ADVANCING A TYPOLOGY OF OPEN INNOVATION

Abstract

Interest in the concept of open innovation (OI) has increased during recent years; yet, this line of inquiry remains limited due to the lack of a more comprehensive conceptual framework. As a first step toward a unifying framework, we provide a critical review of previous research on the conceptualization, antecedents, and consequences of OI. We then offer a typology describing four OI strategies: (i) innovation seeker, (ii) innovation provider, (iii) intermediary, and (iv) open innovator, which emerge through unique combinations of sources of innovation, firm attributes, mechanisms of inter-organizational exchange, and produce varying outcomes. Finally, we discuss our typology's implications for theory and practice, and advance some potential research avenues.

Key Words: Open Innovation, Innovation Broker, Innovation Sourcing, Technological Change, Typology

Introduction

Firms have adopted different systems of innovation in the face of increased global competition. Traditionally, firms have enacted a "closed" approach, leveraging internal research and design capabilities to innovate. Recently, firms have adopted a more "open" approach to innovation through the exchange of knowledge, resources, or capabilities with external partners. Firms who embrace open innovation are able to scale down internal research and development resources, while expanding the scope of their innovation activities. Examples abound of firms shifting towards open innovation (OI); for example, Merck (Chesbrough, 2003c) has leveraged OI to achieve product innovations while reducing research and design staff. In addition, Procter & Gamble (Dodgson, Gann and Salter, 2006) and Xerox (Chesbrough 2003b) have successfully adopted various forms of OI to increase revenues by incorporating innovation from external networks and selling existing intellectual property, respectively.

The promise of open innovation systems has motivated scholars from a diverse set of disciplines – finance (Higgins and Rodriguez, 2006), economics (Cassiman and Veugelers, 2006), marketing (Di Maria and Finotto, 2008), and strategic management (Almirall and Casadeus-Masanell, 2010), just to name a few – to investigate this burgeoning phenomenon. As a consequence, researchers have applied diverse social and organizational theories to investigate the antecedents and consequences of OI; for example, researchers have used network theory to examine the effects of network centrality (Dahlander and Wallin, 2006) and uncertainty (Terwiesch and Xu, 2008), transaction cost economics to examine governance structure (van de Vrande, Lemmens and Vanhaverbeke, 2006), and learning theory to examine absorptive capacity (Gassmann

and Enkel, 2004; Laursen and Salter, 2006) and search capability (Kirschbaum 2005). These diverse views have fostered conceptualizations that emphasize different aspects of this phenomenon. In general, conceptualizations of OI tend to incorporate notions of: (i) inflows and outflows of knowledge, (ii) the permeability of firm boundaries, (iii) firm's deliberate adoption practices, and (iv) factors that influence the success of OI adoption. However, research models vary in how they apply OI concepts, including involved parties, type of transaction, and commercial outcomes. Our review suggests that, despite the early momentum, greater progress in OI is hampered by disparate definitions of constructs, conceptualizations, and findings across previous studies and the lack of a unifying framework that integrates this body of research.

Towards a theory of open innovation, we develop a typology of OI strategies that integrates existing research. In so doing we contribute to the body of OI literature in several important ways (see Figure 1). First, we provide a thorough review of the literature that examines OI at the strategic level. Through our review, we develop a theoretically grounded definition of open innovation, summarize the salient aspects already investigated, and provide a holistic view of the extant, multi-disciplinary research as it relates to two OI dependent variables: adoption and performance. In addition, we develop a typology detailing four OI strategies – *seeker*, *provider*, *open innovator*, and *intermediary* strategies – that emerge through unique combinations of innovation sources, firm attributes, mechanisms of inter-organizational exchange, and produce varying outcomes. These strategies represent four distinct pathways for firms to appropriate their innovation capabilities. Lastly, our typology acts as a catalyst for researchers to investigate several avenues for future OI research. In particular, we identify several areas

of conceptual development through the integration of complementary research; richer theory will in turn motivate large-scale empirical investigation.

