open innovation

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Introduction

In the last decade, open innovation research has been growing exponentially and many interesting publications on the topic have arisen. In this article, we provide an overview of the current state of open innovation research where we focus, in particular, on the definition and origins of open innovation, the contributions of the open innovation literature to existing studies of innovation, and the usefulness of open innovation strategies in applied business settings. We conclude this entry by distinguishing a number of significant themes that will be on the agenda of established and young open innovation researchers in the next 10 years.

Definition and Origins of Open Innovation

While there are historical accounts of external markets for innovation before the rise of the corporate R&D laboratory during the Interbellum (Lamoreaux and Sokoloff, 1999), large industrial companies were successfully following a closed innovation strategy for most of the twentieth century. The Second Industrial Revolution had resulted in the formation of capital-intensive Chandlerian firms that were undertaking all of their (innovation) activities on their own. Rank Xerox, for instance, originally manufactured its own photographic paper. To optimize their large-scale and specialized production activities these firms started to invest heavily in highly firm-specific, internal R&D activities. The large technology base within large corporate R&D laboratories was used not only to significantly reduce the costs of production but also to develop profitable new products (Chandler, 1990). The benefits of internal R&D versus external markets led to the rise of the closed innovation model. Within this vertically integrated innovation model companies typically invest heavily in internal R&D activities and hire the most capable R&D personnel to develop inventions internally that are subsequently protected with tight intellectual property rights (IPR). New products, protected by IPR, generated huge profits, which were then reinvested in internal R&D. This virtuous circle of closed innovation has resulted in many fundamental technological breakthroughs throughout the twentieth century (Chesbrough, 2003).

From the 1990s onward, however, the logic behind the vertical integration strategy of most large companies has started to crumble. Chesbrough (2003) identifies a number of factors that have lead companies to question the main assumptions behind the closed innovation model: the supply of highly trained, flexible R&D personnel has increased tremendously; the quality and accessibility of external expertise has picked up; venture capital as a new and powerful way to finance high-tech ventures has emerged; the knowledge and expertise residing in both customers and suppliers has grown; the time to market of new products and services has significantly decreased; the knowledge structure underlying new technology development has become increasingly complex; and the competitive position of Western firms has eroded. As a result of these developments, many large companies have moved away from an internally focused approach to innovation toward a more open innovation model (the contrasting principles of closed and open innovation are summarized in Table 1. They have come to realize that relevant expertise and knowledge is distributed across the world's knowledge landscape and can be found in many different types of companies (e.g., competitors and noncompetitors, large and small firms), knowledge institutions such as universities, and even in private persons. Large companies cannot solely rely on their corporate R&D laboratories anymore to come up with successful new products and services. Besides looking outside the firm's boundaries for interesting ideas and integrating these ideas into the firm's existing knowledge base, open innovation also entails the spinning-out or licensing-out of ideas that are not used internally to externally parties. The movement toward open innovation models during the last decade of the twentieth century has far-reaching implications for internal R&D departments in large companies. Making use of external knowledge implies the development of a strong absorptive capacity (Cohen and Levinthal, 1990) and the ability to

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Table 1 Closed and open innovation principles.

Closed innovation principles	*Open innovation principles*
Most of the smart people in our field work for us	Not all the smart people work for us, so we must find and tap into the knowledge and expertise of bright individuals outside our company
To profit from R&D, we must discover, develop, and ship ourselves	External R&D can create significant value; internal R&D is needed to claim some portion of that value
If we discover it, we will get it to market first	We do not have to originate the research in order to profit from it
If we are the first to commercialize, we will win	Building a better business model is better than getting to market first
If we create the most and the best ideas in the industry, we will win	If we make the best use of internal and external ideas, we will win
We should control our IPR so that our competitors do not profit from our ideas	We should profit from others' use of our IPR, and we should buy others' IPR whenever it advances our own business model

Adapted from Chesbrough (2003).

determine which technology is lacking and how to use external knowledge to fill this gap. The large-scale movement of most large companies toward open innovation signifies a breach with the sole use of traditional, closed innovation; nowadays, companies use both closed and open innovation models for different areas of their business and for reaching different sets of goals.

