' of firms that differ significantly regarding the breadth and depth of OI and the importance of impediments. Finally, we discuss the significance of these findings for both academics and managers.
Lichtenthaler, U; Ernst, H	Opening up the innovation process: the role of technology aggressiveness	R & D MANAGEMENT	2009	Besides acquiring external knowledge, many firms have begun to actively commercialize technology, for example, by means of out-licensing. This increase in inward and outward technology transactions reflects the new paradigm of open innovation. Most prior research into open innovation is limited to theoretical considerations and case studies, whereas other lines of research have focused either on external technology acquisition or exploitation. In an integrative view, we consider inward and outward technology transactions as the main directions of open innovation. Moreover, technology aggressiveness, which constitutes an important dimension of technology strategy, is identified as a major determinant of open innovation. Data from a survey of 154 industrial firms are used to test three hypotheses relating technology aggressiveness, external technology acquisition, and external technology exploitation. In addition, clusters of firms with homogeneous strategies regarding technology aggressiveness and open innovation are identified.
Aylen, J	Open versus closed innovation: development of the wide strip mill for steel in the United States during the 1920s	R & D MANAGEMENT	2010	A paired comparison is made between rival attempts to develop the first continuous rolling mill for wide strip in the United States during the 1920s. One firm was secretive, and the other relied on collaboration. Development of the wide strip mill is a natural experiment comparing closed and open innovation as two firms were competing for the same target using different institutional arrangements for their R&D. Wide strip-rolling technology was developed by rival teams in the United States during the mid-1920s. The less successful team at Armco, Ashland, Ky was closed to outside influences. Breakthroughs came from Columbia Steel at Butler, PA, which pursued an open pattern of cooperation with equipment suppliers. Columbia Steel's collaboration with machinery suppliers, use of independent advice on bearing technology and willingness to learn from precursors in copper rolling enabled them to build a successful wide strip mill complex, commissioned in 1926. Butler established the dominant design for the next 80 years. The leading equipment supplier at Butler, the United Engineering and Foundry Co., led global sales of the technology for four decades. It is not clear how far this example of successful open innovation in the US inter-war economy is typical. Historical studies of the management of R&D focus on formal, science-based research in large corporate labs rather than engineering development.
Muller-Seitz, G; Reger, G	Networking beyond the software code? an explorative examination of the development of an open source car project	TECHNOVATION	2010	At present several initiatives have emerged that claim to be innovative while acting according to the mechanisms of open source software (OSS) a field frequently deemed to be a role model for open innovation Against this background this study focuses on a case study of the development of an automobile Based on a commons-based peer production-Informed perspective we show that this project displays a variety of characteristics that are usually associated with OSS projects In particular parallels can be drawn between the intrinsic and extrinsic motivations the ability to broadcast ideas due to the virtual nature of the tasks and the self-selection of tasks due to their modular nature The drawing of such parallels however must be done cautiously because diverse factors such as opportunity costs regulations and feasibility studies limit the applicability of OSS principles to this non-software related network of dispersed voluntary contributors within a commons-based peer production framework Herein we attempt to clarify how OSS projects can and cannot work as role models for open innovation in the automotive as well as other product-oriented industries (C) 2010 Elsevier Ltd All rights reserved
Chiaroni, D; Chiesa, V; Frattini, F	Unravelling the process from Closed to Open Innovation: evidence from mature, asset-intensive industries	R & D MANAGEMENT	2010	Open Innovation has been one of the most-debated topics in management research in the last decade. Although our understanding of this management paradigm has significantly improved over the last few years, a number of important questions are still unanswered. In particular, an issue that deserves further attention is the anatomy of the organizational change process through which a firm evolves from being a Closed to an Open Innovator. The paper represents a first step in overcoming this limitation. In particular, adopting a longitudinal, firm-level perspective, it addresses the following question: which changes in a firm's organizational structures and management systems does the shift from Closed to Open Innovation entail? In answering this question, the paper uses established concepts in organizational change research to look into a rich empirical basis that documents the adoption of Open Innovation by four Italian firms operating in mature, asset-intensive industries. The results show that the journey from Closed to Open Innovation involves four main dimensions of the

				firm's organization, i.e. inter-organizational networks, organizational structures, evaluation processes and knowledge management systems, along which change could be managed and stimulated.
Bianchi, M; Campodall'Orto, S; Frattini, F; Vercesi, P	Enabling open innovation in small- and medium-sized enterprises: how to find alternative applications for your technologies	R & D MANAGEMENT	2010	A critical success factor in the practice of Open Innovation is the timely identification of opportunities for out-licensing a firm's technologies outside its core business. This can be particularly challenging for small- and medium-sized enterprise (SMEs), because of their focussed business portfolio, specialized knowledge basis, and limited financial resources that can be devoted to innovation activities. The paper illustrates a quick and easy-to-use methodology for the identification of viable opportunities for out-licensing a firm's technologies outside its core business. The method uses established TRIZ instruments in combination with non-financial weighting and ranking techniques and portfolio management tools. It has been developed by the authors in collaboration with an Italian SME working in the packaging industry.
Sieg, JH; Wallin, MW; von Krogh, G	Managerial challenges in open innovation: a study of innovation intermediation in the chemical industry	R & D MANAGEMENT	2010	The current open innovation literature needs to be complemented with work on the managerial challenges faced by companies working with an innovation intermediary to solve research and development (R&D) problems. Based on an exploratory case study design, we investigate these managerial challenges in seven chemical companies working with the same innovation intermediary. Three recurring challenges were identified in all companies: (1) enlisting internal scientists to work with the innovation intermediary; (2) selecting the right problems; and (3) formulating problems so as to enable novel solutions. Based on the knowledge management literature, we explain how these challenges arise out of scientists' different work practices in internal vs. external R&D problem solving and we identify and discuss a number of remedies to these challenges.
Enkel, E; Gassmann, O	Creative imitation: exploring the case of cross-industry innovation	R & D MANAGEMENT	2010	In cross-industry innovation, already existing solutions from other industries are creatively imitated and retranslated to meet the needs of the company's current market or products. Such solutions can be technologies, patents, specific knowledge, capabilities, business processes, general principles, or whole business models. Innovations systematically created in a cross-industry context are a new phenomenon for theory and practice in respect of an open innovation approach. While the cognitive distance between the acquired knowledge and the problem to be solved was regarded as a counterproductive factor in older research, recent theory regards it as positively related to innovation performance. Following the latest theory, we examine 25 cross-industry cases to ascertain cognitive distance's influence on innovation performance. Our study reveals that there is no direct correlation between a higher or a closer distance and a more explorative or exploitative outcome.
Hughes, B; Wareham, J	Knowledge arbitrage in global pharma: a synthetic view of absorptive capacity and open innovation	R & D MANAGEMENT	2010	This case study examines a global pharmaceutical company widely using open innovation (OI). Three main research questions are addressed: (1) what OI concepts are salient in their innovation portfolio?, (2) what OI concepts are used in the strategy formulation? and (3) what other concepts are present that augment OI? Interviews with 120 managers and archival documents were analyzed using thematic analysis. Two concepts prominent in the literature, (i) value capture models and (ii) technology evaluation criteria, were not present in this portfolio. By contrast, we found a focus on OI capability building, external information sharing and uncertain knowledge arbitrage in networks. Finally, we discuss these capabilities in relation to absorptive capacity, proposing a simple, but important bi-directional perspective to embrace OI.
Lichtenthaler, U	Technology exploitation in the context of open innovation: Finding the right 'job' for your technology	TECHNOVATION	2010	In light of the recent economic crisis, many industrial firms attempt to capture additional value from their technologies by means of open innovation strategies. Besides acquiring external technology, many firms therefore increasingly try to license their own technology to other firms either exclusively or in addition to its application in their own products. This article shows that technology licensing offers important strategic benefits beyond generating licensing revenues, which underscore the need for an integrated management of technology licensing activities. Therefore, this article extends the concept of job-related markets that was recently developed in the managerial literature. A 'job' is the fundamental problem that a customer needs to resolve in a particular situation. Managers may transfer this job-related understanding to technology licensing activities because the right 'job' for a technology may be outside a firm's boundaries, and it may help firms to identify additional licensing opportunities. On this basis, the article presents the concept of an integrated technology exploitation roadmap, which allows firms to use the job-related markets to integrate technology licensing in their strategic planning processes. An example of a machinery firm shows how this roadmap may contribute to strengthening a firm's licensing business. (C) 2010 Elsevier Ltd. All rights reserved.
Spithoven, A; Frantzen, D; Clarysse, B	Heterogeneous Firm-Level Effects of Knowledge	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2010	Product innovation is the result of a constant interaction between the in-house research and development (R&D) department and knowledge exchanges with the firm's environment. Knowledge exchanges come in different forms. They break down into information gathering applied in new product development, research cooperation on particular innovation projects, and managing information outflows allowing the consequent appropriation of the results of product innovation through specific methods. The way firms handle knowledge exchanges

	Exchanges on Product Innovation: Differences between Dynamic and Lagging Product Innovators*			affects their performance. This paper looks at three related indicators of performance: (1) research intensity (a measure of innovative input); (2) the share of revenue realized through innovative product sales (a measure of innovative output); and (3) their impact on the growth in total revenue. The bulk of the econometric literature looking into these matters only allows general statistical statements on the behavior of an "average" firm. This paper takes on another view by using the quantile regression method to stress the heterogeneity of innovative firms in their dealing with knowledge exchange and the effect this has on their performance. A first key finding is that research intensity is positively influenced by knowledge externalities, research cooperation, and appropriability, and it is through this that these variables affect innovative revenue and also the growth in total revenue. By using quantile regression these relationships are further refined to screen for differences in behavior between dynamic and lagging innovators. This refinement indicates that, in the case of research intensity, the knowledge externalities gain in importance in the higher quantiles and are insignificant in the lower ones. Next, research cooperation remains important in all quantiles, but a higher significance is observed in the higher quantiles as well. Finally, appropriability is extremely important for the lower quantiles, but it becomes insignificant in the highest. These findings corroborate the assumptions made in the literature on open innovation: knowledge externalities and research collaboration are vital for those opening up their firm for new ideas and who are, at the same time, reluctant to protect their findings through specific appropriation measures. In the case of innovative revenue all variables on knowledge exchange operate through the research intensity irrespective of the quantile, although the impact of research intensity on this type of revenue is higher in the upper quantiles. As for the growth in revenue, the effect of the innovative revenue is, again, higher in the higher quantiles. This suggests that dynamic product innovators have the most efficient R&D process and the strongest growers are so, especially, because they are successful product innovators.
Barge-Gil, A	Open, Semi-Open and Closed Innovators: Towards an Explanation of Degree of Openness	INDUSTRY AND INNOVATION	2010	There is much controversy in the literature over the relationship between the openness of firms' innovation strategies and firm characteristics such as size, RD intensity and sector. We argue that the controversy arises because, both theoretically and empirically, only a binary, open vs. closed, strategy has been considered. In this paper, we distinguish among three firm strategies: open, semi-open and closed, drawing upon a panel of Spanish firms (2004-2006) using data from Community Innovation Survey (CIS)-type surveys, and two different indicators of openness. Our results show that open innovators are smaller and less RD intensive than semi-open ones, although larger and more RD intensive than closed innovators. These results reduce some of the controversies, and show that two conflicting forces, absorptive capacity and a oneedo effect, are at stake in open innovation strategies.
Harison, E; Koski, H	Applying open innovation in business strategies: Evidence from Finnish software firms	RESEARCH POLICY	2010	Our study aims at shedding light on the innovative business strategies in the software sector and understanding better the economics that underlies the supply of Open Source Software (OSS). We use survey data collected from 170 Finnish software companies to investigate how different properties of software firms, such as size, age, intellectual capital, absorptive capacity, and ownership structure affect their decisions to base their business strategies on OSS supply or proprietary distribution of products and services. Our empirical findings indicate that the adoption of technologically advanced strategies requiring complex legal and managerial knowledge, such as the OSS supply strategy, demands relatively highly educated employees. The support for and development of an education system providing highly skilled people from different fields are essential for the firms' successful adoption of innovative business strategies. We also find that market entrants have largely driven the OSS adoption, but there are no significant age-related differences in the adoption behavior of incumbent software firms. (C) 2010 Elsevier B.V. All rights reserved.
Chiang, YH; Hung, KP	Exploring open search strategies and perceived innovation performance from the perspective of inter-organizational knowledge flows	R & D MANAGEMENT	2010	Based on theories of inter-organizational knowledge flows and organizational learning, we argue that intensively accessing knowledge from a limited number of external channels, i.e., open search depth, can facilitate the innovating company's incremental innovation performance. We also argue that accessing knowledge from a broad range of external channels, i.e., open search breadth, can enhance the innovating firm's radical innovation performance. Using hierarchical regressions to analyze survey data collected from 184 Taiwanese electronic product manufacturers, we found that open search depth is positively related to the innovating firm's incremental innovation performance, and that open search breadth is positively related to radical innovation performance. As our results differ from those of previous studies, we provide a possible explanation for the discrepancy. Examining the effect of open search strategy from a theoretical angle not yet explored before, our findings can contribute to both scholarly and practitioner knowledge of open innovation.
Lee, S; Park, G; Yoon, B; Park, J	Open innovation in SMEs-An intermediated network model	RESEARCH POLICY	2010	In spite of increasing interest in open innovation, discussion about the concept and its potential application to the SME sector has been excluded from mainstream literature. However, given that the argument about the effect of firm size on the effectiveness of innovation is still ongoing, it is Worth addressing the issue from an SME perspective. That is the focus of this article, which seeks, firstly, to place the concept of open innovation in the context of SMEs; secondly to suggest the input of an intermediary in facilitating innovation; and finally to report accounts of Korean SMEs' success in working with an intermediary. The research results support the potential of open innovation

				for SMEs, and indicate networking as one effective way to facilitate open innovation among SMEs. (C) 2009 Elsevier B.V. All rights reserved.
Faems, D; de Visser, M; Andries, P; Van Looy, B	Technology Alliance Portfolios and Financial Performance: Value-Enhancing and Cost-Increasing Effects of Open Innovation	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2010	Firms increasingly adopt an open innovation model in which they rely on technology alliances to complement and supplement their internal innovation efforts. Although previous studies provide in-depth insight into the impact of technology alliances on the innovation performance, they remain relatively silent on how technology alliances eventually influence the financial performance of the firm. The purpose of this paper is to develop and test a conceptual framework that disentangles both the value-enhancing and cost-increasing effects of technology alliances on financial performance. The model was tested with a sample of 305 Belgian manufacturing firms. Combining data from the Belgian Community Information Survey (CIS IV) database and the BELFIRST database, structural equation analyses were conducted on the connection among technology alliance portfolio diversity, product innovation performance, and financial performance. This study's data provide empirical confirmation for the assumption of existing research that technology alliance portfolio diversity has an indirect positive impact on financial performance via increased product innovation performance. However, a direct cost-increasing effect of technology alliance portfolio diversity on financial performance is observed. Moreover, the structural equation analyses suggest that, in the short-term, the direct cost-increasing effect of technology alliance portfolio diversity exceeds the indirect value-generating effect of technology alliances. These findings contribute to the current research on open innovation in two important ways. First, these results support the open innovation model by illuminating the interconnectedness between internal and external innovation strategies. In particular, technology alliance portfolio diversity has a positive impact on internal innovation efforts, which increases product innovation performance. Second, the findings complement the focus of existing open innovation research on the value-generating properties of technology alliances, directing attention to the cost-increasing effects of such collaborative strategies. On a managerial level, these findings suggest that, when making technology alliance decisions, managers not only should consider the potential benefits of such collaborative strategies but also should take into account the additional costs of intensifying the technology alliance portfolio.
Dahlander, L; Gann, DM	How open is innovation?	RESEARCH POLICY	2010	This paper is motivated by a desire to clarify the definition of 'openness' as currently used in the literature on open innovation, and to re-conceptualize the idea for future research on the topic. We combine bibliographic analysis of all papers on the topic published in Thomson's ISI Web of Knowledge (ISI) with a systematic content analysis of the field to develop a deeper understanding of earlier work. Our review indicates two inbound processes: sourcing and acquiring, and two outbound processes, revealing and selling. We analyze the advantages and disadvantages of these different forms of openness. The paper concludes with implications for theory and practice, charting several promising areas for future research. (C) 2010 Elsevier B.V. All rights reserved.
Gassmann, O; Enkel, E; Chesbrough, H	The future of open innovation	R & D MANAGEMENT	2010	Institutional openness is becoming increasingly popular in practice and academia: open innovation, open R&D and open business models. Our special issue builds on the concepts, underlying assumptions and implications discussed in two previous R&D Management special issues (2006, 2009). This overview indicates nine perspectives needed to develop an open innovation theory more fully. It also assesses some of the recent evidence that has come to light about open innovation, in theory and in practice.
Ili, S; Albers, A; Miller, S	Open innovation in the automotive industry	R & D MANAGEMENT	2010	Automotive Original Equipment Manufacturers (OEM) have historically invested in their own research and development (R&D) to boost their innovativeness. Because of an increasing innovation and cost pressure, the automotive industry needs to look outside their own boundaries to escape from this productivity dilemma. While there is a tendency to look outside for external sources to increase the innovativeness, there are hardly any external paths to market outside the current business yet. Our study shows that Open Innovation proves to be more adequate in the attempt to achieve a better R&D productivity for companies in the automotive industry than a closed innovation model.
Schiele, H	Early supplier integration: the dual role of purchasing in new product development	R & D MANAGEMENT	2010	Interest in early supplier integration in new product development (NPD) has increased as an open innovation approach has become more common in firms. To support supplier integration, the purchasing function of a firm can assume a new 'dual' role: contributing to NPD while also managing overall costs. Previous research has offered few insights into how the purchasing function should best be organised so that it will fulfil this dual role. This paper reports on the results of a consortial benchmarking study in which an industry-academic consortium visited and analysed six best-practice firms. The findings describe how innovative firms organise their purchasing function, distinguishing between 'advanced sourcing' and 'life-cycle sourcing' units. The results include the tools that these firms use, such as regular innovation meetings with suppliers and technology roadmaps linking firm strategy, innovation strategy and sourcing strategies. The paper also recommends that researchers shift from a narrow focus on a single project to a broader consideration of supplier and organisational issues in NPD.
Spithoven, A; Clarysse, B; Knockaert, M	Building absorptive capacity to	TECHNOVATION	2010	The discussion on open innovation suggests that the ability to absorb external knowledge has become a major driver for competition. For R&D intensive large firms, the concept of open innovation in relation to absorptive capacity is relatively well understood. Little attention has: however, been paid to how both small firms and firms, which operate in traditional sectors, engage in open innovation activities. The

	organise inbound open innovation in traditional industries			latter two categories of firms often dispose of no, or at most a relatively low level of, absorptive capacity. Open innovation has two faces. In the case of inbound open innovation, companies screen their environment to search for technology and knowledge and do not exclusively rely on in-house R&D. A key pre-condition is that firms dispose of "absorptive capacity" to internalise external knowledge. SMEs and firms in traditional industries might need assistance in building absorptive capacity. This paper focuses on the role of collective research centres in building absorptive capacity at the inter-organisational level. In order to do so, primary data was collected through interviews with CEOs of these technology intermediaries and their member firms and analysed in combination with secondary data. The technology intermediaries discussed are created to help firms to take advantage of technological developments. The paper demonstrates that the openness of the innovation process forces firms lacking absorptive capacity to search for alternative ways to engage in inbound open innovation. The paper highlights the multiple activities of which absorptive capacity in intermediaries is made up; defines the concept of absorptive capacity as a pre-condition to open innovation; and demonstrates how firms lacking absorptive capacity collectively cope with distributed knowledge and innovation. (C) 2009 Elsevier Ltd. All rights reserved.
Bianchi, M; Cavaliere, A; Chiaroni, D; Frattini, F; Chiesa, V	Organisational modes for Open Innovation in the bio-pharmaceutical industry: An exploratory analysis	TECHNOVATION	2011	This paper investigates the adoption of Open Innovation in the bio-pharmaceutical industry, studying through which organisational modes it is put into practice and how these modes are interwoven with the different phases of drug discovery and development process. Two rounds of interviews with industry experts were carried out to develop a model describing the adoption of Open Innovation by bio-pharmaceutical companies. This framework was then applied to an extensive and longitudinal empirical basis, which includes data about the adoption of Open Innovation by the top 20 worldwide industry players, in the time period 2000-2007. The paper provides a thorough discussion of how bio-pharmaceutical firms have used different organisational modes (i.e. licensing agreements, non-equity alliance, purchase and supply of technical and scientific services) to enter into relationship with different types of partners (i.e. large pharmaceutical companies, product biotech firms, platform biotech firms and universities) with the aim to acquire (Inbound Open Innovation) or commercially exploit (Outbound Open Innovation) technologies and knowledge. The implications of the study for Open Innovation research and possible avenues for future investigation are discussed at length in the paper. (C) 2010 Elsevier Ltd. All rights reserved.
Bianchi, M; Chiaroni, D; Chiesa, V; Frattini, F	Organizing for external technology commercialization : evidence from a multiple case study in the pharmaceutical industry	R & D MANAGEMENT	2011	External technology commercialization (ETC) is increasingly being regarded as a strategic priority by companies. ETC is the use of out-licensing to transfer technologies that are disembodied from products to other organizations. Previous research has focused on the economic and strategic dimensions but little attention has so far been paid to how ETC should be organized. This paper explores whether and how firms operating in different contexts adopt dissimilar organizational solutions for their ETC activities. To this aim, a theoretical framework is first developed that comprises the key constitutive elements of ETC organization and a number of firm-level and deal-level factors that are supposed to influence organizational design choices. Based on a multiple case-study analysis involving 16 out-licensing deals executed in seven Italian pharmaceutical firms, the paper shows that the organization of out-licensing tasks and the allocation of decision-making power is shaped by, and adapts to, the relevance of ETC in the corporate strategy, the volume of ETC transactions, the stage of development of the technology being commercialized and the competitive threats due to the deal. The paper is believed to be useful for licensing and R&D managers who can find practical insights into how ETC activities can be organized and which critical contextual factors should be accounted for when designing such organization.
Ollila, S; Elmquist, M	Managing Open Innovation: Exploring Challenges at the Interfaces of an Open Innovation Arena	CREATIVITY AND INNOVATION MANAGEMENT	2011	Collaborating with peers to gain access to knowledge is an attractive alternative for organizations keen to improve their innovativeness, and the rising popularity of open innovation has resulted in the emergence of new actors in the innovation process. Previous research focuses mainly on the firms that collaborate with these actors. This paper adopts the perspective of an open innovation actor and the managerial challenges involved. It is based on a case study of SAFER, a Swedish traffic and vehicle safety research unit with 22 collaborating partners. The unit, which is here called an open innovation arena, differs from an intermediary in that it both enables open innovation within a specific field of expertise and envisages itself as a key player in that same field. The case study reveals three types of challenges for the management of an open innovation arena: challenges that arise at the interface with partner organizations, challenges related to collaboration between the partners, and challenges related to the arena itself.
Lichtenthaler, U	The evolution of technology licensing management: identifying five strategic approaches	R & D MANAGEMENT	2011	Besides applying technology in new products inside the organization, industrial firms may actively license technology to external partners. There is anecdotal evidence that firms have increasingly licensed technology in recent years in order to achieve monetary and non-monetary benefits. However, prior research into the evolution of licensing activities and into the management of these activities is relatively limited. Therefore, we rely on an exploratory research design and collect unique data by means of 57 interviews in 25 industrial firms over a 5-year period. On this basis, we identify five different strategic approaches to licensing management. In addition, we examine the relationship between the firms' licensing management and licensing activity. Finally, we analyze the development of the firms' licensing management over the 5-year period. The results considerably deepen our understanding of licensing management, and they provide new