FIGURE 1 HERE

The remainder of this paper is organized as follows. In the next section, we review the OI literature, including theories which have influenced OI research and the development of existing OI definitions. Further, we develop a nomological network that synthesizes extant OI adoption and OI performance research. Next, we develop a typology of open innovation strategies. We conclude our study with a brief discussion of the limitations of our study and present a comprehensive agenda for future OI research.

Literature Review

Scope and Structure of the Review

Given its importance in understanding organizational evolution and adaptation, innovation is one of the most researched areas in organizational studies attracting a diverse set of disciplines – economics, organization theory, strategic management, sociology, just to name a few. During the past century, researchers have made significant progress developing and testing a rich body of theory. Conducting a comprehensive review of the organizational innovation literature would be a major undertaking, beyond the scope of this paper. Thus, although drawing extensively from established theories of innovation, we confine our review to the developing body of literature investigating one form of innovation: open innovation.

We employed a two-stage approach to identify a comprehensive set of scholarly publications that form the basis of our review. Initially, we performed a search of key

terms in the EBSCO, JSTOR and Science Direct databases, and in the Google Scholar search engine. The search was performed using the keys "open innovation", "innovation outsourcing", "innovation providers" and "innovation networks". Drawing from the sample of studies from the first stage, we subsequently expanded our search using forward and backward citation indices. We continued our search process until we identified an exhaustive set of studies. We added three additional boundary criteria for this review. First, we excluded studies that do not explicitly reference *open innovation*; thus, our review includes only articles published after 2003, when the term was coined (Chesbrough, 2003a; 2003b, 2003c). Second, because the study's primary focus is to better understand the implications of OI adoption on a firm's business model or within its value chain (Chesbrough, 2006; Chesbrough, 2007; Christensen, Olesen, and Kjær 2005), we required that the included articles consider *open innovation* at a strategic level. Finally, although *OI* has gained significant traction in the popular press and with consulting firms, we only included papers published in peer-reviewed scholarly journals.

Table 1 lists the resulting set of 43 studies that comprise our literature review and, for each study, presents the following key attributes: (i) unit of analysis, (ii) exchange partners, (iii) sample frame, (iv) theoretical lens, (v) method, (vi) constructs, (vii) discipline, (viii) locus of innovation, (ix) research focus, and (x) research findings. Within this table, *unit of analysis* is the level at which the analysis is conducted (firm, dyad, network, project). The *exchange partners'* field refers to the type of the organizations engaged in the technology transaction and nature of the inter-organizational tie. Whereas exchange partners include firms (F), communities (C), user communities (UC), and universities (U), the nature of the inter-organizational relationship may be

vertical (V) or horizontal (H). *Sample frame* indicates whether the study investigated OI within a specific industry or across industries, and the *theoretical lens* refers to the specific theories used to examine the OI phenomenon. The *method field* indicates whether the study is theoretical or empirical; the latter case describes the employed methodology (i.e., qualitative or quantitative). *Constructs* refer to the building blocks of the relationships under study; these may be actual constructs, as operationalized within empirical studies, or implicit concepts derived from the relationships and conclusions of the study. *Discipline* indicates the main reference field and stream of literature to which the research belongs. The *locus of innovation* field describes the innovation source and specifies whether knowledge that originates inside a firm (internal) or acquired from external sources (external). Finally, the *research focus* and *findings* fields synthesize the central idea and primary conclusions of the study, respectively.

TABLE 1 HERE

To complement Table 1, we present two figures (Figure 2 and Figure 3), which summarize the theoretical relationships between the constructs identified in our review. Figure 2 summarizes conceptual developments and empirical findings related to OI adoption, and Figure 3 synthesizes prior OI research related to innovation performance. We link the table and figures using a consistent numbering scheme such that the numbers in Figures 2 and 3 correspond with studies listed within Table 1; we associate specific studies with each relationship presented in the figures. This approach allows readers to gain insight into the studies that address specific aspects of OI and also facilitates an assessment of the breadth and depth of extant OI research. Whenever possible, we

denote the nature of the relationship using a plus or minus sign. We omit the direction for studies in which the direction of the relationship between constructs is not articulated.