Throughout the vast literature on open innovation that has emerged in the last decade, we can find many definitions of the concept. However, the original notion of open innovation comes from Henry Chesbrough, professor at the University of California in Berkeley, who wrote the book "Open innovation – The new imperative for creating and profiting from technology" in 2003. In this seminal work, Chesbrough describes an open innovation model where companies commercialize external (as well as internal) ideas by deploying outside (as well as inside) routes to market. In this open innovation model, research projects can be launched from internal or external sources and new ideas can enter at various stages of development (Chesbrough visualizes this open innovation process by means of the open innovation funnel). In a similar vein, R&D projects can find many potential routes to market, such as out-licensing, spin-offs, and traditional marketing channels. A widely accepted definition of open innovation is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively" (Chesbrough *et al.*, 2006, p. 1). There are several key elements pertaining to this definition. First, Chesbrough distinguishes between the "outside in" aspect of open innovation where external ideas and technologies are brought inside the firm's boundaries to be integrated in its own innovation process and the "inside out" aspect where unused and underutilized knowledge within the firm is brought outside its boundaries to be internalized by others. Second, the business model plays a crucial role in open innovation. External ideas that provide an optimal fit with a company's business model can be internalized, while internal ideas that do not fit with the business model can be further developed outside the firm (Chesbrough, 2003).

There are two noteworthy extensions of Chesbrough's definition of open innovation that can be found in the relevant body of literature. The first extension of the concept is proposed by Gassmann and Enkel (2004). They put

forward that the "coupled" process is another important open innovation process besides the outside in and inside out processes. This process refers to jointly undertaken R&D with several types of partners through various kinds of strategic alliances where mutual gain is critical for commercial success. Companies that set up a coupled open innovation process use a combination of the outside in and inside out processes to create and commercialize inventions (Gassmann and Enkel, 2004). The second important extension to the open innovation concept has been offered by Dahlander and Gann (2010). They first assume that open innovation is not so much a dichotomy (open versus closed) but rather a continuum where companies can adopt various degrees of openness to achieve their innovative goals. As such, the outside in, inside out, and coupled open innovation processes distinguished by Chesbrough (2003) and Gassmann and Enkel (2004) can be more or less open. Dahlander and Gann (2010) secondly discern pecuniary (i.e., with direct financial rewards) and nonpecuniary (i.e., without direct financial rewards but with indirect benefits) open innovation interactions where they acknowledge the fact that many innovative activities are not based on ownership and formalized transactions. In fact, there are times when firms can simply give away their technologies and ideas for free as part of their innovation strategy.

Contributions of Open Innovation to Existing Innovation Research

Since the publication of Chesbrough's groundbreaking work in 2003, many books, book chapters, and articles on open innovation have accrued. Although the concept of open innovation as introduced by Chesbrough is generally considered to be new, innovation processes within many companies have always been open to some extent. In a similar manner, the newly emerged open innovation literature does not constitute a new field of research as it builds on important theoretical work undertaken by renowned scholars in innovation management long before the term open innovation was coined. In fact, in their extensive literature review, Dahlander and Gann (2010) show that the open innovation literature has its roots in several well-established concepts and theories, most notably those put forward by Cohen and Levinthal (1990), Teece (1986), March (1991), and others. Mainly in the 1990s, many researchers within the alliance and network literature also stressed the importance of relying on external actors in the innovation process. While building on important existing innovation management theories, however, open innovation researchers have successfully taken on the important but previously untouched task of synthesizing separate literatures, concepts, and ideas and in doing so have attracted fresh attention from managers, researchers, and policy makers alike. Besides stimulating managerial attention through case-based reflections on new innovative practices within large firms and introducing an umbrella term for related but separate developments in innovation, Chesbrough's 2003 publication also offers novel insights to enhance the existing innovation management literature. We highlight the most important ones below (a full description of all contributions is provided in Chesbrough *et al.* (2006) and is summarized in Table 2.