				insights into interfirm differences in the success of active licensing programs. The findings have major implications for research into technology licensing, knowledge exploitation, open innovation, and markets for technology.
Snow, CC; Fjeldstad, OD; Lettl, C; Miles, RE	Organizing Continuous Product Development and Commercializatio n: The Collaborative Community of Firms Model	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2011	The increased importance of knowledge creation and use to firms' global competitiveness has spawned considerable experimentation with organizational designs for product development and commercialization over the last three decades. This paper discusses innovation-related organizational design developments during this period, showing how firms have moved from stand-alone organizations to multifirm network organizations to community-based organizational designs. The collaborative community of firms model, the most recent organizational design in this evolutionary process, is described in detail. Blade.org, a purposefully designed collaborative community of firms dedicated to the continuous development and commercialization of blade servers, a computer technology with large but unforeseeable market potential, is used as an illustrative case. Blade.org's organizational design combines a community "commons" for the collective development and sharing of knowledge among member firms with explicit institutional mechanisms for the support of direct intermember collaboration. These design elements are used to overcome the challenges associated with (1) concurrent technological and market experimentation and (2) the dynamic coordination of a complex emergent system of hardware, software, and services provided by otherwise independent firms. To date, Blade.org has developed more than 60 new products, providing strong evidence of the innovation prowess of the collaborative community of firms organizational model. Based on an analysis of the evolution of organizational designs and the case of Blade.org, implications for innovation management theory and practice are derived.
Chiaroni, D; Chiesa, V; Frattini, F	The Open Innovation Journey: How firms dynamically implement the emerging innovation management paradigm	TECHNOVATION	2011	Open Innovation is currently one of the most debated topics in management literature. Nevertheless, there are still many unanswered questions in Open Innovation research. Especially two issues require further investigation: (i) understanding the relevance of Open Innovation beyond high-tech industries and (ii) studying how firms implement Open Innovation in practice. The paper addresses these topics by studying, through an in-depth case study, the journey that the Italian leading cement manufacturer, has undergone to move from a Closed to an Open Innovation paradigm. The paper shows that the Open Innovation paradigm is implemented along a three-phase process that comprises the stages of unfreezing, moving and institutionalising. Moreover, it emerges that the changes through which Open Innovation has been implemented involve four major dimensions, i.e. networks, organisational structures, evaluation processes and knowledge management systems. They should be therefore conceived as the managerial and organisational levers an innovating firm can act upon to streamline its journey toward Open Innovation. Theoretical and managerial implications of using these levers for implementing Open Innovation are discussed at length. (C) 2009 Elsevier Ltd. All rights reserved.
Mortara, L; Minshall, T	How do large multinational companies implement open innovation?	TECHNOVATION	2011	This paper addresses a major gap in reported research on open innovation (OI): how do companies implement open innovation? To answer this question a sample of 43 cross-sector firms were reviewed for their OI implementation approaches. The study analyzed how firms moved from practising closed to open innovation, classifying the adoption path according to the impetus for the adoption of the OI paradigm and the coordination of the OI implementation. The way firms adopted OI was found to vary according to (1) their innovation requirements, (2) the timing of the implementation and (3) their organizational culture. (C) 2011 Elsevier Ltd. All rights reserved.
Rolandsson, B; Bergquist, M; Ljungberg, J	Open source in the firm: Opening up professional practices of software development	RESEARCH POLICY	2011	Opening up firms to open source has changed professional programmers' work in software development. In their work practice they must cope with two modes of software production: one based on proprietary, closed work situations, the other built around open source community ways of cooperation and knowledge sharing. In this article we present a study of how programmers cope with the co-existence of an industrial/commercial and a community/commons based mode of production. We analyze how they develop strategies to handle tensions that arise from contradictions between these two modes, and how it changes programmers' approach towards open source software development in the company. The study covers proprietary companies that have gradually incorporated open source software (hybrid companies) and SMEs entirely built around open source business concepts (pure-play companies). Four strategies are elaborated and discussed in-depth: Engineering in the lab, Market driven tailoring. Developing the community consortium and Peer-production. At a more general level, the study contributes to our understanding of how the transformation of proprietary production processes into a more open mode of knowledge work is not only associated with company strategies, but also with tensions and new demands on how work is strategically handled by knowledge workers. (C) 2010 Elsevier B.V. All rights reserved.
Remneland-Wikhamn, B; Wikhamn, W	Open Innovation Climate Measure: The Introduction of a Validated Scale	CREATIVITY AND INNOVATION MANAGEMENT	2011	Open innovation describes how organizations open up their innovation processes for external influence and collaboration. Despite this recent, and increasingly popular, development in the industry as well as in academic literature, the field lacks valid assessment tools. As a supportive organizational climate is argued to be a crucial element for successful implementation of open innovation, we propose in this paper Open Innovation Climate Measure (OICM). This three-dimensional assessment tool is tested in three units located in a multinational automotive corporation in the process of incorporating open innovation principles in practice.
Bogers, M; Lhuillery, S	A Functional Perspective on	INDUSTRY AND INNOVATION	2011	We investigate the intra-organizational antecedents of firm-level absorptive capacity (AC). Specifically, we examine how the functional areas of R&D, manufacturing and marketing contribute to the absorption of knowledge coming from different external knowledge sources.

	Learning and Innovation: Investigating the Organization of Absorptive Capacity			The econometric results on a representative sample of Swiss firms show that non-R&D-based AC plays a significantly different role compared to the standard R&D-based one that is typically considered in studies on AC. We also reveal that AC is organized through a specialization of external knowledge absorption across functional areas. In particular, we find: (1) R&D is particularly important as an absorber of knowledge from public research organizations for product innovation; (2) manufacturing is important as an absorber of supplier knowledge for product innovation and of competitor knowledge for process innovation; and (3) marketing helps to absorb customer knowledge for product and process innovation as well as competitor knowledge for product innovation. We further investigate the differences between product and process innovation and find that marketing-based AC is more important for the former, although the overall analysis of these differences is less conclusive. In short, we show how functional areas play a role in the organization of AC and that firms may need an ambidextrous strategy to innovate effectively based on both upstream-and downstream-based AC.
Love, JH; Roper, S; Bryson, JR	Openness, knowledge, innovation and growth in UK business services	RESEARCH POLICY	2011	We explore the causal links between service firms' knowledge investments, their innovation outputs and business growth based on a bespoke survey of around 1100 UK service businesses. We combine the activity based approach of the innovation value chain with firms' external links at each stage of the innovation process. This introduces the concept of 'encoding' relationships through which learning improves the effectiveness of firms' innovation processes. Our econometric results emphasise the importance of external openness in the initial, exploratory phase of the innovation process and the significance of internal openness (e.g. team working) in later stages of the process. In-house design capacity is strongly linked to a firm's ability to absorb external knowledge for innovation. Links to customers are important in the exploratory stage of the innovation process, but encoding linkages with private and public research organisations are more important in developing innovation outputs. Business growth is related directly to both the extent of firms' service innovation as well as the diversity of innovation, reflecting marketing, strategic and business process change. (C) 2011 Elsevier B.V. All rights reserved.
Knudsen, MP; Mortensen, TB	Some immediate - but negative - effects of openness on product development performance	TECHNOVATION	2011	This paper charts an unnoticed theme in the current debate on open innovation, namely the foundational question whether increasing openness is beneficial? The paper approaches this question by conceptualising the degree of 'openness' and analyses the importance of increasing degrees of openness for NPD performance. Inter-organizational relationships in New Product Development lay the foundation for operationalising openness because these represent important sources of ideas and knowledge in purposive inbound open innovation. This exploratory paper finds that on immediate NPD performance measures the single firm strategy is performing better than the collaborative strategy. However, we also find that the use of internal and external relationships is highly correlated and that these interact with each other. Finally, with increasing degrees of openness the product development projects are slower than the norm in the industry, slower than what is usual for the firm's projects and had higher cost than the norm in the industry and the firm's usual projects. These results offer a more critical perspective on openness and NPD performance than the literature on the open innovation paradigm suggests. The paper discusses these results and offers some challenges for management and research of open innovation. (C) 2010 Elsevier Ltd. All rights reserved.
Chen, J; Chen, YF; Vanhaverbeke, W	The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms	TECHNOVATION	2011	It is commonly accepted nowadays that external knowledge sources are important for firms' innovative performance. However, it is still not clear, what dimensions of firms' external knowledge search strategy are crucial in determining their innovation success and whether these search strategies are contingent on different innovation modes. In this study, we analyse how the innovative performance is affected by the scope, depth, and orientation of firms' external search strategies. We apply this analysis to firms using STI (science, technology and innovation) and DUI (doing, using and interacting) innovation modes. Based on a survey among firms in China, we find that greater scope and depth of openness for both innovation modes improves innovative performance indicating that open innovation is also relevant beyond science and technology based innovation. Furthermore, we find that decreasing returns in external search strategies, suggested by Laursen and Salter (2006), are not always present and are contingent on the innovation modes. Next, we find that the type of external partners (we label it "orientation of openness") is crucial in explaining innovative performance and that firms using DUI or STI innovation modes have different sets of relevant innovation partners. This shows that the orientation of openness is an important dimension-in addition to the scope and depth of openness. As respondents are located in China, this study provides evidence that open innovation is also relevant in developing countries. (C) 2011 Elsevier Ltd. All rights reserved.
Fuller, J; Hutter, K; Faullant, R	Why co-creation experience matters? Creative experience and its impact on the quantity and	R & D MANAGEMENT	2011	This article introduces 'virtual design competitions' as a new means of opening up the innovation process and enriching the companies, 'design-ideas' by utilizing the creativity of a multiplicity of external designers and enthused consumers all over the world. The 'Swarovski Enlightened (TM) jewellery design competition', explored in this study, demonstrates the enormous potential of virtual co-creation platforms. It further highlights the importance of the co-creation experience and its impact on the quantity and quality of designs submitted. First, we introduce the idea of virtual co-creation platforms and the requirements on the design of such a platform. Second, we explore the impact of the co-creation experience on the content contributed by participants. Our study shows that co-creation experience significantly impacts the number of contributions by consumers as well as the quality of submitted designs. Our paper contributes to a better theoretic

	quality of creative contributions			understanding of the impact of a participant's perceived autonomous, enjoyable, and competent experience, as well as participants' perceived sense of community on their experience. From a managerial perspective, it provides guidance in designing successful idea and design competitions. While innovation managers may be interested in creative contributions, for participants, it is the experience which matters. Fully featured community platforms rather than single idea submission websites are required to attract creative users to submit their ideas and designs.
Hutter, K; Hautz, J; Fuller, J; Mueller, J; Matzler, K	Communitition: The Tension between Competition and Collaboration in Community-Based Design Contests	CREATIVITY AND INNOVATION MANAGEMENT	2011	Following the concepts of crowdsourcing, co-creation or open innovation, companies are increasingly using contests to foster the generation of creative solutions. Currently, online idea and design contests are enjoying a resurgence through the usage of new information and communication technologies. These virtual platforms allow users both to competitively disclose their creative ideas to corporations and also to interact and collaborate with like-minded peers, communicating, discussing and sharing their insights and experiences, building social networks and establishing a sense of community. Little research has considered that contest communities both promote and benefit from simultaneous co-operation and competition and that both types of relationships need to be emphasized at the same time. In this article, it is argued that the firm-level concept of co-opetition might also be relevant for an innovation's success on the individual level within contest communities. Our concept of 'communitition' should include the elements of competitive participation without disabling the climate for co-operation, as numerous user discussions and comments improve the quality of submitted ideas and allow the future potential of an idea to shine through the so-called 'wisdom of the crowd'.
Huizingh, EKRE	Open innovation: State of the art and future perspectives	TECHNOVATION	2011	Open innovation has become one of the hottest topics in innovation management. This article intends to explore the limits in our understanding of the open innovation concept. In doing so, I address the questions of what (the content of open innovation), when (the context dependency) and how (the process). Open innovation is a rich concept, that can be implemented in many different ways. The context dependency of open innovation is one of the least understood topics; more research is needed on the internal and external environment characteristics affecting performance. The open innovation process relates to both the transition towards open innovation, and the various open innovation practices. As with any new concept, initial studies focus on successful and early adopters, are based on case studies, and descriptive. However, not all lessons learned from the early adopters may be applicable to following firms. Case study research increases our understanding of how things work and enables us to identify important phenomena. They should be followed by quantitative studies involving large samples to determine the relative importance of factors, to build path models to understand chains of effects, and to formally test for context dependencies. However, the evidence shows that open innovation has been a valuable concept for so many firms and in so many contexts, that it is on its way to find its final place in innovation management. (C) 2010 Elsevier Ltd. All rights reserved.
Porter, AL; Newman, NC	Mining external R&D	TECHNOVATION	2011	Open Innovation presses the case for timely and thorough intelligence concerning research and development activities conducted outside one's organization. To take advantage of this wealth of R&D, one needs to establish a systematic "tech mining" process. We propose a 5-stage framework that extends literature review into research profiling and pattern recognition to answer posed technology management questions. Ultimately one can even discover new knowledge by screening research databases. Once one determines the value in mining external R&D, tough issues remain to be overcome. Technology management has developed a culture that relies more on intuition than on evidence. Changing that culture and implementing effective technical intelligence capabilities is worth the effort. P&G's reported gains in innovation call attention to the huge payoff potential. (C) 2011 Elsevier Ltd. All rights reserved.
Seldon, T	Beyond patents: Effective intellectual property strategy in biotechnology	INNOVATION-MANAGEMENT POLICY & PRACTICE	2011	Dispelling the linear view of intellectual property protection in biotechnology, intellectual property (IP) and patents are almost synonymous in the biotechnology industry. In this innovation-intensive industry, it is unsurprising that patents are the foremost means of protection, since they provide (at least) 20 years exclusivity. However, a recent seven-year international study challenged the preconception that patenting leads to heightened innovation (International Expert Group on Biotechnology 2008). The following analysis uses case studies to demonstrate that leading companies take a holistic approach to IP management.
Hsuan, J; Mahnke, V	Outsourcing R&D: a review, model, and research agenda	R & D MANAGEMENT	2011	Outsourcing R&D is an increasingly explored corporate practice. Extant research advanced our initial understanding of its increasing importance and benefits. While the associated literature has blossomed, the enthusiasm of R&D managers is tenured by an increasing realization of the possible downsides, risks, and costs that come with increasing use of external sources of innovation. Here, we suggest that research on outsourcing R&D has to move towards a balanced view on the profitability of such arrangements. To this end, we offer a review of what we know and need to know about outsourcing R&D, suggest a simple, yet integrative model on the relation between outsourcing R&D and performance, and offer a research agenda that is instrumental in guiding companies' process-management and design strategies when seeking to benefit from the outsourcing of R&D.
Mention, AL	Co-operation and co-opetition as open innovation	TECHNOVATION	2011	This study aims to identify the influence of co-operation practices and the use of internal and external information sources on the propensity of firms to introduce new to the market innovations in the service sector. Data come from the 4th Community Innovation Survey, which covers the years 2002-2004. A logistic regression model is applied with the degree of novelty of good/service innovation as

	practices in the service sector: Which influence on innovation novelty?			dependent variable. The analysis of the parameter estimates shows that firms provided with information from market sources and from internal sources as well as firms involved in science-based collaboration for their product innovations are more likely to introduce new to the market innovations, whereas information coming from competitors seems to have a negative influence on the degree of novelty of innovation. (C) 2010 Elsevier Ltd. All rights reserved.
Aslesen, HW; Freel, M	Industrial Knowledge Bases as Drivers of Open Innovation?	INDUSTRY AND INNOVATION	2012	The article presents an analysis of a large-scale survey with the aim of understanding differences in the open, interactive and distributed nature of external innovation relations amongst firms belonging to different industrial knowledge bases. The thesis is that the source of critical innovation relevant knowledge differs between industrial knowledge bases, making the character and the need of openness contingent on these specificities. Accordingly, we anticipate that we will observe systematic variations in how industries access and combine innovation-related external knowledge. In our analyses we attempt to address a gap in the literature by examining how industrial knowledge bases affect the recombination of knowledge by analysing the different extents, forms (formal and informal) and geography of inbound open innovation. The article illustrates that features and structures of inbound open innovation align, to a large extent, with the industries' knowledge bases and that there is a interplay between an industry's knowledge base, the internal organisation of innovation processes and the channels and geography of inbound open innovation.
Bogers, M; West, J	Managing Distributed Innovation: Strategic Utilization of Open and User Innovation	CREATIVITY AND INNOVATION MANAGEMENT	2012	Research from a variety of perspectives has argued that innovation no longer takes place within a single organization, but rather is distributed across multiple stakeholders in a value network. Here we contrast the vertically integrated innovation model to open innovation, user innovation, as well as other distributed processes (cumulative innovation, communities or social production, and co-creation), while we also discuss open source software and crowdsourcing as applications of the perspectives. We consider differences in the nature of distributed innovation, as well as its origins and its effects. From this, we contrast the predictions of the perspectives on the sources, motivation and value appropriation of external innovation, and thereby provide a framework for the strategic management of distributed innovation.
Muller-Seitz, G	Absorptive and desorptive capacity-related practices at the network level - the case of SEMATECH	R & D MANAGEMENT	2012	Previous research has predominantly conceptualized absorptive capacity as an intraorganizational phenomenon, primarily by means of quantitative methods. In contrast, this research develops a practice-based understanding of how an interorganizational network can engage in network absorptive and desorptive capacity-related (NAC and NDC respectively) activities. SEMiconductor MAnufacturing TECHnologies(SEMATECH) is an interorganizational network to develop innovative semiconductor manufacturing solutions globally. Based upon an in-depth case study of SEMATECH we add to the literature as follows: first, we introduce NAC and NDC, venturing beyond the organization or dyad as the unit of analysis. Second, we adopt a practice perspective in order to illustrate how SEMATECH is able to engage in NAC- and NDC-related activities, primarily by means of three practices, that is, congregating, roadmapping and offering access. These practices re-inform each other, allowing SEMATECH, in effect, to coordinate the network's knowledge-related activities with regard to knowledge outside of the network.
Parjanen, S; Hennala, L; Konsti-Laakso, S	Brokerage functions in a virtual idea generation platform: Possibilities for collective creativity?	INNOVATION-MANAGEMENT POLICY & PRACTICE	2012	The open innovation approach emphasizes the importance of service and product users as a source of novel ideas. An essential question is how user-driven innovation is conducted. Information and communications technology offers various new opportunities and means of acquiring information about users and engaging them in innovation activity. This study investigates brokerage functions in a virtual environment where people with diverse experience, areas of expertise and perspectives collaborate. The research question is bow brokerage functions are able to create possibilities for collective creativity. The study focuses on the front-end stage of an innovation process: the ideation phase in a virtual idea generation environment, in which fruitful and fresh ideas based on users; or potential users', needs are sought for in order to support the innovation process.
Remneland-Wikhamn, B; Knights, D	Transaction Cost Economics and Open Innovation: Implications for Theory and Practice	CREATIVITY AND INNOVATION MANAGEMENT	2012	Transaction cost economics (TCE) has had a strong impact on theories of economic exchange but also on open innovation, even though the relationship is often implicit rather than explicit. In this paper, we highlight what we consider to be the problematic use of TCE in the context of open innovation, suggesting that it has a limited descriptive power and potentially does normative damage to open innovation practice. A case study of the Volvo Group will be drawn upon to illustrate these claims. The case questions the belief that hierarchical control eliminates transaction costs. Also, it suggests that an overemphasis on calculative reduction of transaction costs together with a focus on governance and rationality leave little space for an innovative climate, thus diverting attention away from the creative potential of transactions. Indeed the self-fulfilling prophecy character of subscribing to the assumptions of TCE may not merely limit but actually undermine innovation.
Vrgovic, P; Vidicki, P;	Open innovation for SMEs in	INNOVATION-MANAGEMENT	2012	Although there is increasing interest in exploring open innovation in developing countries, the conceptual and potential applications of using open innovation in the small to medium enterprise sector are rarely explored. Since SMEs often have a dominant impact on national