Defining Open Innovation

Extant research on OI employs a variety of theoretical approaches which have fostered the (i) consideration of a wide array of disparate principles and constructs (see Figures 2 and 3), and (ii) development of a variety of definitions of open innovation (see Table 2). Despite this diversity in conceptualizations across disparate studies, we identify several themes that emerge from extant definitions of open innovation and prior research and suggest that these themes may serve as the basis for a unifying definition of OI.

TABLE 2 HERE

A significant body of OI research draws explicitly or tacitly from organizational learning theory (March, 1991) and the notion of absorptive capacity (Cohen and Levinthal, 1990; Zahra and George, 2002). For example, Gassmann and Enkel (2004) identify three archetypes of knowledge flows in open innovation environments, (i) outside-in flows, (ii) inside-out flows, and (iii) bi-directional flows, and suggest that these knowledge flows are critical to firms' innovation processes. Similarly, Lichtenthaler (2008) empirically derives strategic approaches to OI using two criteria: extent of external technology acquisition and exploitation. Related studies consider how absorptive capacity influence firms' existing innovation processes (Cohen and Levinthal, 1990). In particular, researchers have considered the linkage between absorptive capacity and innovation acquisition (Christensen et al., 2005; Dittrich et al. 2007; Dodgson et al., 2006; Lokshin, Belderbos, and Carree 2008). These studies, in conjunction with the

definitions of OI, which explicitly cite "inflows and outflows of knowledge" Chesbrough et al., 2006) and "knowledge flow" (Gassman and Enkel, 2004), suggest that inflows and outflows of knowledge are particularly germane to a definition of open innovation.

Consistent with organizational learning theory, several studies cite the permeability of organizational and innovation process boundaries as a salient aspect of OI. Traditional views of R&D, for example the *development tunnel* (Hayes, Wheelwright, and Clark, 1988), hold that successful innovation requires control; this assumption is the cornerstone of what Chesbrough (2003b) refers to as the old paradigm of closed innovation. Within this paradigm, competitive advantage stems from the possession of unique knowledge, which the firm appropriates via exclusive intellectual property. Firms purposely limit and tightly control flows of information across organizational boundaries; boundary spanning activity is accompanied with exhaustive contracting or buffeted by long standing partner relations (Teece, 2000). In contrast, Chesbrough's (2003d) conceptualization of the innovation funnel decouples the loci of innovation, new product development, and commercialization, holding that firms enhance innovation performance through acquisition and commercialization of innovation within a broader, external innovation network. Dittrich and Duysters (2007) extend this notion of permeability by suggesting that the boundaries of the innovation creation process, rather than the organization, are critical to OI success. Thus, organizational permeability is a pre-condition for enacting and exploiting an OI business model (Chesbrough, 2006). Organizational permeability creates issues of appropriation; drawing upon the concept of appropriability regime (Teece, 1986), researchers have demonstrated how firms benefit from OI by deploying complimentary assets, and through the effective use of contracting

and intellectual property management (Dahlander and Wallin, 2006; West and Gallagher, 2006).

Although researchers posit that OI has implications at all levels of the firm, the main thrust of the research considers its strategic impact. For example, extant OI research has studied how (i) top-down managerial initiatives and business growth goals (Chesbrough and Crowther, 2006), (ii) research awards and business performance metrics (Chesbrough, 2003e), (iii) corporate culture (West and Gallagher, 2006), and (iv) boundary-spanning leaders (Flemong and Waguespack, 2007) affect the transfer of innovation across organizational boundaries. Empirically, research findings indicate that innovation search capabilities significantly influence innovation performance (Laursen and Salter, 2006). Similarly, case-based research suggests that a firm's ability to manage strategic alliances, spin-offs, and license agreements is critical to the commercialization of innovation outside of the firm's traditional channels (Chesbrough, 2003b).