First, open innovation connects inside out and outside in innovation processes by integrating them both into the open innovation model. Particularly, the process of exploiting internal knowledge externally has largely been ignored in the traditional innovation management literature. By offering a model where any intermediate outcome of innovation processes is considered as a valuable asset that can be exploited internally and/or externally, Chesbrough (2003) has presented a very useful addition to existing theories on innovation. Second, open innovation combines the outside in and inside out innovation processes with a firm's strategy: this is realized by the crucial role of the business model in open innovation. The business model determines which knowledge should be acquired (from the outside), which knowledge has to be developed internally, and which knowledge should be sold or licensed out to external parties. This is one of the new contributions of open innovation to the existing innovation management literature. Previously, different external knowledge sources and modes were considered in isolation of firms'

Table 2 Points of differentiation for open innovation, relative to prior theories of innovation.

Points of differentiation
1. Equal importance given to external knowledge, in comparison to internal knowledge
2. The centrality of the business model in converting R&D into commercial value
3. Type I and type II measurement errors (in relation to the business model) in evaluating R&D projects
4. The purposive outbound flows of knowledge and technology
5. The abundant underlying knowledge landscape
6. The proactive and nuanced role of IP management
7. The rise of innovation intermediaries
8. New metrics for assessing innovation capability and performance

Adapted from Chesbrough *et al*. (2006).

strategic objectives. A third considerable theoretical contribution to the traditional innovation management literature is the introduction of the concept of the "false negative." In any innovation process, companies must be able to separate bad research projects from good ones so that they can ignore the former while developing and commercializing the latter. Both the traditional innovation management literature and the open innovation literature are concerned with eliminating the "false positives" or bad research initiatives that initially seem promising, but the open innovation literature also pays attention to firms' ability to recognize and salvage false negatives or research initiatives that seem to be without prospect but turn out to be highly valuable. Companies with an inward focus, that is, those following a closed innovation strategy, are prone to miss out on important opportunities because many will fall outside their current businesses or will need to be combined with external knowledge to realize their full potential. While open innovation draws heavily from established innovation management theories, its focus on external technology commercialization, the importance of connecting innovative efforts to the firm's strategy, and the value associated with a firm's ability to rescue false negatives has provided researchers in innovation management with important new insights.

Applying Open Innovation: When is it Useful?

Open innovation strategies are useless if they do not create substantial value for customers in end markets and when innovative companies are not capable of capturing a large part of that value. That is an immediate consequence of the important connection between the open innovation efforts of companies and their strategies by way of the business model concept. In this regard, we can argue that open innovation strategies are appropriate under particular sets of circumstances. Specifically, companies need to apply open innovation models, closed innovation models, or a combination of these two innovation methods in different settings to reach different sets of innovative goals. A number of interesting publications point out when the employment of open innovation strategies is most useful. These studies typically describe contingencies at the level of industries and organizations or organizational types.

The open innovation literature has typically focused on industries and companies that thrive on the basis of product innovation – the innovation funnel plays a crucial role in Chesbrough's first book on open innovation. However, product innovation is not possible in many industries where products are commodities. Yet, in these industries, companies can determine strategic drivers that may lead to competitive advantage (Vanhaverbeke and Chesbrough, 2014). The case of the crude oil industry illustrates that open innovation strategies can be effectively applied in commodity industries. Competitive advantage in the crude oil industry is determined by several strategic drivers. Specifically, early detection of large oil wells and effective drilling of these wells are two strategic drivers. Oil companies that

detect the richest oil wells earlier than competitors and drill them more effectively through new technologies are more profitable. Oil companies rely on specialized oil-services companies to develop new technologies for oil exploration and extraction. Oil companies, therefore, set up an innovation ecosystem with a number of strategic partners that possess leading-edge exploration and drilling technology to accelerate the exploration and extraction of the most promising wells (Nambisan and Sawhney, 2011 describe how to successfully manage such an innovation ecosystem). This example shows that open innovation models can enable companies in commodity industries to effectively reach their goals. Early open innovation studies typically focused on studying the usefulness of open innovation strategies in high-tech settings such as pharmaceuticals and the information technology sectors. Many researchers have, for instance, described how interfirm R&D networks in pharmaceutical biotechnology have accelerated innovation and knowledge development in this particular high-tech sector. In their 2006 publication, however, Chesbrough and Kardon Crowther establish that open innovation models are also effectively employed in more traditional sectors such as chemicals, consumer packaged goods, and medical devices, albeit at a relatively early stage of adoption.