Glassman, B; Walton, A	developing countries - An intermediated communication network model for collaboration beyond obstacles	POLICY & PRACTICE		economies, their innovative potential should not be neglected. While SMEs in developed countries have learned how to innovate, SMEs in developing countries face a range of obstacles that hinder them from innovating as much as they could This paper suggests that in these cases a government agency using innovation hubs, could help SMEs to connect, communicate and collaborate with independent inventors and other parties to jumpstart innovation practices. A joint innovation model is presented to address known issues and a number of cases from developing countries are summarized to test the model.
Fuller, J; Matzler, K; Hutter, K; Hautz, J	Consumers' Creative Talent: Which Characteristics Qualify Consumers for Open Innovation Projects? An Exploration of Asymmetrical Effects	CREATIVITY AND INNOVATION MANAGEMENT	2012	Virtual customer integration and open innovation are considered as appropriate means to improve the success of new product development. However, only when consumers are qualified and motivated to contribute promising ideas and relevant know-how they are able to add value to a producer's innovation process. In this study, we explore the symmetric and asymmetric impact of various creativity components on consumers' idea generation, concept development, or prototype building abilities as well as interest in co-creation projects. Our results show that creativity components are of different importance. While some characteristics are needed above certain thresholds to successfully accomplish a certain development task, exceeding those does not necessarily lead to better outputs. Other characteristics improve the creative output only if they exceed specific levels.
Frishammar, J; Lichtenthaler, U; Rundquist, J	Identifying Technology Commercializatio n Opportunities: The Importance of Integrating Product Development Knowledge	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2012	New product development (NPD) is a knowledge-intensive activity, perhaps even more so in recent years given the shift toward more open innovation processes, which involve active inward and outward technology transfer. While the extant literature has established that knowledge is critical for NPD performance, knowledge generated through NPD can have an additional impact on external technology exploitationas when firms go beyond pure internal application of knowledge to commercialize their technologies, for example, by means of technology outlicensing. Grounded in the knowledge-based view of the firm, this paper examines how the integration of domain-specific knowledge, procedural knowledge, and general knowledge generated through NPD affects a firm's proficiency in identifying technology commercialization opportunities. Additionally, analysis of how technology opportunity identification relates to technology commercialization performance is provided. Empirically, the paper draws on survey data from 193 Swedish medium-sized manufacturing firms in four industries active with NPD, and regression analyses and structural equation modeling were used to test the hypotheses. The results highlight the importance of integrating domain-specific and general NPD knowledge to proficiently identify technology licensing opportunities. The empirical findings also provide strong support for a subsequent link between technology opportunity identification and technology commercialization performance. Altogether, these results point to strong and previously unexplored complementarities between inward and outward technology exploitation, that is, between NPD and technology licensing. As such, the results provide important theoretical implications for research into the fields of knowledge integration, technology exploitation, opportunity identification, and technology markets. Moreover, the results have significant managerial implications concerning how knowledge generated through NPD can help firms to achieve both strategic and monetary benefits when trying to profit from technology. In particular, to set up proficient technology commercialization processes, it appears beneficial for firms to integrate knowledge that is gained through the ordinary activities of developing and commercializing products. Specifically, the integration of domain-specific knowledge and general knowledge helps firms to match their technologies with new applications and markets, which is often the critical barrier to successful technology commercialization activities. Managers are thus encouraged to integrate domain-specific knowledge and general knowledge from NPD to reap additional benefits in profiting from investments in innovation and technology.
Grote, M; Herstatt, C; Gemunden, HG	Cross-Divisional Innovation in the Large Corporation: Thoughts and Evidence on Its Value and the Role of the Early	CREATIVITY AND INNOVATION MANAGEMENT	2012	Forty-five years after Ansoff's seminal work on synergies, many multi-divisional corporations still struggle to create additional value. Therefore, it is surprising that in times of open innovation, little research has been conducted on the impact of cross-divisional product development. In our paper, we derive conceptual arguments for the relevance of joint initiatives and examine the role of cross-divisional collaboration in the early stages of the innovation process. Our research model is tested using a quantitative survey in 110 multi-divisional firms. We find that the extent of collaboration in the early stages of innovation strongly determines the impact of cross-divisional products on corporate success. To achieve collaboration, our results highlight the relevance of appropriate integration mechanisms and incentives.

	Stages of Innovation			
Fu, XL	How does openness affect the importance of incentives for innovation?	RESEARCH POLICY	2012	When firms open up to external resources for innovation, do internal incentives still matter? This paper investigates the moderating effect of open innovation on the relationship between incentives and innovation using a survey database of British firms. Whilst both openness and incentives are positively associated with innovation efficiency, a substitution effect is found between openness and incentives. Whilst long-term incentives appear to enhance efficiency to a greater extent than short-term incentives, the substitution effect of openness is stronger regarding long-term incentives. (C) 2012 Elsevier B.V. All rights reserved.
Battistella, C; Nonino, F	Open innovation web-based platforms: The impact of different forms of motivation on collaboration	INNOVATION-MANAGEMENT POLICY & PRACTICE	2012	Given that open innovation web-based platforms (OIPs) allow for the collaboration of individuals and companies, this paper focuses on exploring the motivations for participating and collaborating in OIPs. Extant studies are conflicting, especially with respect to the importance of the monetary reward as a motivation. Moreover, literature supports our premise from the individuals' motivations analysis viewpoint, but not from the companies' perspective. Finally, literature does not consider the differences related to different members and to different phases of the innovation process. First, we base the literature on open innovation on the Internet (crowdsourcing, peer production and open source) to identify the potential motivations. We then deeply analyse 116 OIPs to determine if the motivations can be a function of the phase of innovation and the dependency on members. We show that the design of the motivational system should take into consideration the different stages of the innovation process and that the OIPs should consider moving from 'work place' logic to 'social place' logic.
Robertson, PL; Casali, GL; Jacobson, D	Managing open incremental process innovation: Absorptive Capacity and distributed learning	RESEARCH POLICY	2012	In this conceptual article, we extend earlier work on Open Innovation and Absorptive Capacity. We suggest that the literature on Absorptive Capacity does not place sufficient emphasis on distributed knowledge and learning or on the application of innovative knowledge. To accomplish physical transformations, organisations need specific Innovative Capacities that extend beyond knowledge management. Accessive Capacity is the ability to collect, sort and analyse knowledge from both internal and external sources. Adaptive Capacity is needed to ensure that new pieces of equipment are suitable for the organisation's own purposes even though they may have been originally developed for other uses. Integrative Capacity makes it possible for a new or modified piece of equipment to be fitted into an existing production process with a minimum of inessential and expensive adjustment elsewhere in the process. These Innovative Capacities are controlled and coordinated by Innovative Management Capacity, a higher-order dynamic capability. (C) 2012 Elsevier B.V. All rights reserved.
Hsieh, KN; Tidd, J	Open versus closed new service development: The influences of project novelty	TECHNOVATION	2012	Open innovation has become a normative model. However, there is relatively little evidence on its efficacy in different contexts or the specific mechanisms needed to support its implementation. In this study we compare the development of two types of service across two contrasting approaches to development. The first approach, could be characterized as the more conventional or closed, whereas the other approach is much more open. The two types of service vary by the degree of novelty. Based upon 52 interviews with those directly involved in the new service development projects, including partners and suppliers, we identify the influences of project novelty on the effectiveness of open approaches to innovation. We find that higher levels of project novelty demand higher intensity of knowledge sharing and communication. In such cases the more closed new service development tends to reduce the development time, but the more open approach improves the variety and quality of innovation. However, rather than the narrow distinction between internal versus external sources, we find that it is the intensity and quality of such relationships which differentiates innovation outcomes, what we refer to as generative interactions. (C) 2012 Elsevier Ltd. All rights reserved.
Pullen, AJJ; de Weerd-Nederhof, PC; Groen, AJ; Fisscher, OAM	Open Innovation in Practice: Goal Complementarity and Closed NPD Networks to Explain Differences in Innovation Performance for SMEs in the Medical Devices Sector	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2012	Cooperation with other organizations increases the innovation performance of organization, especially for small and medium-sized enterprises (SMEs) as they encounter liabilities of smallness (e.g., limited financial resources, and manpower). In the medical devices sector, collaboration with external partners for NPD becomes increasingly important due to the complexity of the products and the development process. About 80% of companies in this sector are SMEs. These companies operate in a highly regulated sector, which affects the organization of the external network required for the new product development (NPD) process. SMEs are practicing extensively open innovation activities, but in practice face a number of barriers in trying to apply open innovation. This paper examines multiple network characteristics simultaneously in relation to innovation performance and thereby aligns with and builds further on configuration theory. Configuration theory posits that for each set of network characteristics, there exists an ideal set of organizational characteristics that yields superior performance. In this research, the systems approach to fit is used. Fit is high to the extent that an organization is similar to an ideal profile along multiple dimensions. This ideal profile represents the network profile that the 15% highest performing companies use. It is argued that the smaller the distance between the ideal profile and the network profile that is used, the higher the performance. The objective of this research is (1) to examine the relation between the ideal profile and innovation performance and (2) to examine which organization of the network profile is related to high innovation performance. Quantitative survey data (n?=?60, response rate 61.9%) form

				the core of this research. The quantitative results are clarified and have been triangulated with qualitative interview data (n?=?50). Our findings suggest the presence of an ideal NPD network profile (in terms of goal complementarity, resource complementarity, fairness trust, reliability trust, and network position strength): the more a company's NPD network profile differs from this ideal profile, the lower the innovation performance. In addition, the results of our study indicate that the NPD network profiles of successful and less successful SMEs in the medical devices sector significantly differ in terms of goal complementarity, while this is less the case for trust and resource complementarity labeled distinctive by previous research. Finally, results show that a relatively closed, focused, and consistent business-like NPD networking approach, which is characterized by result orientation and professionalism, is related to high innovation performance. It is recommended that SMEs in the medical devices sector aiming to distinguish themselves from competitors in terms of innovation performance focus on goal complementarity while adopting such a business-like attitude toward their NPD network partners.
Segarra-Cipres, M; Bou-Llusar, JC; Roca-Puig, V	Exploring and exploiting external knowledge: The effect of sector and firm technological intensity	INNOVATION-MANAGEMENT POLICY & PRACTICE	2012	This paper analyses whether the technological environment in which firms operate conditions the opening up of the innovation process, or whether it is the firm's R&D efforts, regardless of the sector it operates in, that determine to a greater extent the firm's capacity to explore and exploit external knowledge. Using negative binomial models, the paper analyses the effect of external sources of knowledge on innovation outputs, and the moderator effect of technological intensity of the sector and firm. Results show that the most R&D intensive firms and sectors explore external sources of knowledge to a greater extent than those which are less R&D intensive. In contrast, no substantial differences emerge with regard to the exploitation of these sources. Results also show that opening up the innovation process is not a sectoral phenomenon, since there are significant differences in the use of external sources within the industry itself Highly open, dynamic and innovative firms can be found in low technology-intensive sectors, indicating that heterogeneity in intra-industrial innovative behaviour should be taken into account when formulating sector-based policies to support the opening up of the innovation process.
Suh, Y; Kim, MS	Effects of SME collaboration on R&D in the service sector in open innovation	INNOVATION-MANAGEMENT POLICY & PRACTICE	2012	This study analyses the effects of four types of collaborative activities on the R&D performance of service SMEs in the context of open innovation: in-house R&D (non-collaboration), technology acquisition, R&D collaboration, and networking. For this, the study employs data envelopment analysis, a power tool that uses multiple inputs and outputs to measure the relative efficiency of collaborative activities of service SMEs for R&D. The results indicate that technology acquisition is the most efficient type of collaboration for R&D of service SMEs. More specifically in-house R&D, technology acquisition, and R&D collaboration are positively related to product/service innovation, patenting activity, and process innovation, respectively. However, networking is not significantly related to any three types of R&D performance. In addition, the service SMEs' strategic focus did not match their strategic purposes, suggesting a need for adjusting their collaborative activities. The results have important implications for managers and policy-makers interested in facilitating open innovation in service SMEs through various collaborative activities.
Tranekjer, TL; Knudsen, MP	The (Unknown) Providers to Other Firms' New Product Development: What's in It for Them?	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2012	For every inbound activity by a firm in open innovation, a reciprocal outbound activity by another firm must be generated. The reciprocal outbound activities range from transferring of knowledge and ideas to solutions delivered to other firms' new product development projects. This paper names the firms that produce the reciprocal outbound activity for providers, and is the first to empirically investigate such providers of ideas, solutions, and technologies for other firms' open innovation activities. The literature review shows a surprising shortage of research on who the providers are, how they engage with other firms, and not least what potential benefits can be achieved from supporting other firms' innovation activities. The paper uses a quantitative survey on Danish small and medium-sized enterprises (SMEs) carried out in 2010 to identify the providers, the role they take on, and the main benefits the providers gain. This paper finds that firms that are providers are indeed an under-researched and important phenomenon for firms' innovation activities. Compared to receivers of knowledge, the providers are younger, have a higher R&D intensity, adopt more open innovation practices, have higher absorptive capacity, and fewer barriers toward knowledge sharing as demonstrated by the NIH and NSH syndromes. Finally, although only tentatively, the paper finds that the provider firms are more product innovative compared to nonproviders. The paper further finds that more projects, more embedded relationships, and mutual rather than one-way exchange relationships significantly raise the probability that a firm experiences a substantial benefit from providing to other firms' new product development projects. The overall ambition of the paper at this point is to inspire other researchers to pursue the agenda on the provider perspective for future research. To support such research, the paper suggests a broadening of the research perspectives from the receiver of knowledge, in the literature on interorganizational relationships and open innovation, to include the provider, and even suggests some preliminary ideas for such research. Hence, the contribution of this paper lies not only in opening a new research topic but also in identifying some first characteristics of the phenomenon adding a substantial perspective to the literature on open innovation and interorganizational relationships. The paper formulates three indicative recommendations for managers that consider becoming a provider to other firms' NPD.
Michelfelder, I; Kratzer, J	Why and How Combining Strong	JOURNAL OF PRODUCT	2013	The purpose of this paper is to demonstrate why and how an ambidextrous interorganizational R&D collaboration outperforms other collaboration structures in the creation of innovation. This research effort contributes to a growing stream of research in social network

	and Weak Ties within a Single Interorganizationa l R&D Collaboration Outperforms Other Collaboration Structures	INNOVATION MANAGEMENT		theory suggesting that the contradictory theories of the strength of weak ties and weak network structures on the one hand and the theory of strong ties and closed network structures on the other have a mutually reinforcing effect on innovation outcomes if combined rather than considered separately. An in-depth exploratory single case study approach within an innovatively organized national R&D collaboration allowed giving further evidence for such a superior innovation performance and for this research to contribute to theory by demonstrating why and how such a combination may lead to higher innovation output and how this effect can be actively reinforced. It is suggested that the combination of strong and weak ties should occur at the individual rather than at the project or firm level. The authors distinguish between the additive effects of the respective innovation benefits of strong and weak ties, a positive interaction effect in the portfolio of dyadic ties of an individual and a second multilevel interaction effect of weak ties embedded in the ambidextrous network structure. Referring to previous empirical findings, intellectual property regulation and structural interdependency between network members showed a higher impact than trust with regard to leveraging weak ties and are important sources for achieving the multilevel interaction effect. Managerial implications of this research are that a large network will outperform several smaller, independent networks given that the right structure and processes are in place. Direct implications for the architecture of an ambidextrous R&D collaboration are discussed, and a framework for a new form of technology R&D collaboration called semi-open organization is presented, which places itself between the extremes of traditional R&D in closed organizations and completely open innovation approaches.
Xia, TJ	Absorptive capacity and openness of small biopharmaceutical firms - a European Union-United States comparison	R & D MANAGEMENT	2013	The complementarities between internal capabilities and external linkages have been widely acknowledged in the open innovation literature, yet little is known about the extent to which internal capabilities affect firms' openness within different institutional contexts. This paper therefore empirically explores the relationship between absorptive capacity (ACAP) and openness in the United States and European biopharmaceutical sectors. Based on analysis of data from a large-scale international survey of 349 biopharmaceutical firms in the United States, the United Kingdom, France and Germany, the results suggest that exploratory openness depends more strongly on the research and development (R&D) aspect of firms' potential absorptive capacity, whereas exploitative openness is more conditional on firms' realized absorptive capacity (RACAP). The results also highlight the major differences between firms' openness and ACAP in the United States and Europe - in the United States, firms' skill levels prove more significant in contributing to firms' engagement with exploratory relationships, whereas in Europe, continuity of R&D proves more important. Engagement with exploitative relationships, however, is more conditional on firms' RACAP in Europe only.
Clausen, TH; Korneliussen, T; Madsen, EL	Modes of innovation, resources and their influence on product innovation: Empirical evidence from R&D active firms in Norway	TECHNOVATION	2013	Evolutionary theory of the firm argues that firms follow different approaches to innovation with implications for their performance. Consistent with evolutionary theory, this paper develops a taxonomy of innovation modes which capture the variation in firms' approaches to product innovation. The taxonomy is based on the open/closed innovation and exploration/exploitation literatures and identifies the following modes: "Open exploration", "closed exploration" "open exploitation", and "closed exploitation". The paper theorizes that the identified innovation modes influence product innovation through their effect on the firms' technological and market resources. Using survey data from over 1000 R&D active firms in Norway analyzed with structural equation modelling it is shown how four modes of innovation are related to actual product innovation. (C) 2013 Elsevier Ltd. All rights reserved.
Teirlinck, P; Spithoven, A	Research collaboration and R&D outsourcing: Different R&D personnel requirements in SMEs	TECHNOVATION	2013	The literature on 'open' innovation emphasises the need to engage in external knowledge relations in order to innovate. Particularly for SMEs, research cooperation and R&D outsourcing can offer possibilities to complement the often limited internal research resources. However, they also bring in their wake requirements in terms of absorptive capacity and managerial skills of the internal R&D personnel. The paper focuses on the different requirements in terms of availability and training of research managers and R&D experts for research cooperation versus R&D outsourcing in SMEs. An empirical analysis of micro-level data provided by the OECD business R&D survey for Belgium reveals that the. relation between R&D personnel requirements and research collaboration and R&D outsourcing depends upon the SME size. Therefore, to study this subject appropriately a distinction between very small, small, and medium-sized firms is relevant. Very small firms engage significantly less in research cooperation than medium-sized firms and the propensity to engage in research cooperation is positively associated with the share of PhD holders among the research managers and R&D experts. For R&D outsourcing a lower involvement is noted in medium-sized firms, and the propensity to outsource increases with the formal qualification level of the R&D personnel and with R&D training. Among the SME, small firms are most engaged in research cooperation and in R&D outsourcing. In the case of research cooperation they rely on highly qualified experts. For R&D outsourcing activities both the presence of research managers and R&D experts is important. (C) 2012 Elsevier Ltd. All rights reserved.