Consistent with our review, we suggest that three themes emerge from extant OI research: (i) open innovation requires inflows and/or outflows of knowledge and innovation, (ii) an organization must have permeable boundaries that allow knowledge and innovation flows into and out of an organization, and (iii) open innovation is a "firm-level" strategy that enables organizations to appropriate value. Consistent with these emergent themes, we define an open innovation strategy as a *business model that is designed to purposefully allow and facilitate knowledge and technology transfers across organizational boundaries.*

Nomological Network of Open Innovation

We organize our discussion of the literature into sections in accordance with the two primary dependent variables: OI adoption and innovation performance. As suggested in Figure 2, several factors affect a firm's decision to adopt OI practices, and subsequently, the magnitude of it usage. Contextual factors, such as the characteristics of the environment (Perkmann and Walsh, 2007; Van de Vrande et al, 2006), the firm (Henkel, 2006; Higgins and Rodriguez, 2006), or the technology (Dodgson et al., 2006; Piller and Walcher, 2006), are important preconditions to OI adoption. Figure 3 indicates that several factors, in additional to OI adoption, affect innovation performance, including industry structure (Henkel 2006), inter-firm relational attributes (Dahlander et al. 2008), organizational activities (Laursen and Salter, 2006), and user and user community involvement (Kaiser and Muller-Seitz 2008). The following two sections proceed in accordance with Figures 2 and 3.

Open Innovation Adoption

Firms face the choice of whether to and the degree to which they adopt OI strategies. Research has identified three broad categories of determinants of OI adoption: firm characteristics, technology considerations, and external environmental conditions (Gassmann and Enkel, 2004; Perkmann and Walsh, 2007). Each affects "organizational fit" – the extent to which critical firm-level characteristics (i.e., systems, process, structures, and incentives) are aligned with external environmental conditions.

Firm Characteristics: Firm characteristics play a prominent role in determining OI adoption. For many firms, changes to organizational structure and existing processes must take place in order to facilitate OI adoption (Dodgson et al., 2006; Witzeman et al.,

2006). Antiquated organizational structures and systems supporting closed innovation strategies are oriented towards knowledge management and storage; whereas, OI strategies require networking and knowledge exchange capabilities (Dodgson et al., 2006). Indeed, the reshaping of practices and technologies goes beyond the adoption of specific practices and instead requires that the firm reshape its entire business model. Firm size also plays a role; however, to date findings are equivocal. Lichtenthaler (2008) found that larger firms are more likely to leverage OI strategies as a means to ward off competitive pressure from smaller and more entrepreneurial firms. In contrast, other studies find that smaller firms are more likely to engage in OI practices (Henkel, 2006; Van der Meer, 2007). Because OI is an emerging phenomenon, the choice of research settings and methods may explain these conflicting findings. Additionally, the degree of a firm's product variety may help explain OI adoption; the more varied a firm's product offerings the less likely the firm is to rely completely on internal innovation (Lichtenthaler, 2008). Another important firm-level factor relates to experience with the focal technology. As with size, the findings are not clear, especially when industry considerations are taken into effect. Henkel (2006) found that experience with embedding Linux into a product lowers the need to exchange knowledge with the community; however, Higgins and Rodriguez (2006) found that the familiarity with another firm's technology increases the likelihood that mergers may be used to acquire such technology.

Technology Considerations: In addition to firm characteristics, OI research suggests that the type of technology employed by the firm is also likely to impact the adoption of an OI strategy. Modular technologies are better suited for OI methods; whereas, technologies with complex interfaces make OI adoption more difficult

(Gassmann and Enkel, 2004). Also firms will try to protect core technologies by making them inaccessible to external partners, limiting open innovation exchanges (Dodgson et al., 2006). Lastly, research has yet to explore the relationship between technology portfolio management and OI adoption. In a broader perspective, prior to adopting an OI strategy, firms must understand the *appropriability regime* in which they will transact such that they can effectively minimize risks of replication or emulation from potential imitators and capture value through innovation (Hurmelinna et al., 2007).