While most studies of the employment of open innovation models and the circumstances under which companies can derive most value from these models have typically been positioned in the context of large companies, several interesting studies on small firms have come into existence in recent years. Vanhaverbeke (2012) in his research report demonstrates that small companies can benefit from open innovation initiatives just as much as large firms. Deteriorating market conditions have forced small companies to adapt or reinvent their businesses through new technologies or unique value propositions. Because smaller firms typically lack the required resources and technical capabilities to rely solely on closed innovation models, they must also apply open innovation strategies to compete. Those for which open innovation strategies have proved to be most useful have devised new business models to leverage value from knowledge and assets in other firms and/or have codeveloped new product or service offerings. In both high-tech and low-tech settings, small firms that are capable of managing a network of innovation partners that creates more value than any of the partners is capable of generating on its own can seize new opportunities to become highly profitable. A good example of a small firm that is capable of successfully managing such a network of partners is DNA Interactif Fashion. The company's business model transforms shopping into a new virtual experience that optimizes the purchase process for customers. The process starts with a body scan of customers and then enables them to see themselves on large screens as virtual, three-dimensional models dressed in clothes from various collections. This innovation replaces the sometimes awkward process of fitting clothes in stores. For developing the innovation, DNA Interactif Fashion teamed up with a dense network of partners to develop the displays and 3D scanning device required for virtual shopping.

Other open innovation researchers have studied particular contingencies within firms that determine the value companies can derive from applying open innovation models. Chesbrough and Schwartz (2007), for example, distinguish between three types of R&D capabilities, that is, core capabilities, critical capabilities, and contextual competences in research. Core competences form the basis of a firm's competitive advantage. Critical capabilities are not crucial for the value-adding potential of the firm but represent the underpinning of the commercial success of a particular product or service offering in end markets. Contextual skills are important to develop a particular product or service but do not offer the company the possibility to distinguish itself vis-à-vis competitors. Depending on what type of R&D capability a company aims to develop, open innovation may or may not represent the most adequate strategic option. Particularly in the case that a company is in need of a set of critical capabilities is when open innovation represents a viable option where the firm can jointly develop these capabilities with an external partner or a set of partners. On the basis of their survey research of early adopters in low-tech industries, Chesbrough and Kardon Crowther (2006)

point out that implementing an open innovation strategy is particularly valuable to companies that have set up requisite internal conditions for optimally benefiting from open innovation. These necessary conditions include among others: the strategic prioritization of open innovation projects both in terms of top management support and prolonged funding; the appointment of an open innovation champion who facilitates the project from the very start until the ultimate incorporation of innovations into the business; and the installment of appropriate open innovation processes, metrics, and incentives.

Research Themes

While the past decade has resulted in a fairly large body of research on open innovation that *inter alia* shows under which circumstances open innovation strategies can be effectively applied, several important research themes remain un(der) explored and serve as fertile research grounds for the next 10 years (Chesbrough, Vanhaverbeke, and West, 2014). Specifically, researchers need to map the specifics of low-tech industries that may create a different set of opportunities for using open innovation models than in high-tech settings. Furthermore, existing research shows that some of the lessons we learned from the use of open innovation in large firms do not apply for small firms. More research into the particular needs of small firms is therefore necessary. Finally, some companies seem to benefit more from open innovation models than others. Open innovation researchers need to pay significant attention to explaining these differences in success when companies apply open innovation models. Particularly, they need to pinpoint how open innovation is effectively managed and organized within companies.

See also *innovation models*; *sources of innovation*; *types of innovation*

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