Hung, KP; Chou, C	The impact of open innovation on firm performance: The moderating effects of internal R&D and environmental turbulence	TECHNOVATION	2013	Researchers have identified open innovation as two dimensions, external technology acquisition and external technology exploitation. This study explores the direct and interactive effects of these two dimensions on firm performance and further examines the moderation effects of two factors (i.e., internal R&D and environmental turbulence) on the relationship between both types of open innovation and firm performance. Based on Chesbrough's open innovation model, multi-item scales were developed to measure two dimensions of firm-level open innovation. Survey results of 176 Taiwanese high tech manufacturing firms provide support for most hypotheses. The result shows that external technology acquisition positively affects firm performance, whereas external technology exploitation does not. This study also finds that external technology acquisition strengthens the relationship between external technology exploitation and firm performance. Both external technology acquisition and external technology exploitation are positively related to firm performance under high internal R&D investment and a turbulent market environment. However, technological turbulence only positively affects the relationship between external technological acquisition, but not external technology exploitation, and firm performance. The findings contribute to enhanced understanding of how the degree of leveraging open innovation dimensions depends on their complementarity, internal R&D, and environmental turbulence. (C) 2013 Elsevier Ltd. All rights reserved.
Roper, S; Vahter, P; Love, JH	Externalities of openness in innovation	RESEARCH POLICY	2013	Discussion of open innovation has typically stressed the benefits to the individual enterprise from boundary-spanning linkages and improved internal knowledge sharing. In this paper we explore the potential for wider benefits from openness in innovation and argue that openness may itself generate positive externalities by enabling improved knowledge diffusion. The potential for these (positive) externalities suggests a divergence between the private and social returns to openness and the potential for a sub-optimal level of openness where this is determined purely by firms' private returns. Our analysis is based on Irish plant-level panel data from manufacturing industry over the period 1994-2008. Based on instrumental variables regression models our results suggest that externalities of openness in innovation are significant and that they are positively associated with firms' innovation performance. We find that these externality effects are unlikely to work through their effect on the spread of open innovation practices. Instead, they appear to positively influence innovation outputs by either increasing knowledge diffusion or strengthening competition. Our evidence on the significance of externalities from openness in innovation provides a rationale for public policy aimed at promoting open innovation practices among firms. (C) 2013 The Authors. Published by Elsevier B.V. All rights reserved.
Barge-Gil, A	Open Strategies and Innovation Performance	INDUSTRY AND INNOVATION	2013	Scholarly interest in the relationship between open strategies and innovation performance has been unfailing, and in recent years has even increased. The present paper focuses on inbound open strategies and reviews various approaches (transaction costs, competences, open innovation) dealing with firms' decisions about these strategies. The different approaches result in different conclusions about the optimum level of openness. They are tested empirically taking account of the different degrees of firms' openness (closed, semi-open, open, ultra-open) and their relationship with sales of new-to-the-market products, and using a panel of Spanish firms from a Community Innovation Survey type survey for the period 2004-2008. Our results show that closed and semi-open strategies are the most common among Spanish firms and that open strategies are associated with the best performance, while semi-open strategies are correlated to a higher performance than closed ones. These results hold across different subsamples based on firm size and industry, and are robust to different ways of defining the indicators and to different estimation methods.
Berchicci, L	Towards an open R&D system: Internal R&D investment, external knowledge acquisition and innovative performance	RESEARCH POLICY	2013	To cope with fast-changing business environments, firms are increasingly opening up their organizational boundaries to tap into external source of knowledge. By restructuring their R&D system, firms face the challenge of balancing internal and external R&D activities to profit from external knowledge. This paper examines the influence of R&D configuration on innovative performance and the moderating role of a firm's R&D capacity. The findings suggest that firms that increasingly rely on external R&D activities have a better innovative performance, yet up to a point. Beyond this threshold, a greater share of external R&D activities reduces a firm's innovative performance. And such substitution effect is larger for firms with greater R&D capacity. Overall, this paper provides a better understanding of the open innovation paradigm by suggesting that the opportunity cost for further opening up R&D borders is higher for firms with a superior technological knowledge stock. (C) 2012 Elsevier B.V. All rights reserved.
Cruz-Cazares, C; Bayona-Saez, C; Garcia-Marco, T	Make, buy or both? R&D strategy selection	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2013	The aim of this paper is to increase our knowledge of a firm's innovative behaviour by jointly analysing its internal resources, industry characteristics and appropriability conditions as drivers of its R&D strategy selection: make, buy and make-buy. Based on panel data (1992-2005) covering 1539 Spanish manufacturing firms, results show that firms lacking organisational resources and competing in stable markets prefer the buy strategy. Firms with a high level of technological resources that are immersed in high-tech industries are prone to selecting the make-buy strategy. Internationalised firms with high levels of appropriability prefer the make strategy. (c) 2013 Elsevier B.V. All rights reserved.

Andries, P; Faems, D	Patenting Activities and Firm Performance: Does Firm Size Matter?	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2013	Whereas prior research has provided valuable insights into the willingness of small and medium-sized enterprises (SMEs) and large firms to engage in patenting, a comparison of the performance implications of patenting activities across small and large firms is still lacking. This gap is important because SMEs and large firms, having different resources and capabilities, might benefit from patenting activities in different ways. In particular, SMEs can be expected to benefit less from patenting activities in terms of protection against imitators than large firms. On the other hand, the propensity and ability of SMEs to license out their patents and generate additional revenue streams might be relatively higher than that of their large counterparts. This paper studies the impact of patenting on licensing, innovation, and financial performance for both SMEs and large firms, using multiple-group path analyses on a sample of 358 manufacturing firms. Contrary to expectations, this study demonstrates that not only large firms, but also SMEs benefit from patenting in terms of commercializing product innovations. Moreover, for both SMEs and large firms, such increased innovation performance in turn contributes to higher profit margins. Patenting activities also increase the ability of SMEs and large firms to license out knowledge to external parties, and this positive effect is significantly stronger for large firms. However, neither in SMEs nor in large firms, these outward licensing activities generate short-term financial benefits. Finally, the study demonstrates that patenting activities do not trigger significant cost disadvantages for either SMEs or large firms. Jointly, these findings provide unique insights in the value-generating and cost-increasing effects of patenting, suggesting that not only large firms, but also SMEs should consider patenting as a viable strategy to fully reap commercial benefits from their innovation activities. At the same time, they temper open innovation scholars' expectations regarding the financial benefits of licensing out knowledge. Overall, these findings point to opportunities for optimizing the intellectual property management of both SMEs and large firms.
Wikhamn, BR	Two Different Perspectives on Open Innovation - Libre versus Control	CREATIVITY AND INNOVATION MANAGEMENT	2013	The concept of open innovation has successfully diffused in academia as well as in industry. However, criticisms have at the same time been raised regarding the lack of a precise definition and also similar past research has not been sufficiently recognized. This paper highlights two perspectives of openness related to innovation - open as libre' versus controlled' - arguing that they rest on different underlying assumptions and theoretical foundations related to knowledge and value production. The paper concludes that the general research on open innovation' implicitly utilizes both perspectives, which tends to give a somewhat fragmented and incoherent perception of what open innovation is and how it should be applied in practice.
Rass, M; Dumbach, M; Danzinger, F; Bullinger, AC; Moeslein, KM	Open Innovation and Firm Performance: The Mediating Role of Social Capital	CREATIVITY AND INNOVATION MANAGEMENT	2013	This article examines the role of social relations and networks in open innovation settings. Building on extant open innovation literature as well as on social capital theory, we develop a model that conceptualizes social capital as a mediator between the implementation of open innovation instruments and firm performance. In doing so, this paper adds to the understanding of the role of structure and content of social relations in open innovation contexts as well as of sustainable side-effects of open innovation. In particular, we argue that apart from a direct effect of open innovation instruments on firm performance, there is also a mediated relationship between these variables. More precisely, we propose that the implementation of open innovation instruments strengthens an organization's social capital, which is, in turn, positively related to firm performance.
Lichtenthaler, U	The Collaboration of Innovation Intermediaries and Manufacturing Firms in the Markets for Technology	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2013	Many manufacturing firms have opened up their product innovation processes and actively transfer knowledge with external partners in the markets for technology. However, the markets for technological knowledge have remained inefficient in comparison with the markets for most products. To reduce some of the market inefficiencies, manufacturing firms may collaborate with innovation intermediaries, which are defined as organizations that act as agents or brokers in the innovation process between two or more parties. These innovation intermediaries comprise different service providers ranging from consulting companies to Internet marketplaces for technology. In light of an increasing importance of intermediary services in the context of open innovation, this paper specifically focuses on the collaboration of manufacturing firms and innovation intermediaries, which may be critical for the success of intermediary services. Based on new interview data from 30 innovation intermediaries and 30 European manufacturing firms, this paper examines the question of how innovation intermediaries and manufacturing firms collaborate concerning the following issues, which emerged as the key themes from the interviews: potential of intermediation, roles of intermediaries, types of intermediation, drivers of intermediation, complementarity of intermediation, compensation of intermediation, and the importance of repeated collaborations. The findings indicate how manufacturing firms may reduce their transaction costs in technology markets by collaborating with intermediaries. However, intermediary services can only be regarded as a complement rather than a substitute of manufacturing firms' internal activities of managing technology transfer. Thus, manufacturing firms need sufficient internal capabilities for managing technology transfer, such as absorptive capacity and desorptive capacity.
Belderbos, R; Cassiman, B; Faems, D;	Co-ownership of intellectual property: Exploring the	RESEARCH POLICY	2014	Combining both interview data and empirical analyses at the patent and firm levels, we explore the value-appropriation and value-creation implications of R&D collaboration resulting in the co-ownership of intellectual property (i.e. co-patents). We make an explicit distinction between three different types of co-patenting partners: intra-industry partners, inter-industry partners, and universities. Our findings indicate that the value-appropriation challenges of IP sharing are clearly evident with intra-industry co-patenting, where partners are more

Leten, B; Van Looy, B	value-appropriation and value-creation implications of co-patenting with different partners			likely to encounter overlapping exploitation domains. Co-patenting with universities is associated with higher market value, since appropriation challenges are unlikely to play a role and collaboration may signal novel technological opportunities. Although we find some evidence that co-patenting corresponds to higher (patent) value, patents co-owned with firms are significantly less likely to receive self-citations, indicating constraints on the future exploitation and development of co-owned technologies. (C) 2013 Elsevier B.V. All rights reserved.
Caner, T; Sun, J; Prescott, JE	When a firm's centrality in R&D alliance network is (not) the answer for invention: The interaction of centrality, inward and outward knowledge transfer	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2014	Bridging three research domains, centrality in R&D alliance networks, knowledge transfer, and the determinants of firm invention output, we develop an interaction model explaining how the centrality-invention output relationship is contingent on the levels of firm inward and outward knowledge transfer. A positive interaction between inward and outward knowledge transfer enhances invention output. However, an invention dissipation effect occurs when central firms have low levels of inward and high levels of outward knowledge transfer. Our findings and implications for managing tensions between inward and outward knowledge transfer are based on an 18-year panel data set including 287 biopharmaceutical firms. (C) 2014 Elsevier B.V. All rights reserved.
Du, JS; Leten, B; Vanhaverbeke, W	Managing open innovation projects with science-based and market-based partners	RESEARCH POLICY	2014	This paper examines the relationship between (outside-in) open innovation and the financial performance of R&D projects, drawing on a unique dataset that contains information on the open innovation practices, management and performance of 489 R&D projects of a large European multinational firm. We introduce two types of open innovation partnerships - science-based and market-based partnerships and examine their relationships with project financial performance. In addition, we investigate whether the open innovation project performance relationships are influenced by the way how R&D projects are managed. Our results show that R&D projects with open innovation partnerships are associated with a better financial performance providing that they are managed in the most suitable way. Market-based partnerships are positively correlated with project performance if a formal project management process is used; however these partnerships are associated with a lower performance for loosely managed projects. In contrast, science-based partnerships are associated with higher project revenues for loosely managed projects only. (C) 2014 Elsevier B.V. All rights reserved.
Gambardella, A; Panico, C	On the management of open innovation	RESEARCH POLICY	2014	In an open innovation relationship, the party that owns a key asset enjoys bargaining power that discourages the investments of the other party in the collaboration. We show that these incentives can be restored by conferring on the weak party the power to take decisions during the research process - e.g., a pharmaceutical firm with manufacturing and commercialization assets offers the direction of a joint research project to a biotech partner. However, on many occasions, the strong party still captures more value from the collaboration by retaining the power to take decisions during research even if it produces less innovation value and fewer aggregate profits. We conclude that the potential of open innovation is underexploited. In particular, owners may not release enough power to take decisions on the use of their assets. (C) 2013 Elsevier BM. All rights reserved.
Martinez, MG; Walton, B	The wisdom of crowds: The potential of online communities as a tool for data analysis	TECHNOVATION	2014	Online communities have become an important source for knowledge and new ideas. This paper considers the potential of crowdsourcing as a tool for data analysis to address the increasing problems faced by companies in trying to deal with "Big Data". By exposing the problem to a large number of participants proficient in different analytical techniques, crowd competitions can very quickly advance the technical frontier of what is possible using a given dataset. The empirical setting of the research is Kaggle, the world's leading online platform for data analytics, which operates as a knowledge broker between companies aiming to outsource predictive modelling competitions and a network of over 100,000 data scientists that compete to produce the best solutions. The paper follows an exploratory case study design and focuses on the efforts by Dunnhumby, the consumer insight company behind the success of the Tesco Clubcard, to find and lever the enormous potential of the collective brain to predict shopper behaviour. By adopting a crowdsourcing approach to data analysis, Dunnhumby were able to extract information from their own data that was previously unavailable to them. Significantly, crowdsourcing effectively enabled Dunnhumby to experiment with over 2000 modelling approaches to their data rather than relying on the traditional internal biases within their R&D units. (C) 2014 Elsevier Ltd. All rights reserved.
Franzoni, C; Sauermann, H	Crowd science: The organization of scientific research in open	RESEARCH POLICY	2014	A growing amount of scientific research is done in an open collaborative fashion, in projects sometimes referred to as "crowd science", "citizen science", or "networked science". This paper seeks to gain a more systematic understanding of crowd science and to provide scholars with a conceptual framework and an agenda for future research. First, we briefly present three case examples that span different fields of science and illustrate the heterogeneity concerning what crowd science projects do and how they are organized. Second, we identify two fundamental elements that characterize crowd science projects - open participation and open sharing of intermediate inputs -

	collaborative projects			and distinguish crowd science from other knowledge production regimes such as innovation contests or traditional "Mertonian" science. Third, we explore potential knowledge-related and motivational benefits that crowd science offers over alternative organizational modes, and potential challenges it is likely to face. Drawing on prior research on the organization of problem solving, we also consider for what kinds of tasks particular benefits or challenges are likely to be most pronounced. We conclude by outlining an agenda for future research and by discussing implications for funding agencies and policy makers. (C) 2013 The Authors. Published by Elsevier B.V. All rights reserved,
Henkel, J; Schoberl, S; Alexy, O	The emergence of openness: How and why firms adopt selective revealing in open innovation	RESEARCH POLICY	2014	Open innovation is often facilitated by strong intellectual property rights (IPRs), but it may also function, and even be boosted, when firms deliberately waive some of their IPRs. Extant literature has pointed out the potential benefits of such behavior, but falls short of explaining what triggers firms to practice it in the first place and to maintain or extend it. Since the waiving of IPRs runs counter to common views on strategy and competition and to engrained practices, this is a non-trivial question. To address it, we conduct an empirical study in a segment of the computer component industry which traditionally has taken a rather proprietary stance. With the advent of the open source operating system Linux, firms increasingly waived their IPRs on software drivers. We trace and analyze this process using both qualitative and quantitative methods. Our results indicate that component makers went through a learning process, which led some to realize how selectively waiving IPRs may be beneficial for their business. We uncover customer demand pull as the initial trigger and observe how a positive feedback loop sets in subsequently, leading to a further increase in the use of selective revealing. Overall, we find that openness develops into a new dimension of competition. We discuss the implication of our findings for research on open innovation and highlight how they impact managers in practice. (C) 2013 Elsevier B.V. All rights reserved.
Burcharth, ALD; Knudsen, MP; Sondergaard, HA	Neither invented nor shared here: The impact and management of attitudes for the adoption of open innovation practices	TECHNOVATION	2014	Despite the massive interest in open innovation, limited attention has been expressed concerning the intra-organizational challenges in implementing it. An exemplary issue is the unwillingness of employees to undertake extra-organizational knowledge transactions in the form of negative attitudes against the sourcing of external knowledge (the not-invented-here (NIH) syndrome) and against the external exploitation of knowledge assets (the not-shared-here (NSH) syndrome). Using survey data collected from 331 firms, this article empirically assesses the theoretical assertion that the NIH and NSH syndromes have negative impacts on the adoption of inbound and outbound open innovation. Furthermore, it investigates how their effects can be reduced through competence-building programs based on the training of employees. By focusing on two attitudinal antecedents to openness, the findings offer an explanation for the problems that firms face in benefiting from inflows and outflows of knowledge and possible guidance as to how managers can disengage such attitudes. (C) 2013 Elsevier Ltd. All rights reserved.
Cheng, CCJ; Huizingh, EKRE	When Is Open Innovation Beneficial? The Role of Strategic Orientation	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2014	Various scholars have accomplished a great deal to better understand open innovation effectiveness. Case studies have detailed its performance effects, while other studies showed the effectiveness of an aspect of open innovation, such as collaboration with third parties, external technology commercialization, and cocreation. Though most studies report a positive relation between open innovation and innovation performance, some studies indicate possible negative effects. This has resulted in a call for research on what kind of organizational context suits open innovation best. This study therefore addresses two questions: (1) does performing open innovation activities lead to increased innovation performance, and to which aspects of innovation performance is open innovation most strongly related? (2) what is the moderating impact of various kinds of strategic orientation on the relation between open innovation and innovation performance? In this study, we investigate three types of strategic orientations: entrepreneurial orientation, market orientation, and resource orientation. In a survey among 223 Asian service firms, we first develop and test a comprehensive measurement scale for open innovation that captures the entire range of open innovation activities, including outside-in activities, inside-out activities, and coupled activities. The final scale comprises of 10 items and indicates to what extent a firm has implemented open innovation activities. Next, we study the relation between open innovation and innovation performance. The results indicate that performing open innovation activities is significantly and positively related to all four dimensions of innovation performance: new product/service innovativeness, new product/service success, customer performance, and financial performance. The impact of open innovation is not limited to a particular aspect of innovation performance; it positively affects a broad range of innovation performance indicators. Though open innovation is positively related to all four dimensions of innovation performance, the effect sizes are not equal. The impact on new service innovativeness and financial performance is relatively stronger. Regarding the influence of a firm's strategic orientation, we find that all significant moderation effects are positive. This suggests that, in general, having a more explicit strategic orientation enhances the effectiveness of open innovation. When comparing the three strategic orientations, entrepreneurial orientation strengthens the positive performance effects of open innovation significantly more than market orientation and resource orientation do. In turn, market orientation has a significantly stronger moderation effect than resource orientation. These findings provide empirical evidence of the context

				dependency of open innovation. Especially an entrepreneurial orientation, which is associated with proactive and entrepreneurial processes, seems to create a fertile setting for open innovation.
Laursen, K; Salter, AJ	The paradox of openness: Appropriability, external search and collaboration	RESEARCH POLICY	2014	To innovate, firms often need to draw from, and collaborate with, a large number of actors from outside their organization. At the same time, firms need also to be focused on capturing the returns from their innovative ideas. This gives rise to a paradox of openness the creation of innovations often requires openness, but the commercialization of innovations requires protection. Based on econometric analysis of data from a UK innovation survey, we find a concave relationship between firms' breadth of external search and formal collaboration for innovation, and the strength of the firms' appropriability strategies. We show that this concave relationship is stronger for breadth of formal collaboration than for external search. There is also partial evidence suggesting that the relationship is less pronounced for both external search and formal collaboration if firms do not draw ideas from or collaborate with competitors. We explore the implications of these findings for the literature on open innovation and innovation strategy. (C) 2013 The Authors. Published by Elsevier B.V. All rights reserved.
Dahlander, L; Piezunka, H	Open to suggestions: How organizations elicit suggestions through proactive and reactive attention	RESEARCH POLICY	2014	This paper analyzes organizations' attempts to entice external contributors to submit suggestions for future organizational action. While earlier work has elaborated on the advantages of leveraging the knowledge of external contributors, our findings show that organizational attempts to attract such involvement are likely to wither and die. We develop arguments about what increases the likelihood of getting suggestions from externals in the future, namely through (1) proactive attention (submitting internally developed suggestions to externals to stimulate debate) and (2) reactive attention (paying attention to suggestions from externals to signal they are being listened to), particularly when those suggestions are submitted by newcomers. Findings from an analysis of about 24,000 initiatives by organizations to involve external contributors suggest these actions are crucial for receiving suggestions from external contributors. Our results are contingent upon the stage of the initiative because organizations' actions exert more influence in initiatives that lack a history of prior suggestions. Our work has implications for scholars of open innovation because it highlights the importance of considering failures as well successes: focusing exclusively on initiatives that reach a certain stage can lead to partial or erroneous conclusions about why some organizations engage external contributors while others fail. (C) 2013 Elsevier B.V. All rights reserved.
Vahter, P; Love, JH; Roper, S	Openness and Innovation Performance: Are Small Firms Different?	INDUSTRY AND INNOVATION	2014	We explore whether and how the benefits of openness in innovation are different for small plants (less than 50 employees) compared to medium and large plants. Using panel data from Irish manufacturing we find that the contribution of the "breadth" of openness (i.e., the variety of plants' innovation linkages) on innovation performance is stronger for small plants than for larger plants. Both small and larger plants face diminishing returns as the breadth of openness increases, but small plants experience negative returns at lower level of the breadth of openness than larger plants. Our results suggest that small plants can gain significantly from using wider set of innovation linkages, but for such plants appropriate partner choice is a particularly important issue. Small plants also gain significantly more than larger ones from investing in the linkages within the supply chain.
Balka, K; Raasch, C; Herstatt, C	The Effect of Selective Openness on Value Creation in User Innovation Communities	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2014	Open innovation research and practice recognize the important role of external complementors in value creation. At the same time, firms need to retain exclusive control over some essential components to capture value from their product and/or service system. This paper contributes to the literature by analyzing some of the trade-offs between openness to external value creation and closedness for internal value capture. It focuses on selective openness as a key variable and investigates how it affects value creation by external complementors, specifically the members of user innovation communities. Openness, it is hypothesized, matters to community members: The more open a product design is, the higher their sense of involvement in the innovation project, and the larger the effort they devote to it. Unlike prior literature, different forms and loci of openness are distinguished, specifically the transparency, accessibility, and replicability of different components of the product being developed. Hypotheses are tested based on survey data (n=309) from 20 online communities in the consumer electronics and information technology hardware industries. Multilevel regression analysis is used to account for clustering, and thus nonindependent data, at the community level. We find that openness indeed increases community members' involvement in the innovation project and their contributions to it. Interestingly, however, some forms and loci of openness strongly affect community perceptions and behavior, while others have limited or no impact. This finding suggests that, at least in relation to user communities, the trade-off that firms face between external value creation and internal value capture is softer than hitherto understood. Contingency factors that may be able to explain these patterns are advanced. For example, users are expected to value the form of openness that they have the capabilities and incentives to exploit. The findings in this paper extend the literature on selective openness in innovation. They emphasize the need to study the demand for different forms of openness at the subsystem level and align supply-side strategies to it. In managerial practice, a careful assessment of the demand for openness enables firms to successfully use selective openness and to effectively appropriate value from selectively open systems.