External Environmental Conditions: The third broad consideration regarding OI adoption relates to external environmental conditions. Consistent with Chesbrough's (2003b) concept of "erosion factors", research has examined how environmental changes have undermined the functionality of the closed model. Industry characteristics such as industry speed (i.e. length of product life cycles, frequency of changes in industry structure, and development of new markets) and high- or low-tech nature are likely antecedents of the decision to adopt OI strategies (Chesbrough and Crowther, 2006). Although, OI is generally associated most closely with high-tech industries, research has begun to examine OI in more traditional sectors. The prominence of OI in high tech industries is explained by their higher *clockspeed* (Eisenhardt and Brown, 1998; Fine, 1998); high tech industries are more research-intensive, which makes firms more active searchers for innovation. Research posits that technological uncertainty, often associated with industries with fast cycles and high *clockspeed*, increases the likelihood that firms employ a more an open approach to innovation (Van de Vrande et al., 2006).

Open innovation performance

A complementary body of research investigates the performance affects of OI adoption. In line with mainstream innovation research, scholars have conceptualized OI performance in a variety of ways depending upon the unit of analysis and specific OI processes under investigation. In general, researchers have broadly considered innovation performance in terms of: (i) incremental and radical innovation (Chesbrough and Crowther 2006; Laursen and Salter 2006; Lettl, Herstatt, and Gemuuenden 2006), (ii) commercialization and value appropriation (Chesbrough 2003b; Cooke 2005; Henkel 2006; Hurmelinna et al., 2007; Lichtenthaler and Ernst 2007; West and Gallagher, 2006), and (iii) labor productivity (Lokshin et al., 2008) and efficiency gains through innovation contests (Terwiesch and Xu 2008) and open source communities (Dahlander and Wallin 2006; Di Maria and Finotto 2008; Gruber and Henkel 2006; West and O'Mahony 2008). Consistent with extant research, we adopt a broad view of OI performance and, as suggested in Figure 3, consider many environmental, firm-specific, and technological factors that affect innovation performance.

Firms simultaneously seek incremental innovations to enhance existing product offerings, while discover radical solutions to open new, fertile markets. Researchers have examined the extent to which employing OI practices affect a firm's innovation portfolio (i.e. incremental vs. radical). Instituting OI practices denotes a firm's commitment to external search and a reliance upon its absorptive capacity efficacy. External search, in terms of breadth and depth, drives the number and type of strategic partners available for collaboration. Laursen and Salter (2005) found that breadth and depth of search have a curvi-linear (inverted U-shaped) affect on both incremental and radical innovation;

whereas the consideration of external sources (i.e., breadth) and intensive interaction within search channels (i.e., depth) initially contributes to innovation, bounded rationality and managerial attention limits suggest that over-search, i.e., excessive breadth and depth of search, is detrimental to innovation performance. Similarly, drawing on the notion of diminishing returns from extensive search, Cooke (2005) suggested that a robust regional network is critical to successful innovation. In a similar vein, Almirall and Casadesus (2010) employed an analytical approach to show how the number of available partners (i.e., "flexible partnership" regime) leads to more innovative end-products which embody greater customer value. Broadening innovation networks increases the likelihood of finding innovative solutions (Almirall and Casadesus-Masanell, 2010).

Complementary to external search, research suggests that a firm's absorptive capacity influences its ability to develop novel innovations. Absorptive capacity is predicated on shared understanding whereby common language, norms, and culture facilitate efficient transfers of knowledge across functional and firm boundaries Cohen, and Levinthal, 1990). A certain amount of internal knowledge is a prerequisite for effectively leveraging external sources (Lokshin et al., 2008). Laursen and Salter (2006) identify R&D intensity as a proxy for absorptive capacity and argue that investments in R&D enable firms to identify promising new innovations, and subsequently, improve the effectiveness of search activities. However, empirical findings are mixed; Laursen and Salter (2006) show that the interaction of R&D intensity and search negatively affects innovation search suggesting that firms view R&D intensity and search capabilities as substitutes rather than complements. Conversely, Lokshin and his colleagues (2008) find that greater R&D intensity allow firms to benefit most from increases in external R&D.