Andries, P; Thorwarth, S	Should Firms Outsource their Basic Research? The Impact of Firm Size on In-House versus Outsourced R&D Productivity	CREATIVITY AND INNOVATION MANAGEMENT	2014	It has been long known that firms can benefit substantially from basic research. Recently, however, the open innovation literature has questioned whether firms should conduct these basic research activities in-house and has suggested that outsourcing is more appropriate both for small and large firms. However, existing empirical work investigates the performance implications of R&D outsourcing in general, but does not take into account the differences between basic research on the one hand and more applied R&D on the other. This paper therefore studies whether outsourced basic research indeed contributes equally to firm productivity as in-house basic research, while explicitly incorporating the moderating effect of firm size. A production function approach is applied to firm-level data stemming from three waves of the Flemish R&D survey, combined with data from firms' annual accounts. The results show that small firms benefit from outsourcing their basic research activities. For medium-sized and large firms, however, in-house basic research is more productive than outsourced basic research. These results contradict the general belief that small firms benefit little from basic research and cast doubts on the recent trend to close medium-sized and large firms' corporate labs.
Bianchi, M; Frattini, F; Lejarraga, J; Di Minin, A	Technology Exploitation Paths: Combining Technological and Complementary Resources in New Product Development and Licensing	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2014	Technological resources in the form of patents, trade secrets, and know-how have become key assets for modern enterprises. This paper addresses a critical issue in technology and innovation management, namely, the commercial exploitation of technological resources resulting from research and development (R&D) investments. Extracting economic value from these resources by maximizing the benefits for shareholders is an extremely challenging task because technological resources are intangible, idiosyncratic, uncertain, predominantly tacit, and with poorly defined property rights. In their attempt to extract the maximum value from their technological resources, firms increasingly combine their internal exploitation through new product development (NPD) with external exploitation through licensing. However, most existing studies on NPD and technology licensing have treated the two exploitation paths independently and in isolation, which has resulted in two separate research streams using different theories and addressing different managerial challenges. The purpose of this paper is to contribute to filling this gap by developing and testing a comprehensive conceptual framework that simultaneously considers the antecedents affecting the successful implementation of NPD and licensing strategies as well as their consequences on firm profitability. The paper in particular investigates the effects of the interplay between technological resources and three types of complementary resources, marketing, manufacturing, and relational. We test the model using structural equation modeling on a sample of 733 Spanish manufacturing firms observed from 2003 to 2007. The data provide support for the existence of different paths to market firm technologies: an internal path, whereby the ownership of technological resources fully explains NPD performance, and an external path, whereby high intensity of marketing and relational resources reinforces the positive effect of technological resources on licensing performance. This sustains the relevance of the resource-based value-enhancing effects of complementary resources in licensing, as opposed to the motivation-reducing effects advanced by transaction cost-based literature. Moreover, the empirical analysis shows a substitution effect between NPD and licensing, whereby their simultaneous pursuit at intense levels is associated with lower profit margins. This provides evidence of the much theorized, but seldom tested, rent dissipation effect. These findings offer several contributions to research on licensing, NPD, open innovation, and the resource-based view of the firm. On a managerial level, they suggest that achieving maximum value from proprietary technologies may not entail exploiting them both through external and internal paths. Managers are also informed that the resource combinations that enhance licensing performance include marketing and relational resources.
Colombo, MG; Piva, E; Rossi-Lamastra, C	Open innovation and within-industry diversification in small and medium enterprises: The case of open source software firms	RESEARCH POLICY	2014	This paper examines the within-industry diversification of software small and medium enterprises that collaborate with the open source software community (OSS SMEs). In doing so, it offers new insights into the association between open innovation and diversification. We rely on arguments inspired by the literature and evidence collected through interviews with OSS SMEs' top managers to investigate factors that favor or hinder within-industry diversification. First, in line with the mainstream diversification literature, we focus attention on the role of firm size. Second, in the spirit of the open innovation research, we concentrate on the mechanisms that OSS SMEs put in place to get access to the external resources of the OSS community. Econometric evidence on 100 European OSS SMEs shows that firm size is negatively associated to within-industry diversification, while OSS SMEs that have contributed to a larger number of OSS projects have a more diversified portfolio of software products. Furthermore, we provide preliminary evidence that the practice of authorizing firm programmers to contribute autonomously to OSS projects of their own choice during working hours may be positively associated to within-industry diversification only if OSS SMEs possess adequate internal technological resources. (C) 2013 Elsevier B.V. All rights reserved.
West, J; Bogers, M	Leveraging External Sources of Innovation: A Review of Research on Open Innovation	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2014	This paper reviews research on open innovation that considers how and why firms commercialize external sources of innovations. It examines both the outside-in and coupled modes of open innovation. From an analysis of prior research on how firms leverage external sources of innovation, it suggests a four-phase model in which a linear process(1) obtaining, (2) integrating, and (3) commercializing external innovationsis combined with (4) interaction between the firm and its collaborators. This model is used to classify papers taken from the top 25 innovation journals, complemented by highly cited work beyond those journals. A review of 291 open innovation-related publications from these sources shows that the majority of these articles indeed address elements of this inbound open innovation process

				model. Specifically, it finds that researchers have front-loaded their examination of the leveraging process, with an emphasis on obtaining innovations from external sources. However, there is a relative dearth of research related to integrating and commercializing these innovations. Research on obtaining innovations includes searching, enabling, filtering, and acquiringeach category with its own specific set of mechanisms and conditions. Integrating innovations has been mostly studied from an absorptive capacity perspective, with less attention given to the impact of competencies and culture (including not invented here). Commercializing innovations puts the most emphasis on how external innovations create value rather than how firms capture value from those innovations. Finally, the interaction phase considers both feedback for the linear process and reciprocal innovation processes such as cocreation, network collaboration, and community innovation. This review and synthesis suggests several gaps in prior research. One is a tendency to ignore the importance of business models, despite their central role in distinguishing open innovation from earlier research on interorganizational collaboration in innovation. Another gap is a tendency in open innovation to use innovation in a way inconsistent with earlier definitions in innovation management. The paper concludes with recommendations for future research that include examining the end-to-end innovation commercialization process, and studying the moderators and limits of leveraging external sources of innovation.
Love, JH; Roper, S; Vahter, P	Dynamic complementarities in innovation strategies	RESEARCH POLICY	2014	Using a panel of Irish manufacturing plants over the period 1991-2008 we test for dynamic complementarities in the joint use of internal R&D and external knowledge sources. We find little evidence, either from considering successive cross-sectional waves of comparable surveys, or in terms of the strategy switch choices of specific plants, that there has been a systematic move towards the joint use of internal and external knowledge in innovation. We then test formally for the presence of complementarities in the joint use of internal R&D and external innovation linkages. In static terms we find no evidence of complementarity, but in dynamic terms find evidence that strategy switches by individual plants towards a more 'open' strategy are accompanied by increased innovation outputs. (C) 2014 The Authors. Published by Elsevier B.V.
Felin, T; Zenger, TR	Closed or open innovation? Problem solving and the governance choice	RESEARCH POLICY	2014	Scholars have recently highlighted the promise of open innovation. In this paper, we treat open innovation in it's different forms and manifestations as well as internal or closed innovation, as unique governance forms with different benefits and costs. We discuss how each governance form, whether open or closed, is composed of a set of instruments that access (a) different types of communication channels for knowledge sharing, (b) different types of incentives, and (c) different types of property rights for appropriating value from innovation. We focus on the innovation "problem" as the central unit of analysis, arguing for a match between problem types and governance forms, which vary from open to closed and which support alternative forms of solution search. In all, the goal of this paper is to provide a comparative framework for managing innovation, where we delineate and discuss four categories of open innovation governance forms (markets, partnerships, contests and tournaments and user or community innovation) and compare them with each other and with two internal or closed forms of innovation governance (authority and consensus-based hierarchy). (C) 2014 The Authors. Published by Elsevier B.V. All rights reserved.
Mina, A; Bascavusoglu-Moreau, E; Hughes, A	Open service innovation and the firm's search for external knowledge	RESEARCH POLICY	2014	The concept of open innovation captures the increasing propensity of firms to work across their traditional boundaries of operation. This phenomenon has largely been studied from the viewpoint of manufacturing businesses while services have received much less attention despite the predominant role they play in advanced economies. This paper focuses on open innovation in services, both as a subsector of the economy and as a component of the activities of manufacturing firms. We study the open innovation practices of business services firms and then consider the implications for open innovation of the adoption of a service inclusive business model by manufacturing firms. Our analyses are based on a unique dataset with information on open innovation activities amongst UK firms. Overall, engagement in open innovation increases with firm size and R&D expenditure. Business services are more active open innovators than manufacturers; they are more engaged in informal relative to formal open innovation practices than manufacturers; and they attach more importance to scientific and technical knowledge than to market knowledge compared to manufacturing firms. Open innovation practices are also associated with the adoption of a service inclusive business model in manufacturing firms and service-integrated manufacturers engage in more informal knowledge-exchange activities. The paper contributes towards a reconceptualisation of open innovation in service businesses and a deeper evidence-based understanding of the service economy. (C) 2013 The Authors. Published by Elsevier B.V. All rights reserved.
Sabidussi, A; Lokshin, B; de Leeuw, T; Duysters, G; Bremmers, H; Omta, O	A comparative perspective on external technology sourcing modalities: The role of synergies	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2014	This paper assesses the impact on innovative performance of alternative external sourcing strategies. In particular, the study under discussion compared external sourcing strategies based on specialization to those based on integrating various sourcing modalities (e.g., alliances and M&As). Survey data from three waves of the Community Innovation Survey (CIS) in the Netherlands were used to investigate the implications of these sourcing strategies for innovative performance. The findings indicate that synergies exist among external sourcing modalities: Integrating different external sourcing modes is more effective than specializing in a single mode, especially when the specialization is focused on M&As. Among the specialized strategies, focusing on the use of strategic alliances leads to higher levels of innovative performance than relying exclusively on M&As. (C) 2014 Elsevier B.V. All rights reserved.

Wang, YD; Li-Ying, J	When does inward technology licensing facilitate firms' NPD performance? A contingency perspective	TECHNOVATION	2014	Many firms find inward technology licensing (ITL), as a means to access external technological knowledge, an effective and relatively inexpensive way for new product development (NPD). However, although the literature has suggested some advantages and disadvantages of ITL with respect to NPD, the relationship between ITL and licensee firms' subsequent NPD performance has not yet been found convincingly evident. Sharing with many other likeminded scholars and practitioners, we believe that the dynamics between external knowledge, internal capability, external environment, and firm performance should be investigated through a contingency perspective. Thus, this study posits that a firm's propensity to develop new products through ITL is contingent upon two categories of contingency factors that are internal and external to firms. Using a dataset containing information about Chinese firms' licensing activities, we find support for our hypotheses: the positive relationship between ITL and NPD performance of a licensee firm is moderated by firms' absolute and relative absorptive capacity and the knowledge endowment in the region where the licensee firm operates. (C) 2013 Elsevier Ltd. All rights reserved.
Bengtsson, L; Lakemond, N; Lazzarotti, V; Manzini, R; Pellegrini, L; Tell, F	Open to a Select Few? Matching Partners and Knowledge Content for Open Innovation Performance	CREATIVITY AND INNOVATION MANAGEMENT	2015	The purpose of the paper is to illuminate the costs and benefits of crossing firm boundaries in inbound open innovation (OI) by determining the relationships among partner types, knowledge content and performance. The empirical part of the study is based on a survey of OI collaborations answered by R&D managers in 415 Italian, Finnish and Swedish firms. The results show that the depth of collaboration with different partners (academic/consultants, value chain partners, competitors and firms in other industries) is positively related to innovation performance, whereas the number of different partners and size have negative effects. The main result is that the knowledge content of the collaboration moderates the performance outcomes and the negative impact of having too many different kinds of partners. This illustrates how successful firms use selective collaboration strategies characterized by linking explorative and exploitative knowledge content to specific partners, to leverage the benefits and limit the costs of knowledge boundary crossing processes.
Egbetokun, AA	The more the merrier? Network portfolio size and innovation performance in Nigerian firms	TECHNOVATION	2015	A positive relationship between firms' networking activities and innovativeness has been consistently established in the literature on innovation. However, studies considering different innovation types, and on developing countries are scarce. This paper addresses questions concerning the relationship between networking strategies and innovativeness of firms, using innovation survey data on Nigerian firms. Quantile regression is applied to trace the link between portfolio size and innovation at different levels of innovative success. The results show a positive relationship between a firm's innovation performance and the size of its networking portfolio. This relationship varies across different innovation types and with increasing innovation performance. The findings suggest that the widely accepted portfolio approach to external search for knowledge is not necessarily always the best its utility depends on the firm's current level of innovative success. This poses a challenge for open innovation. (C) 2015 Elsevier Ltd. All rights reserved.
Frishammar, J; Ericsson, K; Patel, PC	The dark side of knowledge transfer: Exploring knowledge leakage in joint R&D projects	TECHNOVATION	2015	Knowledge leakage refers to loss of technological knowledge intended to stay within a firm's boundaries and may cause a "weakened state" in which a focal firm loses its competitive advantage and industry position. Based on multiple case studies of knowledge leakage in joint research and development (R&D) projects in large firms in Sweden, this paper makes two contributions. First, in contrast to the uni-dimensional dyadic leakage process assumed in the literature, we find that the knowledge leakage process is multi-dimensional and exists in three varieties: i) a process whereby an external party assimilates knowledge from a focal firm, ii) a process whereby an external party assimilates knowledge from another external party, and iii) a process whereby the focal firm uses knowledge already shared with an external party in such a way that it becomes sensitive. Second, where the prior literature suggests that core knowledge must be protected from leakage, we find that some core knowledge can leak without negative effects, whereas some knowledge, being non-core to a focal firm, can have severe negative effects. These insights provide novel theoretical implications and new insights into how firms can manage knowledge leakage in practice. (c) 2015 Elsevier Ltd. All rights reserved.
Gesing, J; Antons, D; Piening, EP; Rese, M; Salge, TO	Joining Forces or Going It Alone? On the Interplay among External Collaboration Partner Types, Interfirm Governance Modes, and Internal R&D	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2015	This paper adds to the emerging literature stream advocating a contingency view on open innovation. Drawing on the relational view of the firm, this study sheds light on the complex interplay among collaboration partner types (market- and science-focused innovation partners), governance modes (informal, self-enforcing and formal, contractual collaboration governance), and internal research and development(R&D). More specifically, it is proposed that the use of governance modes tailored to both the characteristics of each innovation partner type and the specific innovation objectives pursued by the focal firm (incremental and radical new product development) can increase the payoff from innovation collaboration. Moreover, appropriate collaboration governance is expected to reduce the focal firm's vulnerability to possible negative side effects often assumed to be associated with the simultaneous pursuit of external collaboration and internal R&D, among which most notably the not-invented-here (NIH) syndrome. Cross-industry evidence from 2502 German firms underlines the critical role of collaboration governancea contingency factor that is at the heart of the relational view, yet has remained surprisingly absent from the open innovation debate so far.

Goduscheit, RC; Knudsen, MP	How Barriers to Collaboration Prevent Progress in Demand for Knowledge: A Dyadic Study of Small and Medium-Sized Firms, Research and Technology Organizations and Universities	CREATIVITY AND INNOVATION MANAGEMENT	2015	This article analyses the challenging collaboration between small and medium-sized enterprises (SMEs) and knowledge institutions. The aim of the article is to shed light on the barriers, which hinder collaboration, and to investigate the particular role of research and technology organizations (RTOs) as potential mediators of collaboration between SMEs and universities. On the basis of a unique sample consisting of 151 SMEs, RTOs and universities from seven countries, the differences across dyads of potential collaborations are identified. In particular, the article finds that both firms and universities with collaboration experience with the other partner in general perceive higher barriers than inexperienced firms or universities. In terms of the mediating role of RTOs, the article illustrates that universities perceive lower barriers when collaborating with RTOs than with SMEs. A similar tendency to a mediating role of RTOs can be found among the SMEs' perception of university collaboration. Finally, the analysis shows that the knowledge institutions perceive the SMEs as very important collaboration partners, but the same sense of importance is not shared by the SMEs regarding collaboration with the knowledge institutions. Hence, there seems to be a quite unbalanced view on the potential of the collaborative ties, which is further discussed in the conclusion.
Guimon, J; Salazar-Elena, JC	Collaboration in Innovation Between Foreign Subsidiaries and Local Universities: Evidence from Spain	INDUSTRY AND INNOVATION	2015	Collaboration between foreign subsidiaries and universities is relevant for multinational companies (MNCs) that aim at absorbing knowledge from abroad, as well as for universities and policy-makers attempting to maximize the spillovers associated with foreign direct investment (FDI). In this paper, we explore how MNCs collaborate with universities in the foreign countries where they locate and provide new empirical evidence for Spain as a host country. Using a probit model with panel data comprising 9,614 firms for the period 2005-2011, we explore differences between the propensity to collaborate with universities of foreign subsidiaries and Spanish firms. Subsequently, building on a new survey to 89 foreign subsidiaries and on a more detailed analysis of five case studies, we discuss the variety of motivations that drive collaboration with universities and relate the scale and scope of such collaborations with the dynamic mandates of foreign subsidiaries in global innovation networks.
Hu, YS; McNamara, P; McLoughlin, D	Outbound open innovation in bio-pharmaceutical out-licensing	TECHNOVATION	2015	Our study investigates the outbound open innovation of firms engaged in technological venturing. Leveraging insights from the sociology theory and innovation literatures, we clarify whether social status helps entrepreneurial ventures overcome market imperfection and information asymmetry in out-licensing and illustrate the importance of specific aspects of social status building in this context. We also examine the effect of failure experiences on out-licensing. We take a dynamic view of desorptive capacity by studying an entrepreneurial venture's learning process, both internally, in terms of its own technology trajectory, and externally, through inter-organizational alliances. We apply a negative binomial model to our novel panel of 180 firms studied over an 18-year period with controls for stocks of clinical development activities, patenting and prior licensing activities. Empirical analysis enables us to observe the impact which the firms' technological and development status, reputation and desorptive capacity exert upon out-licensing volume. Prior outbound open innovation studies do not account for the heterogeneity of technology and R&D success and failure experiences observed in our study. We also demonstrate the contingency effect of external learning from alliances during the building-up of a firm's desorptive capacity, or the way in which the number of co-authoring partners in scientific publications negatively moderates the positive effect of the number of commercial alliances on the volume of its out-licensing deals. Our findings contribute to the understanding of external knowledge exploitation and complement important aspects of the literatures on outbound open innovation and desorptive capacity, offering empirically rich insights for bin-pharmaceutical firms into the drivers behind volumes of out-licensing deals. Crown Copyright (C) 2014 Published by Elsevier Ltd. All rights reserved.
Eftekhari, N; Bogers, M	Open for Entrepreneurship: How Open Innovation Can Foster New Venture Creation	CREATIVITY AND INNOVATION MANAGEMENT	2015	This paper explores how an open approach to new venture creation - purposefully managing knowledge flows across the venture's organizational boundary - can be beneficial for start-up entrepreneurs. Our inductive case study, of both failure and success, identifies the key attributes of this open approach and how they affect start-ups' short-term survival. We find that ecosystem collaboration, user involvement and an open environment directly influence new venture survival, and that their effects were moderated by the entrepreneurs' open mindset. These findings carry a number of implications for entrepreneurship and innovation research and practice, providing some attention points for researchers, entrepreneurs, investors and policy makers interested in developing successful new ventures.
Parmentier, G	How to innovate with a brand community	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2015	This study examines how a firm can innovate with a brand community via an inductive, longitudinal study of three brand communities. The proposed framework for building an innovative brand community features six mechanisms: animation, openness, structuring, linking, theorization, and integration that support three processes: generation, socialization and adoption of user contributions. An innovative brand community can generate valuable innovations for the firm without reducing its own vitality. It brings together lead, creative, and other types of users to create ideas and new functions, uses, and contents pertaining to innovation. On the one hand, firms that partially open their boundaries by leaving space in the process of innovation for creation and discussion can benefit from the contribution of users without

				suffering appropriation problems. On the other hand, brand communities should receive toolkits for creation and animation, and encourage the development of both communities and innovation. (c) 2015 Elsevier B.V. All rights reserved.
Jahanmir, SF; Lages, LF	The Lag-User Method: Using laggards as a source of innovative ideas	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2015	The literature on user innovation has not considered laggards - the last group of users to adopt a product - as a source of new ideas for innovative products and services. In this paper, we develop the Lag-User Method to investigate laggards' role in the process of idea generation and new product development (NPD) and so enable firms to gain access to their insights. We study laggards for 4 years in three countries and apply the Lag-User Method to different technologies, products, and services, thereby generating 62 innovative ideas across a wide range of industries and sectors. These ideas are discussed with executives to obtain managerial insights. Our studies reveal that laggards who generate new ideas (i.e. lag-users) can enrich NPD. Being coached through the systematic Lag-User Method, they can come up with radical, really new, or incremental innovations. Moreover, applying the method increased laggards' perception regarding their (a) understanding of innovation, (b) perception that people can learn to innovate, (c) perception of their ability to develop new products on their own, (d) confidence about their own new ideas, and (e) perception of considering themselves capable of innovating. Thus, we propose that by involving lag-users in idea generation and NPD process, both academia and firms can improve the effectiveness of NPD, overcome barriers to adoption of innovations, cross the chasm, and accelerate the diffusion of their new products or services. (c) 2015 Elsevier B.V. All rights reserved.
Ooms, W; Bell, J; Kok, RAW	Use of Social Media in Inbound Open Innovation: Building Capabilities for Absorptive Capacity	CREATIVITY AND INNOVATION MANAGEMENT	2015	This study investigates the effects of the use of social media in inbound open innovation on capabilities for absorptive capacity of companies. Seven explorative case studies were conducted in an R&D and business context of two large global high-tech companies. The results suggest that if the necessary conditions are met, social media usage increases the transparent, moderational and multi-directional interactions that in turn influence four capabilities for absorptive capacity: connectedness, socialization tactics, cross-functionality and receptivity, a hitherto overlooked capability. Hence, we observe that social media are boundary-spanning tools that can be used to build and increase companies' absorptive capacity.
Patterson, W; Ambrosini, V	Configuring absorptive capacity as a key process for research intensive firms	TECHNOVATION	2015	Absorptive capacity is a dynamic capability which creates new firm resources by searching, acquiring, assimilating, transforming and exploiting external knowledge with internal resources and act as a process framework for innovation. Despite being one of the most frequently cited strategic management concepts, absorptive capacity as a dynamic capability has limited empirical evidence with unverified assumptions. The concept is at risk of reification. With this study we contribute to the literature by providing empirical evidence for absorptive capacity which challenge the assumptions of how the construct is configured. We follow the strategic factor of intellectual property rights (IPR) in European biopharmaceutical firms using a qualitative process study with temporal bracketing. By tracking IPR, we found evidence for absorptive capacity in all firms we studied, but the process framework in use is different to Zahra and George's (2002. Acad. Manage. Rev. 27,185-203) and Todorova and Durisin's (2007. Acad. Manage. Rev. 32,774-786) theoretical models. Based on our evidence and literature review we develop some theoretical insights and propose a modified absorptive capacity model. This new model puts a greater emphasis on assimilating knowledge from outside the firm and provides more clarity on how research intensive firms might use absorptive capacity. (C) 2014 Elsevier Ltd. All rights reserved.
Perkmann, M; Schildt, H	Open data partnerships between firms and universities: The role of boundary organizations	RESEARCH POLICY	2015	Science-intensive firms are experimenting with 'open data' initiatives, involving collaboration with academic scientists whereby all results are published with no restriction. Firms seeking to benefit from open data face two key challenges: revealing R&D problems may leak valuable information to competitors, and academic scientists may lack motivation to address problems posed by firms. We explore how firms overcome the challenges through an inductive study of the Structural Genomics Consortium. We find that the operation of the consortium as a boundary organization provided two core mechanisms to address the above challenges. First, through mediated revealing, the boundary organization allowed firms to disclose R&D problems while minimizing adverse competitiye consequences. Second, by enabling multiple goals the boundary Organization increased the attractiveness of industry-informed agendas for academic scientists. We work our results into a grounded model of boundary organizations as a vehicle for open data initiatives. Our study contributes to research on public-private research partnerships, knowledge revealing and boundary organizations.
Kim, N; Kim, DJ; Lee, S	Antecedents of open innovation at the project level: empirical analysis of Korean firms	R & D MANAGEMENT	2015	The concept of open innovation has recently gained wide academic attention, as it seems to have significant impact for company performance. Most empirical investigations about this emerging concept have been case studies of successful early adopters of open innovation, and their analyses have largely been at the company level. Although case studies at that level provide meaningful implications, the new phenomena merit a more in-depth examination: that is, we need to collect and analyze data on multiple companies to explore more systematic findings about open innovations across companies. Moreover, analyses may need to go down to the individual project rather than the whole company level because innovation activities are often conducted as part of research and development (R&D) projects. To meet these needs, this study examines companies' open innovation efforts at the level of the individual R&D project. Specifically, the

				present study focuses on project-level openness to better understand the mechanisms of open innovation. It explores systematic relationships between various antecedent factors and the degree of openness. Project-level openness could be affected by team and task characteristics, such as team size, learning distance, strategic importance, technology and market uncertainty, and relevance to the main business. Relevant data collected from 303 companies in Korea were used to identify the antecedents that affect inbound and outbound openness. The research findings are expected to help provide a concrete theoretical framework suited for more generalized application and further practical development of open innovation strategy.
Michelino, F; Lamberti, E; Cammarano, A; Caputo, M	Measuring Open Innovation in the Bio-Pharmaceutical Industry	CREATIVITY AND INNOVATION MANAGEMENT	2015	The paper suggests a methodology for measuring the degree of openness in companies' innovation processes through the analysis of annual reports. Four openness dimensions are defined based on costs and revenues deriving from open innovation activities and new investments and divestments of innovation-related intangibles, occurring in either separate acquisitions or business combinations. A synthetic measure of openness is defined, including all the four dimensions. The model is then applied to a sample of 126 global top R&D spending companies in the bio-pharmaceutical industry for the period 2008-2012, for a total of 630 annual reports analysed. Results show a negative correlation of openness degree with firm age, dimension and efficiency, with biotech companies being more open than pharmaceutical ones. The paper contributes to the research on open innovation by suggesting a comprehensive framework for the measure of the pecuniary dimension of the phenomenon in both inbound and outbound processes. From a managerial point of view, the framework can be used by companies to both monitor their own degree of openness and to benchmark it with those of competitors.
Salter, A; Ter Wal, ALJ; Criscuolo, P; Alexy, O	Open for Ideation: Individual-Level Openness and Idea Generation in R&D	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2015	Organizations are increasingly encouraging their scientists and engineers to source knowledge externally. However, it is unclear how the openness of individuals to external sources of knowledge affects their ideation performance, that is, their ability to develop new, useful innovative ideas for their organization, and which factors might moderate this process. Drawing on theories of combinatorial search, and using a sample of 329 R&D scientists and engineers working in a large organization, we demonstrate that individuals' openness to external sources of knowledge is curvilinearly related to their ideation performance. Openness provides benefits such as alertness and variety which contribute to ideation up to the point where increasing integration and approval costs cause negative returns to set in. We also examine how the R&D time horizon, ties to senior managers, and the breadth of individual knowledge moderate the costs and benefits of openness to individuals. We explore the implications of these findings for managerial practice.
Cruz-Gonzalez, J; Lopez-Saez, P; Navas-Lopez, JE; Delgado-Verde, M	Open search strategies and firm performance: The different moderating role of technological environmental dynamism	TECHNOVATION	2015	Mainly driven by the rapid progress of the 'open innovation' paradigm, previous research has devoted considerable efforts in investigating how the degree of openness to external knowledge influences firms' innovation performance. However, much less is known about its impact on performance at the firm level. Moreover, the question of which open search strategy is more suitable depending on environmental features is unresolved. We focus on breadth and depth as two distinct open search strategies and claim that, besides their different benefits in terms of learning and innovation, it is also necessary to consider their costs. Based on survey data of 248 high-technology manufacturing Spanish firms, this study extends recent research about the context dependency of openness effectiveness by showing that the effect of these two open search strategies on perceived firm performance is contingent with technological environmental dynamism in a reverse fashion. While search breadth is found to be positively associated with performance in less technologically dynamic environments, it seems to hurt performance in more dynamic contexts. On the contrary, while search depth is found to have a positive effect on performance in highly technologically dynamic environments, it appears to harm firm performance in more stable contexts. (C) 2014 Elsevier Ltd. All rights reserved.
Kathan, W; Hutter, K; Fuller, J; Hautz, J	Reciprocity vs. Free-Riding in Innovation Contest Communities	CREATIVITY AND INNOVATION MANAGEMENT	2015	Innovation contest communities are virtual tools for corporations to integrate external knowledge and creativity into the innovation process. Built on both the principle of competition and the advantages of a collaborative community, innovation contest communities constitute special interaction phenomena. The present study explores how different co-operation behaviours, namely reciprocal giving, initial altruistic giving and free-riding, influence the quality of participants' ideas on an open virtual contest platform with more than 2,000 members and more than 4,000 submissions. Our findings show that reciprocity and free-riding are substantial behavioural elements of innovation contest communities leading to different outcomes regarding quality of submitted ideas. With this study, we contribute to a better theoretical understanding of distinctive types of co-operation and free-riding among individuals in the context of open innovation, extending theories of the evolution of co-operation.
Ghisetti, C; Marzucchi, A; Montresor, S	The open eco-innovation mode. An empirical investigation of eleven European countries	RESEARCH POLICY	2015	This paper deals with the open, innovation mode in the environmental realm and investigates the effects that knowledge sourcing has on the environmental innovations (EIs) of firms. Using the Community Innovation Survey (CIS) 2006-2008, we refer to the firm's probability of both introducing an El and extending the number of EI-typologies adopted. We estimate the impact of the 'depth' and 'breadth' of knowledge sourcing. In addition, we test for the moderating role of the firm's absorptive capacity. Knowledge sourcing has a positive impact on both types of El-performance. However, a broad sourcing strategy reveals a threshold above which the propensity to introduce an El diminishes. Cognitive constraints in processing knowledge inputs that are too diverse may explain this result. Absorptive capacity

				generally helps firms to turn broadly sourced external knowledge into El. However, internal innovation capabilities and knowledge socialization mechanisms seem to diminish the El impact of knowledge sourced through deep external interactions. The possibility of mismatches between the management of internal and external knowledge, and of problems in distributing the decision-makers' attention between the two, may explain this result. (C) 2014 Elsevier B.V. All rights reserved.
Chou, C; Yang, KP; Jhan, J	Empowerment Strategies for Ideation through Online Communities	CREATIVITY AND INNOVATION MANAGEMENT	2015	Successful ideation is vital for new product development. In a novel approach, firms have recently and successfully empowered their customers through online communities by applying democratic principles to open innovation. In this paper, we borrow insights from the democratic system to examine the enhancement of, and the boundary conditions for, the adoption of this empowerment strategy. We conducted three series of experiments to investigate whether online community size and lead user status might affect the link between empowerment strategy and perceived impact. This study also highlights the double-edged influence of the selected outcome of an empowerment task by focusing on the negative emotions that threaten the effectiveness and sustainability of empowerment strategy. Our results show that empowerment strategy in small communities and higher lead user status can produce higher perceived impact. In addition, the outcome of empowerment strategy may engender positive and negative emotions in members of the community, which leads to distinct and different corresponding behaviour. The theoretical and practical implications of our research are discussed in the conclusion.
Lichtenthaler, U	A note on outbound open innovation and firm performance	R & D MANAGEMENT	2015	The concept of open innovation has attracted a lot of interest over the past decade. In light of a relative emphasis on inbound open innovation (indicating an outside-in process) in prior research, this brief note addresses the relationship between outbound open innovation (indicating an inside-out process) and firm performance. In particular, it suggests that outbound open innovation may have positive and negative effects on firm performance based on potential benefits and risks of transferring technology. To what degree these effects materialize depends on internal factors, e.g. desorptive capacity, and external factors, e.g. appropriability. Consequently, a proficient internal management of outbound open innovation is critical to avoid its potential risks and to capture its substantial benefits. In this regard, future research may substantially deepen the insights into the relevance and role of outbound open innovation.
Su, CY; Lin, BW; Chen, CJ	Technological knowledge co-creation strategies in the world of open innovation	INNOVATION-MANAGEMENT POLICY & PRACTICE	2015	This paper explores the role, patterns, and characteristics of technological knowledge co-creation in a cross-organizational setting and examines the relationship between ownership structure and the value of co-created technological knowledge. The empirical results reveal an upward trend in the share of co-created technological knowledge from 1976 to 2008 and show that co-created technological knowledge is more exploratory and pioneering and has shorter technology cycle times (TCTs) than solely created knowledge. Our findings also indicate that the technological knowledge that firms co-create with other firms or with universities is significantly correlated with shorter TCTs and higher numbers of forward citations. Overall, this paper provides new evidence regarding the importance of cross-organizational technological knowledge co-creation.
Bianchi, M; Lejarraga, J	Learning to license technology: the role of experience and workforce's skills in Spanish manufacturing firms	R & D MANAGEMENT	2016	Firms increasingly pursue technology licensing for appropriating economic returns from their R&D investments. Despite this tendency, extracting revenues from licensing remains a challenge for most firms. This article explores the role of task-specific experience and of workforce skills as determinants of superior licensing volume. The rationale is that these factors contribute to the development of a desorptive capacity that allows companies to overcome the complexities posed by technology licensing. Using panel data of Spanish manufacturing firms, we find that prior experience in licensing positively affects licensing revenues at a decreasing rate. These learning-by-doing effects are strengthened when firms have a higher proportion of their workforce endowed with advanced skills, whereas they are reduced when firms have a higher proportion of low-skilled employees. These results contribute to licensing and open innovation research by partly specifying the nature and anatomy of desorptive capacity and by highlighting the key role of intellectual human capital in licensing, whose contribution depends on the skills level. They also inform managers on the mechanisms that can enhance their firms' licensing volume.
Cricelli, L; Greco, M; Grimaldi, M	ASSESSING THE OPEN INNOVATION TRENDS BY MEANS OF THE EUROSTAT COMMUNITY INNOVATION SURVEY	INTERNATIONAL JOURNAL OF INNOVATION MANAGEMENT	2016	Many authors showed the benefits of open innovation (OI) to firms, consequently encouraging managers to adopt the OI paradigm to improve innovation performance. Nevertheless, whether firms have accepted such exhortations or not is almost empirically unexplored. The frequent claim that firms are increasingly adopting the OI paradigm is mostly anecdotal. This paper presents a large-scale analysis of firms' OI adoption by means of four waves of the community innovation survey, including 275,697 questionnaires. The analysis focuses on the trends in the use of inbound (internal use of external knowledge) and coupled (collaboration with partners) OI approaches. The results confirm that the share of firms adopting the OI paradigm has increased, both in terms of inbound and coupled OI actions. Similarly, firms have intensified the use of the inbound OI mode, whereas they have not intensified the use of collaborations. However, the analyses of different measures of OI show that in most cases the positive trends have not been monotonic, nor steep as they are anecdotally considered to be.

De Zubielqui, GC; Jones, J; Lester, L	KNOWLEDGE INFLOWS FROM MARKET- AND SCIENCE-BASED ACTORS, ABSORPTIVE CAPACITY, INNOVATION AND PERFORMANCE : A STUDY OF SMEs	INTERNATIONAL JOURNAL OF INNOVATION MANAGEMENT	2016	Small to medium-sized enterprises (SMEs) are increasingly opening up their innovation processes in order to improve innovation outcomes. Exactly how openness influences enterprises' ability to innovate and benefit from external sources of innovation is not well understood. Despite theoretical models explicating knowledge inflows as the antecedent and innovation as the consequence of absorptive capacity, to date, the relationships between external knowledge inflows from specific external actors, absorptive capacity, innovation and SME performance remain underexplored. We address this gap, focussing on market-and science-based knowledge flows, absorptive capacity, innovation and SME performance. Using structural equation modelling on a sample of 838 Australians SMEs, we find evidence indicating that the mechanisms by which external knowledge inflows from market-and science-based actors affect innovation differ: external knowledge inflows from market-based actors influence innovation directly or "serendipitously", while external knowledge inflows from science-based actors influence innovation indirectly via absorptive capacity. We also find that their effect on innovation differ, with external knowledge inflows from market-based actors exerting a positive direct effect on innovation vis-a-vis external knowledge inflows from science-based actors where there is no significant direct effect. In contrast, external knowledge inflows from science-based actors influence innovation through absorptive capacity. In addition to this mediation effect, absorptive capacity has a positive direct effect on innovation, and an effect on firm performance through innovation. This research contributes to our understanding of how, and the extent to which, external knowledge inflows from specific external actors influence absorptive capacity, innovation and firm performance in SMEs.
Galan-Muros, V; Plewa, C	What drives and inhibits university-business cooperation in Europe? A comprehensive assessement	R & D MANAGEMENT	2016	Knowledge transfer between universities and organizations is essential, not only for the organizations involved but also for the broader innovation system. Understanding the factors that drive or inhibit this process, thus, becomes a priority. Yet, the increasingly prolific academic literature dealing with university-business cooperation (UBC) possesses a strong focus on barriers rather than drivers and only examines few of the cooperation activities that exist in practice. This article offers a comprehensive review and analysis of an extensive set of barriers and drivers across seven UBC activities with a large sample of European academics from 33 countries. Results highlight that while the identified drivers significantly affect the development of all cooperation activities, barriers have more diverse effects. While significantly limiting research and valorization activities, they barely impact cooperation in education. Additionally, results show that even if academics perceive no barriers they still may not cooperate with business if there are no drivers in place. This article concludes by discussing the relevant implications for research, management and policy development regarding UBC, leading to directions for future research.
Manzini, R; Lazzarotti, V	Intellectual property protection mechanisms in collaborative new product development	R & D MANAGEMENT	2016	Intellectual property (IP) is widely recognized to be a critical issue for implementing open innovation and collaborative research in new product development (NPD). Several intellectual property protection mechanisms (IPPMs) can be employed by companies to protect their critical technology and know-how (patents, designs, trade secrets, trademarks, copyrights). However, how they should be used in the different phases of collaborative NPD processes is still debatable, and few empirical studies regarding the issue are available at the moment. This paper, which is based upon the case of an Italian NPD service company named MR&D, focuses on one main question: how can companies protect ideas, technology, and know-how in collaborations concerning different phases of the NPD process? It proposes an initial tentative framework to answer this question by way of an analysis of pertaining literature and a case study.
Miozzo, M; Desyllas, P; Lee, HF; Miles, I	Innovation collaboration and appropriability by knowledge-intensive business services firms	RESEARCH POLICY	2016	We uncover a "paradox of formal appropriability mechanisms" in the case of knowledge-intensive business services (KIBS) firms. Despite evidence that KIBS firms do not typically consider formal appropriability mechanisms, such as patents, to be central mechanisms for capturing value from innovation, we show that they are nevertheless important for their innovation collaboration. Drawing on an original survey of publicly-traded UK and US KIBS firms, we find a significant positive association between the importance of innovation collaboration and the importance of formal appropriability mechanisms. We interrogate the evidence for clients, as they are the most important partners for innovation collaboration. We find that the importance of innovation collaboration with clients goes hand-in-hand with the importance of formal appropriability mechanisms, although a negative relation appears when firms assign very high importance to formal appropriability mechanisms. Thus, modest levels of emphasis on formal appropriability mechanisms may prevent conflicts over ownership of jointly developed knowledge assets and knowledge leakages, while also avoiding the possibly negative effects of overly strict controls by legal departments on innovation collaboration. As well as exploring formal appropriability mechanisms, we also investigate the relationship between contractual and strategic appropriability mechanisms and innovation collaboration for KIBS firms. 2016 The Authors. Published by Elsevier B.V.
Rangus, K; Drnovsek, M; Di Minin, A	Proclivity for open innovation: Construct development and	INNOVATION-MANAGEMENT POLICY & PRACTICE	2016	Over the past decade, the concept of open innovation has received substantial attention. Research has ranged from case study representations to large-scale quantitative studies using the Community Innovation Survey data or developing novel approaches to measuring open innovation. In this study, we conceptualise and validate a firm-level measure of proclivity for open innovation, which relates to the firm's predisposition to perform inbound and outbound open innovation activities. To do so, we focus on smaller firms, assessing their organisational and behavioural perspectives related to open innovation. Building on existing scholarly research and a field

	empirical validation			study, we begin by conceptualising the theoretical framework of the multidimensional construct. We then develop and validate its measurement scale on two cross-cultural samples. The measure contains the following dimensions: inward IP licensing and external participation, outsourcing R&D and external networking, customer involvement, employee involvement, venturing, and outward IP licensing. Our results indicate that the measure has good reliability and validity. Implications for future research are also discussed.
Hooge, S; Le Du, L	Collaborative Organizations for Innovation: A Focus on the Management of Sociotechnical Imaginaries to Stimulate Industrial Ecosystems	CREATIVITY AND INNOVATION MANAGEMENT	2016	Confronted with the need to improve their innovation capabilities in an increasingly holistic context, companies are creating new forms of collaborative organizations to collectively explore potential radical innovation fields. In this paper, we propose a study of the nature of these new collectives for innovation through two managerial patterns: objects of collaboration and organizational mechanisms of co-ordination. This research is based on longitudinal collaborative research with the French carmaker Renault and analyses the Renault Innovation Community, whose members participated in original collaborative initiatives to stimulate the industrial ecosystem of mobility and support the potential emergence of new ecosystems. The main results of the empirical research emphasize that: (1) tasks of collaboration favour a focus on the regeneration and dissemination of sociotechnical imaginaries rather than on societal expectations, and (2) organizational mechanisms of collaboration exceed open innovation logics to focus on the collective creation of favourable conditions for the emergence of new industrial ecosystems.
Ollila, S; Ystrom, A	Exploring Design Principles of Organizing for Collaborative Innovation: The Case of an Open Innovation Initiative	CREATIVITY AND INNOVATION MANAGEMENT	2016	In a distributed world, relationships and partnering become even more critical for business, as delivering on rising and complex demands and addressing complex issues is more than one organization can do alone. Such a situation constitutes a huge challenge for many organizations. Building on an inductive case study of an open innovation initiative, illustrating the complex and messy nature of such organizing, we outline five design principles that appear fundamental to the organizing for collaborative innovation. These design principles are our main contribution to the emerging research on organizing for collaborative innovation as they form a perspective and a conceptual tool to talk about and understand the messiness and disorganization of dynamic and discontinuous contemporary organizational constructs.
Lopez-Vega, H; Tell, F; Vanhaverbeke, W	Where and how to search? Search paths in open innovation	RESEARCH POLICY	2016	Search for external knowledge is vital for firms' innovative activities. To understand search, we propose two knowledge search dimensions: search space (local or distant) and search heuristics (experiential or cognitive). Combining these two dimensions, we distinguish four search paths - situated paths, analogical paths, sophisticated paths, and scientific paths - which respond to recent calls to move beyond "where to search" and to investigate the connection with "how to search." Also, we highlight how the mechanisms of problem framing and boundary spanning operate within each search path to identify solutions to technology problems. We report on a study of 18 open innovation projects that used an innovation intermediary, and outline the characteristics of each search path. Exploration of these search paths enriches previous studies of search in open innovation by providing a comprehensive, but structured, framework that explains search, its underlying mechanisms, and potential outcomes. (C) 2015 The Authors. Published by Elsevier B.V.
Gomez, IP; Olaso, JRO; Zabala-Iturriagagoitia, JM	Trust builders as open Innovation intermediaries	INNOVATION-MANAGEMENT POLICY & PRACTICE	2016	The concept of innovation intermediaries has gained relevance in the innovation management literature due to the role they play in supporting innovation processes. This paper focuses on the concept of 'trust builders'. These are defined as volunteers that cooperate with firms, facilitating their interaction with other stakeholders in developing innovation projects. The role of 'trust builders' is analyzed from the impact they have on the territory, promoting initiatives that influence and improve local competitiveness through joint activities. The research is based on a case study conducted in Durango County, Spain. It aims to explore the impact of trust builders' activity in the increased willingness of cooperation and coopetition in the territory. Our results suggest that trust builders constitute an interesting mechanism to promote new products, processes, and technological and market opportunities through knowledge sharing.
Galati, F; Bigliardi, B; Petroni, A	OPEN INNOVATION IN FOOD FIRMS: IMPLEMENTATION STRATEGIES, DRIVERS AND ENABLING FACTORS	INTERNATIONAL JOURNAL OF INNOVATION MANAGEMENT	2016	Open innovation has so far been studied mainly in research-intensive industries, while still little attention has been devoted to the more traditional ones. Our study addresses this gap by focusing on low-tech industries, and on the food one in particular by exploring if and how open innovation is implemented by food companies. Drawing on a database collected from food firms operating in Italy and adopting quantitative techniques, we investigate the implementation strategies of the open innovation paradigm, conscious that food companies are adopting an open approach to innovation. Results show that they mainly implement two different strategies, according to different sets of drivers and enabling factors. These strategies should be referred to with the terms "open market pull" and "open technology push".

Cheng, CCJ; Yang, CL; Sheu, C	Effects of open innovation and knowledge-based dynamic capabilities on radical innovation: An empirical study	JOURNAL OF ENGINEERING AND TECHNOLOGY MANAGEMENT	2016	Building on knowledge-based dynamic capabilities, this paper examines how knowledge capabilities influence the effectiveness of open innovation inbound and outbound activities on radical innovation performance. Based on a survey of 213 firms, the statistical results indicate that the effectiveness of open innovation inbound and outbound activities is contingent on the presence of knowledge acquisition capabilities and knowledge sharing capabilities. Specifically, a firm practicing inbound activities to strengthen radical innovation is more likely to benefit from knowledge sharing capabilities than from knowledge acquisition capabilities. In contrast, a firm practicing outbound activities is more likely to enhance radical innovation performance through knowledge acquisition capabilities than through knowledge sharing capabilities. Managerial implications and research contributions are provided, followed by a discussion of future research directions. (C) 2016 Elsevier B.V. All rights reserved.
Sikimic, U; Chiesa, V; Frattini, F; Scalera, VG	Investigating the Influence of Technology Inflows on Technology Outflows in Open Innovation Processes: A Longitudinal Analysis	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2016	The open innovation (OI) paradigm emphasizes the importance of integrating inbound and outbound flows of technology to increase a firm's innovation performance. While the synergies between technology inflows and outflows have been discussed in conceptual OI articles, the majority of empirical studies have typically focused on either the inward or the outward dimension of OI. According to recent reviews of OI literature, there is a need for further research that takes an integrated perspective on this topic and studies the combination of the inbound and outbound dimensions of OI. This paper follows these calls by focusing on technology licensing as the main contractual form for OI, and by investigating the relationship between technology in-licensing and out-licensing activities at the firm level of analysis. In particular, this paper argues that technology in-licensing positively influences the volume of technology out-licensing through two mechanisms. The firstresource-basedoccurs because in-licensing investments expand and enrich the firm's technology base, thus increasing its value and, as a result, creating more opportunities for out-licensing. The secondcapabilities-basedoccurs because, due to commonalities between technology in-licensing and out-licensing in terms of performed tasks and required skills, repeated execution of in-licensing transactions contributes to the development of higher out-licensing capabilities and, as a result, increase out-licensing volume. These arguments are tested using a panel dataset of 837 Spanish manufacturing firms over the period 1998-2007. Consistent with the predictions, the empirical analysis shows that higher investments in in-licensing and more extensive in-licensing experience lead to superior volumes of technology out-licensing. These results contribute to research on OI and licensing, by empirically showing the existence of positive interactions between technology inflows and outflows and of synergies in the development of absorptive and desorptive capacities.
Schemmann, B; Herrmann, AM; Chappin, MMH; Heimeriks, GJ	Crowdsourcing ideas: Involving ordinary users in the ideation phase of new product development	RESEARCH POLICY	2016	The different roles of users in new product development (NPD) have been extensively described. Currently online idea crowdsourcing, via long-term open idea calls, is increasingly being used by companies to collect new product ideas from ordinary users. Such open idea calls can result in thousands of suggested ideas and detecting the ones that a company wants to implement can be problematic. Empirical research in this area is lacking. We therefore investigate which ideator and idea-related characteristics determine whether an idea for NPD is implemented by a crowdsourcing company. To answer this question, we use a cross-sectional research design to analyse publicly available data from an open idea call, run by an internationally active beverage producer. Our results reveal that ideators paying major attention to crowdsourced ideas of others, the idea popularity, as well as its potential innovativeness positively influence whether an idea is implemented by the crowdsourcing company. Counterintuitively, the motivation of an ideator, reflected in the number of ideas suggested, does not influence the likelihood of an idea being implemented. (C) 2016 Elsevier B.V. All rights reserved.
Nitzsche, P; Wirtz, BW; Gottel, V	INNOVATION SUCCESS IN THE CONTEXT OF INBOUND OPEN INNOVATION	INTERNATIONAL JOURNAL OF INNOVATION MANAGEMENT	2016	The concept or paradigm of open innovation has gained more and more attention over the last couple of years. Firms see open innovation nowadays as an important capability to build and maintain innovativeness, even in dynamic global markets. Nevertheless, there is still a lot of uncertainty regarding the question which factors determine successful innovation within the open innovation environment. In this regard, based on the dynamic capabilities view, we hypothesise that a firm's openness, its absorptive capacity and its flexibility primarily determine innovation success in in-bound open innovation environments. To test these hypotheses, we analyse a large scale survey sample of 496 German manufacturing companies from different industries by applying structural equation modelling. As a main result, we find evidence for a positive association between the three mentioned constructs and innovation success.
Valentim, L; Lisboa, JV; Franco, M	Knowledge management practices and absorptive capacity in small and medium-sized enterprises: is there really a linkage?	R & D MANAGEMENT	2016	Small and medium-sized enterprises (SMEs) are more vulnerable to globalization and rapid technological change due to their scarcity of resources. SMEs' absorptive capacity allows them to access knowledge and plays a key role in their ability to explore and exploit opportunities in their environment. Therefore, this study aims to identify and categorize knowledge management practices which SMEs can adopt to develop absorptive capacity. From a population of 4,534 Portuguese SMEs, 260 usable completed questionnaires were returned. We concluded that Portuguese SMEs are engaged in knowledge management practices, through collaboration with business partners, favoring learning processes based on experience, knowledge transfer to employees and knowledge absorption by employees, reflecting the importance given by SMEs to the tacit nature of knowledge which helps them in efficiency improvements, strategic adaptation, and the launch of new products and services. Our study contributes to advancing theory in the fields of knowledge management and absorptive capacity. We combine and extend previous research which allows us to reconcile the sometimes contradictory findings concerning

				knowledge management practices which SMEs can adopt to reinforce absorptive capacity. Some theoretical and practical implications are also presented.
Roberts, DL; Piller, FT; Luttgens, D	Mapping the Impact of Social Media for Innovation: The Role of Social Media in Explaining Innovation Performance in the PDMA Comparative Performance Assessment Study	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2016	Social media (SM) allow users to easily create, edit, or share content. The vast numbers of individuals that converge around sites like LinkedIn, Facebook, or Twitter embody a rich source of external knowledge that could be utilized for new product development (NPD). Complementing other channels for open innovation (OI), SM can provide access to novel information about customer needs and technological solutions unknown to the firm. Anecdotal evidence suggests that there are considerable benefits from using SM during an innovation project, but empirical evidence is scarce. Contributing to the perspective of openness in search, a number of hypotheses propose how SM as a new channel for OI can contribute to firm performance. This model is tested using data from the PDMA Comparative Performance Assessment Study, identifying factors influencing the relationship between SM and NPD performance. The findings indicate that utilizing information from SM channels can lead to higher performance, but that this link is influenced by the formalization of a firm's NPD process. This study also finds that the ability of a firm to benefit from external search in SM strongly depends on complementary internal processes when organizing and conducting this activity. Furthermore, managers have to take care when utilizing information from SM channels in radical projects, as for this kind of project only a weak significant performance contribution of SM could be found.
Bianchi, M; Croce, A; Dell'Era, C; Di Benedetto, CA; Frattini, F	Organizing for Inbound Open Innovation: How External Consultants and a Dedicated R&D Unit Influence Product Innovation Performance	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2016	Firms increasingly acquire technological knowledge from external sources to improve their innovation performance. This strategic approach is known as inbound open innovation. The existing empirical evidence regarding the impact of inbound open innovation on performance, however, is ambiguous. The equivocal results are due to moderating factors that influence a firm's ability to acquire technological knowledge from external sources and to transform it into innovation outputs. This paper focuses on a relevant yet overlooked category of moderating factors: organization of research and development (R&D). It explores two organizational mechanisms: one informal and external-oriented (involvement of external consultants in R&D activities) and one formalized and internal-oriented (existence of a dedicated R&D unit), in the acquisition of technological knowledge through R&D outsourcing, a particular contractual form for inbound open innovation. Drawing on a capabilities perspective and using a longitudinal dataset of 841 Spanish manufacturing firms observed over the period 1999-2007, this paper provides a fine-grained analysis of the moderating effects of the two organizational mechanisms. The involvement of external consultants in R&D activities strengthens the impact of inbound open innovation on innovation performance by increasing marginal benefits of acquiring external technological knowledge through R&D outsourcing. Moreover, it reduces the level of inbound open innovation to which the highest innovation performance corresponds. Instead, the existence of a dedicated R&D unit makes the firm less sensitive to changes in the level of inbound open innovation, by reducing marginal benefits of acquiring external technological knowledge through R&D outsourcing, and increases the level of inbound open innovation to which the highest innovation performance corresponds. The results regarding the role of informal and formalized R&D organizational mechanisms contribute to research on open innovation and absorptive capacity, and also inform managers as to what organizational mechanism is recommended to acquire external technological knowledge, depending on the objectives that the firm pursues.
Du, SL; Yalcinkaya, G; Bstieler, L	Sustainability, Social Media Driven Open Innovation, and New Product Development Performance	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2016	Sustainability and social media use in open innovation play important roles in a firm's new product development (NPD) process. This research examines, in conjunction, the roles of sustainability and social media driven inbound open innovation (SMOI) for a firm's NPD performance, and further, takes a more refined approach by differentiating between different types of SMOI activities. To this end, this research develops and tests a conceptual framework, which predicts that (1) a firm's sustainability orientation (SO) is positively associated with its NPD performance, (2) customer focus (CF) partially mediates the SO-NPD performance link, and (3) particular SMOI activities moderate the CF-NPD performance link. The empirical results, using data from the Product Development and Management Association (PDMA)'s comparative performance assessment study, provide support for most of the framework. Notably, this research documents a positive link between SO and NPD performance, as well as a partial mediating role of CF. The results further suggest that social media driven open innovation activities focused on gathering market insights enhance CF directly, while social media driven open innovation activities that garner technical expertise enhance the link between CF and NPD performance. This paper bridges the separate literatures on sustainability and open innovation, and contributes to the NPD research. The findings suggest that managers should take a strategic approach to sustainability and embed it in the NPD process. Furthermore, managers should manage social media based open innovation carefully to fully benefit the firm during the front end and back end of NPD.
Chen, YF; Vanhaverbeke, W; Du, JS	The interaction between internal R&D and	R & D MANAGEMENT	2016	This paper investigates to what extent internal R&D efforts and different types of external knowledge sources jointly affect innovation performance of firms in emerging economies. Based on a survey about external knowledge sourcing activities of Chinese innovative firms, we categorize external knowledge sources into four groups: science-based partners; horizontal connections; value chain partners, and

	different types of external knowledge sourcing: an empirical study of Chinese innovative firms			technology service providers. We find that both internal R&D activities and external knowledge sourcing have a positive effect on firms' innovation performance. Strong internal R&D capabilities also increase the effect of sourcing from value chain partners and horizontal connections, but we do not find support for complementarity between internal R&D and collaborations with universities and research labs. These findings jointly suggest that the mixture of different types of external knowledge partners in combination with internal R&D capabilities is crucial in understanding the role of open innovation in emerging economies.
Thanasopon, B; Papadopdulos, T; Vidgen, R	The role of openness in the fuzzy front-end of service innovation	TECHNOVATION	2016	The early stages of innovation involve high levels of uncertainty, leading to it being labelled as the "fuzzy-front end" (FFE). Although openness has been identified as pivotal to innovation performance in the open innovation literature, little effort has been put into exploring its role in the FFE. Specifically, this study examines 'openness competence' within the FFE-i.e., the ability of a FFE team to explore, gather and assimilate operant resources from external sources by means of external searches and inter-organisational partnerships. The aim is to investigate the impact of openness competence on front-end uncertainty reduction and service innovation success. Data were obtained from a survey of 122 IT-based service innovation projects implemented by IT service provider firms in Thailand. The results suggest that openness competence positively influences both the degree of uncertainty being reduced during the FFE and the overall success of service innovations. These findings offer several implications for research on open innovation and the FFE as well as encouragement to managers to apply a more open approach to the FFE of their service innovation projects. (C) 2015 Published by Elsevier Ltd.
Veer, T; Lorenz, A; Blind, K	How open is too open? The mitigating role of appropriation mechanisms in R&D cooperation settings	R & D MANAGEMENT	2016	In this article, we investigate the influence of firms' R&D cooperation activities on their likelihood to experience imitation. Analyses of firm-level survey data concerning the R&D cooperation behavior of 2,797 German firms reveal that companies engaging in R&D cooperation face significantly more imitation than their peers that do not cooperate on R&D. Further, we show that cooperation with all potential collaboration partner types except universities and research institutions and in all phases of the innovation process increases the risk of imitation. While we find evidence that intellectual property rights (IPR) generally work well as governance mechanisms moderating the relationship between R&D cooperation and imitation, contracts do not. Hence, IPR apparently provide better protection against imitation than contracts. Our findings indicate that the risks associated with firms' increased engagement in R&D cooperation could eventually harm the production of new knowledge.
Arora, A; Athreye, S; Huang, C	The paradox of openness revisited: Collaborative innovation and patenting by UK innovators	RESEARCH POLICY	2016	We revisit the "paradox of openness" in the literature which consists of two conflicting views on the link between patenting and open innovation-the spillover prevention and the organizational openness views. We use the data from the Survey of Innovation and Patent Use and the Community Innovation Survey (CIS6) in the UK to assess the empirical support for the distinct predictions of these theories. We argue that both patenting and external sourcing (openness) are jointly-determined decisions made by firms. Their relationship is contingent upon whether the firms are technically superior to their rivals and lead in the market or not. Leading firms are more vulnerable to unintended knowledge spillovers during collaboration as compared to followers, and consequently, the increase in patenting due to openness is higher for leaders than for followers. We develop a simple framework that allows us to formally derive the empirical implications of this hypothesis and test it by estimating whether the reduced form relationship between patenting and collaboration is stronger for leaders than for followers. (C) 2016 The Authors. Published by Elsevier B.V.
Randhawa, K; Wilden, R; Hohberger, J	A Bibliometric Review of Open Innovation: Setting a Research Agenda	JOURNAL OF PRODUCT INNOVATION MANAGEMENT	2016	Through an objective, systematic, and comprehensive review of the literature on open innovation (OI), this article identifies gaps in existing research, and provides recommendations on how hitherto unused or underused organizational, management, and marketing theories can be applied to advance the field. This study adopts a novel approach by combining two complementary bibliometric methods of co-citation analysis and text mining of 321 journal articles on OI that enables a robust empirical analysis of the intellectual streams and key concepts underpinning OI. Results reveal that researchers do not sufficiently draw on theoretical perspectives external to the field to examine multiple facets of OI. Research also seems confined to innovation-specific journals with its focus restricted to a select few OI issues, thereby exerting limited influence on the wider business community. This study reveals three distinct areas within OI research: (1) firm-centric aspects of OI, (2) management of OI networks, and (3) role of users and communities in OI. Thus far, studies have predominantly investigated the firm-centric aspects of OI, with a particular focus on the role of knowledge, technology, and R&D from the innovating firm's perspective, while the other two areas remain relatively under-researched. Further gaps in the literature emerge that present avenues for future research, namely to: (1) develop a more comprehensive understanding of OI by including diverse perspectives (users, networks, and communities), (2) direct increased attention to OI strategy formulation and implementation, and (3) enhance focus on customer co-creation and conceptualize open service innovation. Marketing (e.g., service-dominant logic), organizational behavior (e.g., communities of practice), and management (e.g., dynamic capabilities) offer suitable theoretical lenses and/or concepts to address these gaps.

Martinez, MG; Zouaghi, F; Garcia, MS	Capturing value from alliance portfolio diversity: The mediating role of R&D human capital in high and low tech industries	TECHNOVATION	2017	Research has demonstrated the value of external linkages to augment in-house R&D efforts; however, very little is known about how managers can operationally leverage the potential benefits of open innovation to create an innovative edge. This paper examines the value of alliance portfolio diversity and whether R&D human capital is the pathway through which alliance portfolio diversity influences innovation novelty. We reason that the absorptive capacity of R&D human capital determines a firm's potential gains from highly diverse alliance portfolios. Using data from the Spanish Technological Innovation Panel (PITEC) for the period 2005-2012, results support the curvilinear (inverted U-shaped) association between alliance portfolio diversity and firm innovation performance reported in studies, suggesting that not only too little, but also too much alliance portfolio diversity may be detrimental to firm innovation performance. Findings emphasise the value of alliance portfolio diversity in high-technology industries to achieve explorative performance objectives, given the technological complexity, market uncertainty and the divergent skill sets required for breakthrough innovations in these sectors. Further, we find evidence that R&D human capital plays an important role in innovation novelty by partially mediating the relationship between alliance partner diversity and firm innovation performance, emphasising the importance of internal capabilities to harness external knowledge assets. This study provides valuable insights to managers aiming to increase the effectiveness of their alliance portfolios. (C) 2016 Elsevier Ltd. All rights reserved.

Table 35: Extant literature contributions on openness and performance

Authors	Year	Sample	Dependent variable	Independent variables	Control variables	Moderating variables
Hwang, J; Kim, E; Kim, S	2009	- Large-scale survey - 157 OSS Korean company - 91 respondents, 86 accepted - Logistic regression	1.Technologically new product innovation, 2. technologically improved product, 3. technological process innovation	1. Total network (TOTALNET), 2. Domestic network (DOMNET), 3. Global network (GLOBNET), 4. State-Supported Network (STATESUP), 5. Outside Developer Network (COMMU), 6. Code Developer Weight (COREDEV), 7. Market Structure (CR3), 8. Age (AGE), 9. Size (SIZE and SIZE^2)		
Stam, W	2009	- Large-scale survey - OSS firms in the Netherlands - 125 firms involved, 121 responses from 90 firms received (72% response rate)	1. Innovative performance - n. of new products introduced by the firm 2. Financial performance - self-reported measures of firms' financial performance relative to competitors: sales growth, market share, gross profits, and net profit margin.	1. Community participation - 5-point Likert scale 2. R&D Intensity - share of R&D investments over previous years' sales	1. firm size - log of FTE 2. firm age - log of years 3. OSS Specialization - % of revenues generated from OSS 4. OSS Projects - n. of projects 5. Self-initiated OS projects - % of projects started from the focal firm	
Wincent, J; Anokhin, S; Boter, H	2009	- Focus on Swedish small-firm networks - 53 networks sample - Industries: engineering, food, health, tourism, wood, telecommunications, IT	1. Network innovative performance, 1-7 Likert Scale	1. Network continuity (% of directors with >1-year continuity)	1. Financial indicators, 2. size of board, 3. network age, 4. competence diversity within the board, 5. frequency of meetings, 6. board independence, 7. board compensation	1. Network size (n. of firms in the network each year)
Chiang, YH; Hung, KP	2010	- Large-scale questionnaires - 800 randomly selected Taiwanese electronic product manufacturing companies - 220 valid responses (27%) in phase 1. - 184 effective responses (23%) after phase 2	1. Incremental innovation performance 2. Radical innovation performance	1. Search breadth and depth	1. market potential, 2. technological turbulence 3. R&D intensity 4. company size (as a surrogate)	
Faems, D; de Visser, M; Andries, P; Van Looy, B	2010	- Community Innovation Survey, 2005 - 2075 Belgian manufacturing firms, 888 respondents (42.8%	1. Diversity of Technology Alliance Portfolio	1. Internal innovation efforts, 2. Product innovation performance, 3. Financial performance,	1. Industry, 2. firm size, 3. if the firm is part of a	

		response rate). - 526 selected firms in the final sample		4. Personnel costs in value added, 5. Profit margin	divisional entity, 4. past financial performance	
Spithoven, A; Frantzen, D; Clarysse, B	2010	- CIS dataset - Two stratification variables: (1. the number of employees (as the average of 1998, 1999, and 2000) as an indication of size; and (2) the sector the enterprise belonged to - Belgium - 4,482 firms sample, 2,035 responses were received, containing both innovating (1,310) and non-innovating (725) firms - 1,987 firms final sample	1. research intensity (LRDI) - log of R&D/Sales; 2. innovative revenue (LIREV) - log of new or innovative products/Sales; 3. growth in revenue (GREV) - logSales^2000-logSales^1998.	1. Knowledge externalities (KEXT) - importance of different interfirm linkages (KEXT ^ if) and inter-organizational linkages (KEXT ^ io) 2. Research cooperation (COOP), dummy variable of interfirm cooperation (COOP ^ if) and inter-organizational cooperation (COOP ^ io) 3. Appropriability (APPR), dummy variable measuring the degree on which the firm pursues strategic protection	1. CRES - complex research, ratio between information sourced from universities, government and conferences over all information sources 2. PROC - dummy variable for process innovation 3. LHEI - log of share of employees with higher education 4. LEXI - log of share of exports over revenues 5. LSIZE - log of number of employees 6. GRMS - dummy variable for "mother" or "subsidiary" firm 7. Industry-specific dummy variables, five sectors: - ISUP - supplier-dominated - ISCL - scale-intensive - ISPS - specialized suppliers - ISCB - science-based - IINF - information intensive	
Bogers, M; Lhuillery, S	2011	- Swiss innovation survey, 1991-1993 - 659 observations	1. Product innovation-related variables (R&D Prod, Manufacturing Prod, Marketing Prod) 2. Process innovation-related variables (R&D Proc, Manufacturing Proc, Marketing Proc)	1. Customers, Suppliers, Competitors, Group members (part of the same conglomerate), 2. PROs (including universities of applied sciences, universities and public research institutes) 3. Consulting (also including private research institutes), for both product and process innovation.	1. Appropriation, for both product and process innovation; 2. Size, 3. Group, 4. Price competition; 5. non-price competition; 6. Duration of innovative project; 7. Financial constraints; 8. Diversification; 9. Industry.	
Mention, AL	2011	- CIS survey, years 2002-2004 - 1052 service firms in Luxembourg	1. Innovation novelty - binary variable. Its value is 1 when firms do introduce innovations that are new to the market and is worth 0 when innovations are only new to the firm.	1. Co-operation practices: market-based, science-based, intra-group co-operation and co-opetition practices. Each type of co-operation is a binary variable and receives the value one if co-operation has occurred with at least one partner of the group.		

Pullen, AJJ; de Weerd-Nederhof, PC; Groen, AJ; Fisscher, OAM	2012	- 751 Dutch companies in medical devices (complete population) - up to 250 full time employees - 105 companies identified - 97 available for study - 60 final sample, response rate 61.9%	1. Innovation performance - 5 items measured on a 7-point Likert scale	Network characteristics - 1. Goal complementarity, 2. Fairness trust, 3. Reliability trust, 4. Resource complementarity and 5. Network position strength		
Segarra-Cipres, M; Bou-Llusar, JC; Roca-Puig, V	2012	- Spanish survey on business strategies (ESEE) 2003-2006 - Two groups: 1. Firms with more than 200 employees, and 2. Firms with 10 to 200 employees - 2.188 firms surveyed - 1277 firms sample, of which 362 innovative	1. Firm's innovation outcome (RDO) - N. of new products, patents and utility models registered by the firm	1. Contribution of external sources - technological alliances with customers, suppliers, competitors and universities, joint ventures and hiring R&D employees with and without R&D experience	1. Firm size (LGS) - log number of employees, 2. Firm's age (LGA) - log of years, 3. Mean R&D in the last two years (MRDO)	
Barge-Gil, A	2013	- PITEC dataset - Spanish manufacturing firms - 2004-2008	1. Percentage of sales obtained in the last year of the period of analysis, from products new to the market, introduced in the previous three years (LNEWMK)	Openness strategy - 4 dummy variables: 1. Closed - no collaborative or inbound OI links 2. Semi-open - new products were obtained mainly by the enterprise on its own 3. Open - new products were achieved mainly through cooperation with other organizations 4. Ultra-open - new products are the result predominantly of the efforts of third parties	1. firm size 2. R&D intensity 3. sector 4. export behavior 5. obstacles to innovation 6. belonging to a group 7. market share 8. appropriability conditions	
Berchicci, L	2013	- Surveys of Italian Manufacturing firms - 1992-2004 original sample, 2001-2004 observations considered for analysis (covering 1998-2003) - 8969 observations (and 6872 firms) - Final sample of 2905 observations (and 2537 firms)	1. Share of innovative sales - share of turnover from new or significantly improved products. Percentage value	1. External R&D - percentage of outsourced R&D activities over total R&D activities. Percentage value. 2. R&D capacity - number of R&D employees over total n. of employees	1. Size - total number of employees. Log function. 2. Age - total number of years. Log function. 3. Export - dummy variable for firm exporting activities. 4. Wave 2004 - dummy variable for firms included in the 2004 survey.	
Hung, KP; Chou, C	2013	- Taiwanese high tech manufacturers - Online questionnaire - 791 companies selected for analysis - 176 responses (22.3% response rate)	1. Firm performance - firm's Tobin q: ratio of firm market value to the replacement cost of its assets	1. internal R&D effort - ratio between company R&D expenditure over sales. 2. Technological turbulence - change rate of technology used in the business 3. Market turbulence - speed of change in customer needs and preferences in competitor actions	1. Industry sectors - dummy variables for sectors (chemical & pharmaceuticals, Mechanical and electric equipment, Semiconductors, and Electronics) 2. Size - number of employees. Log measure	

Roper, S; Vahter, P; Love, JH	2013	- Irish Innovation Panel (IIP) - 1994-2008	1. Proportion of plants' sales derived from products that were either newly introduced or improved during the previous three years. 2. Product innovation dummy	1. Measures of the breadth of innovation linkages (based on Laursen and Salter, 2006)		
Caner, T; Sun, J; Prescott, JE	2014	- USPTO database - Bio-pharmaceutical firms in the US - 1990-2007 - 2209 firm observations for 287 firms	1. Invention output - average number of patents granted over a three-year period	1. Centrality - degree centrality, the number of direct ties in a firm's early stage R&D alliance network. Log value. 2. Inward technology transfer - sum of the count of patent citations made in a firm's patents to patents held by other organizations, over five years (t-5 to t-1. Log value. 3. Outward technology transfer - sum of the number of out-licensing agreements over a five-year period (t-5 to t-1. Log value. 4. Interactions - Centrality*Inward knowledge transfer, Centrality*Outward knowledge transfer, Inward knowledge transfer*Outward knowledge transfer, and Centrality*Inward knowledge transfer*Outward knowledge transfer	1. Therapeutic area diversity - 22 therapeutic areas Herfindahl index measure. 2. Size - number of employees. Log value 3. Age - n. of years 4. R&D intensity - R&D expenditure over total assets. 5. Available slack - Ratio of current assets to current liabilities 6. Recoverable slack - working capital to sales ratio 7. Potential slack - debt to equity ratio 8. Time - dummy variables for years.	
Cheng, CCJ; Huizingh, EKRE	2014	- 24 in-depth interviews - Pilot study for validity with 39 senior management	Innovation performance - Four items: 1. New product/service innovativeness 2. New product/service success 3. Customer performance 4. Financial performance	1. Outside-in 2. Inside-out 3. Coupled	1. Market turbulence 2. Technological turbulence 3. Competitive intensity 4. Firm size 5. Industry	1. Entrepreneurial orientation 2. Market orientation 3. Resource orientation
Du, JS; Leten, B; Vanhaverbeke, W	2014	- Cross sectional dataset on R&D projects - Focus on large multinational, multi-business, European-based manufacturing companies. - 2003-2009 - 489 R&D projects sample	1. Financial performance - measured as the total revenues that are generated by the 'transferred' outcomes of an R&D project to one, or multiple, business departments between the start of the project and the latest year of data collection (i.e. mid-2013.	1. Open innovation partnerships - dummy variable on whether the firm participated in a collaboration with a science-based on market-based partner during the project. 2. Science-based partnership - dummy 3. Market-based partnership - dummy	1. Project resources - n. of full time equivalents working on the project 2. Technology fields - dummy variables for technologies involved in the project 3. Firm patent stock - n. of patents (developed in the previous 5 years) accessible to project team 4. Project patent - dummy	

				4. Project management formality - 5-value scale measure	variable on whether the project resulted in a patent application 5. Sponsor departments - dummy variables identifying the department sponsoring the project 6. Development departments - dummy variables identifying the department in charge of developing the project after its conclusion 7. N. of projects under management 8. Project initiating year - dummy variables 9. Project ending year - dummy variables	
Sabidussi, A; Lokshin, B; de Leeuw, T; Duysters, G; Bremmers, H; Omta, O	2014	- Community Innovation Survey - Netherlands - 1996, 1998, 2000 reference years (covering 1994-2000) - 3657 observation and 2862 firms	1. Innovation performance - "total innovation": total sales derived from new products, with the share of sales from products new to the market and new to the firm (jointly). Log (Percentage of sales from new products / number of employees) + 1	Strategy - firm strategy. Dummy variables for three approaches: 1. M&A strategy 2. Alliance strategy 3. Integration strategy.	1. R&D intensity - Log (R&D intensity / n. of employees) +1 2. Alliance partner diversity - Dummy variables for 7 categories: customers, suppliers, competitors, commercial laboratories, research institutes, universities, and subsidiary companies). 3. Firm size - Log of n. of employees. 4. Sources of innovation - Dummy variables for three categories: I. Export, II. MNE, III. Domestic group 5. Sector - Dummy variables for industry classification.	
Vahter, P; Love, JH; Roper, S	2014	- Irish Innovation Panel (IIP) - 1994-2008 - 2170 small plants in the sample, 1672 medium and large	1. Proportion of plant sales derived from products that were either newly introduced or improved during the previous three years. Percentage (0-100)	1. OI Breadth - number of different types of innovation linkages 2. SCL - dummy variable for linkages inside the supply chain (suppliers and/or customers) 3. UNILAB - dummy variable for linkages with universities or labs 4. OTHER - dummy variable for other linkages - with	1. In-house R&D - dummy variable 2. Multi nationality - dummy variable 3. Workforce with degree - percentage 4. Public support - dummy variable on whether firms have received public support for their innovation activity 5. Herfindahl index - proxy for sectoral competition	

				competitors, joint ventures or consultants		
Cruz-Gonzalez, J; Lopez-Saez, P; Navas-Lopez, JE; Delgado-Verde, M	2015	- Spain - Multi-industry sample: Chemical, pharmaceutical, computer electronic and optical products, electrical equipment, machinery and equipment, motor vehicles trailer and semi-trailers, and other transport equipment. - Large- and medium-sized firms (>50 FTE) - 1188 firms in the initial sample, reduced to 1142 - Large-scale survey - 248 respondents (21.7% response rate)	1. Firm performance - 7-point Likert Scale based on six item variables on subjective scale for firm performance (Venktatraman, 1989).	1. External search breadth - 7-point Likert scale, based on the importance of 16 external sources 2. External search depth - 7-point Likert scale, based on the importance of 16 external sources	1. Past performance 2. Part of a group 3. Foreign 4. Firm R&D 5. Innovation strategy 6. Technological diversification 7. Industry R&D 8. Industry sales growth 9. Other environmental instability	1. Technological dynamism - 7-point Likert Scale based on 4-item questions
Gesing, J; Antons, D; Piening, EP; Rese, M; Salge, TO	2015	- Cross-sectoral data from German firms operating in 21 distinct manufacturing and services sectors. - Of the 18,109 German firms surveyed, 6684 returned usable questionnaires (response rate of 36.9%). - After accounting for missing data on the variables included in the model, 2502 German firms remain in the final sample - Among these 2502 German firms, 1486 (59.4%) were operating in manufacturing sectors and 1016 (40.6%) in service sectors.	1. Revenue share from new-to-firm products - Estimated percentage share of a firm's total revenues in 2007, which can be attributed to products launched between 2005 and 2007 that are new to the focal firm, but not to its target market. 2. Revenue share from new-to-market products - Estimated percentage which captures firms' success in launching and commercializing radically new products that constitute true market novelties.	The combination of: 1. Two partner types for innovation collaborators: 1. business customers and 2. universities and research institutes 2. Three governance modes: 1. informal, self-enforcing governance (never contract based); 2. hybrid governance (partly contract based); and 3. formal, contractual governance (always contract based) --> Six dummy variables: 1. Informal market-focused collaboration, 2. Hybrid market-focused collaboration, 3. Formal market-focused collaboration, 4. Informal science-focused collaboration, 5. Hybrid science-focused collaboration, and 6. Formal science-focused collaboration	1. Firm size - log of number of FTE 2. Human capital - ratio of employees holding a university degree 3. Export intensity - ratio between international revenues over total revenues 4. Firm location - dummy variable for West Germany (0) or East Germany (1. 5. Industry dummies - 21 categories	R&D intensity - ratio of total R&D expenditures over total revenues
Bianchi, M; Croce, A; Dell'Era, C; Di Benedetto, CA; Frattini, F	2016	- Spanish Business Strategy Survey - 1999-2007 sample of 1856 firms - 841 firms selected for the	1. Product Innovation Performance - n. of new products developed and commercialized by the firm in reference year	R&D Outsourcing - ratio of expenditures for R&D outsourcing over total sales, spent in the last three years	1. R&D Internal - ratio of expenditures for R&D over total sales, spent in the last three years. 2. Existing products - log of	1. R&D Consultants - dummy variable 2. R&D Unit - dummy variable

		analysis, 6161 firm-year observations.			products commercialized by the firm in the reference year. 3. Patents stock - log of firm's patent stock at reference year. 4. Patents - dummy variable 5. Export - dummy variable 6. Export intensity - share of sales from exports 7. Subsidized - dummy variable 8. Employees - log of n. of employees (proxy for firm size) 9. Age - log of n. of firm's years	
Chen, YF; Vanhaverbeke, W; Du, JS	2016	- China - Two waves of survey conducted among innovative firms in Zhejiang province - 2006-2007 and 2013 - 478 firms in the final sample	Innovation performance - ratio of sales derived from new or substantially improved products	Collaboration with different types of partners - nine types of potential partners in the survey: lead users, major clients, suppliers, competitors, firms in other industries, universities and research institutions, technology agencies, intellectual property organizations, and venture capitalists	1. Internal R&D activities - R&D intensity, ratio of R&D expenditures over sales 2. Firm size - n. of employees 3. Firm age - n. of years since firm establishment 4. Employees with higher degree - n. of employees with high-education degree divided by the total number of employees 5. Nature of firm ownership - dummy variables on whether the firm is state-owned, privately owned, joint venture or fully-owned subsidiary of a foreign firm. 6. Stage of growth - dummy variables on whether the firm is in its initial stage, growth stage, expansion stage or maturity stage. 7. Industries - dummy variables 8. Year of survey - dummy variables	
De Zubielqui, GC; Jones, J; Lester, L	2016	- Adelaide Metropolitan area of South Australia - SMEs (<200 employees) - 14,206 target firms - 4,788 firms (33.7) not available - Final dataset of 9,418 firms - 1,226 questionnaires received,	Firm performance - ordinal sales growth + ordinal market share growth	1. External knowledge inflows from market-based actors (EKMK) - three indicators: 1. n. of methods/channels of external knowledge inflows from market-based actors (0-15.; 2. whether firms had used external ideas from market-based actors for		1. Absorptive capacity - dummy variables on whether the firm possesses engineering or scientific skills (0-6) 2. Innovation outcomes - dummy variables on whether

		838 used for analysis (8.9% response rate)		innovation activities (0-4.; and 3. count of which market-based actors the firms collaborated with (0-6. 2. External knowledge inflows from science-based actors (EKINST) - three indicators: 1. n. of methods/channels of external knowledge inflows from science-based actors (0-14.; 2. whether firms had used external ideas from science-based actors for innovation activities (0-4.; and 3. count of which science-based actors the firms collaborated with (0-8).		the firm undertake different types of innovation activities
Sikimic, U; Chiesa, V; Frattini, F; Scalera, VG	2016	- Spanish Business Strategy Survey (SBSS) - 1998-2007 - The questionnaire was sent to all firms with more than 200 workers and to a random sample of firms with less than 200 workers, but more than 10 workers. - Unbalanced panel data - 837 firms	Technology Out-Licensing Volume (TOLV) - log of revenues from out-licensing of technology	1. Technology Licensing Investments (TILI) - distributed lags (t-1. t-2 and t-3) of in-licensing investments 2. Number of Years Firm In-Licensed (NYFIL) - n. of years the firm has engaged in in-licensing prior to year t. 3. Firm Continuously In-Licensed (FCIL) - dummy variable on whether the firm in-licensed in all the three years previous to year t.	1. R&D intensity (RNDI) - ratio of R&D investments over sales 2. Patent Portfolio (PP) - count of new patent registered by the firm in the reference year 3. Number of New Product Innovations (NNPI) - n. of new product innovations the firm generated internally 4. Manufacturing Assets (MA) - ratio of firm's tangible fixed assets over total assets 5. Size - n. of employees 6. Age - n. of years of company from foundation 7. Industry - dummy variables 8. Year - dummy variables	
Thanasopon, B; Papadopdulos, T; Vidgen, R	2016	- IT service providers in Thailand who had participated in the FFE of service innovation projects. - 598 Bangkok-based firms in the initial sample - 200 firms randomly selected - 83 firms agreed to participate - 122 valid responses in the final sample	1. Financial success 2. Non-financial success 3. Market uncertainty reduction 4. Technical uncertainty reduction	Openness competence - four-components: I) Searching capability (SEARCH), II) coordination capability (COOR), III) collective mind (CMIND) IV) absorptive capacity (AB_CAP)	1. Years of experience 2. Experience of the project team 3. Innovativeness 4. Firm size	
Martinez, MG; Zouaghi, F; Garcia, MS	2017	- Technological Innovation Panel (PITEC) - Spain - 2005-2012	Firm innovation performance - 2-item ratio of sales from innovation:	Alliance portfolio diversity - 8-item construct of cooperation agreements in the last two years: 1. customers,	1. Firm size - log 2. Alliance experience - dummy variable on firm's previous external	1. R&D human capital - 2-item construct based on education and skills 2. R&D education intensity -

		- 32,836 observations, 14,740 for high tech sectors and 18,096 for low tech sectors	I) radical - ratio from products new to the world introduced in the last two years; II) incremental - ratio from products new to the firm introduced in the last two years	2. suppliers, 3. competitors, 4. firms belonging to the same enterprise group, 5. universities, 6. public research organizations, 7. technological centers, 8. commercial laboratories/R&D enterprises. 2. In addition, geographical dummy variables are added: I) Spain, II) Europe, III) Other countries	collaboration experience 3. R&D intensity - ratio of firm's R&D expenditure over total sales 4. Export intensity - log of ratio of export over total sales 5. Industry effects - high-tech and low-tech dummy variables 6. Year - dummy variable	ratio of R&D staff with third level education or higher 3. R&D skills intensity - ratio of top-skilled R&D staff