Users may also contribute to both radical and incremental innovation (Kaiser and Muller-Seitz, 2008). Lettl and colleagues (2006) found that user-innovators: (i) were motivated by severe problems that existing technologies did not address, (ii) were open to adopt new technologies that facilitated problem resolution, (iii) maintained access to inter-disciplinary tacit knowledge, and (iv) were intrinsically motivated to invent new solutions. Importantly, the same study finds that establishing linkages with innovative users enabled manufacturers to develop more innovative products while decreasing development times and costs. Related research suggests that company-provided toolkits, which facilitate access to customers' novel ideas, may effectively enhance innovation performance (Piller and Walcher 2006).

In addition to securing incremental versus radical solutions, OI performance may denote commercialization and value appropriation by the inventing firm. One factor influencing successful commercialization is the presence of complementarities – firm-specific resources valued by a partnering firm (Teece, 1986). The presence of complementary assets underlies the notion of technological or commercial "fit" or "match" between firms. In general, extant research suggests that the presence of complementarities allows firms to simultaneously exploit their own and their partners' core competencies. In Chesbrough's (2003b) investigation of Xerox spin-offs, he finds, contrary to expectations, complementarities (i.e. market and technical relatedness) have no effect on spin-off revenue growth. In related research, Christensen et al. (2005) and Cooke (2005) examine the inter-relationships amongst complementarities, product life cycle (PLC), and commercialization. Their qualitative analysis of the consumer electronics and biotechnology industries suggests that the effectiveness of specific

approaches to commercialization is conditioned by the PLC stage. In particular, Christensen et al. (2005) emphasize how, with embryonic product technologies, entrepreneurial firms sought strategic partnerships within high-end markets to carve out niche positions. However, as the product technology matured, the same firms sought ties with large, mass marketers of mainstream consumer electronics (Christensen et al. 2005).

In addition to complementarities and stage of the PLC, specific firm strategies and the governance of the partnerships affect commercialization and value appropriation. In contrast to closed innovation systems, where proprietary innovation is prominent, open innovation espouses the exploitation of both internal and external intellectual property (Hurmelinna et al, 2007). Accordingly, research suggests that a key aspect of an OI strategy is the protection of intellectual property. Strong intellectual property rights may protect first-mover advantage, facilitate product marketing, legitimize product technology, enhance a firm's image, and increase licensing opportunities (Hurmelinna et al. 2007, p. 136). However, tight protection may also be harmful: patents may reveal important innovation information to competitors and strong protection may impede knowledge transfers to partners, even when transfer is desirable. Related studies consider the effects of free revealing on appropriability. Henkel (2006) suggests that, under certain conditions, firms may reveal their innovations, without protection, in order to attain collaborative benefits from a wider community. Similarly, von Hippel and von Krogh (2006) propose that free revealing may generate excess profits when: (i) the innovation is similar to that of others, (ii) patents yield little revenue, and (iii) there are other non-monetary benefits to revealing the innovation (i.e., providing a public good).

A final OI performance outcome relates to gaining greater efficiencies within a firm's existing innovation system. Research has found that strategic partnerships have a positive effect on internal labor efficiencies; in OI settings, internal human capital can leverage external knowledge sources to create a stronger pipeline and bring these innovations to market more efficiently (Lokshin et al., 2008). Similarly, the development of close partnerships facilitates efficiencies within the new product development and commercialization processes (Chesbrough and Schwartz 2007). For example, Adobe's ability to establish partnerships with companies willing to support their platform ultimately determined its success (Chesbrough, 2003c). Firms may foster further efficiencies within their innovation process through the use of innovation contests. In this line of research, Terwiesch and Xu (2008), using analytical methods, found that firms may customize contest design and reward structures to optimize firms' expected profits across different types of innovation projects.

Research into open source software (OSS), (i.e., software without proprietary standards), indicates that firms may leverage software development communities to realize efficiencies within the software development process. Many global firms leverage OS software in their operations or are otherwise impacted by the spread of OS software (Henkel, 2006). Of importance is a firm's commitment to OSS online communities. Some firms actually employ programmers to participate in such communities, contribute to them and at the same time leverage its collective power (Dahlander and Wallin, 2006). Others directly sponsor the development and functioning of online communities to create a highly productive external locus of innovation, constantly improving their software at a rate that would not be achievable otherwise (West and O'Mahony, 2008). Further,

reliance on open source communities can significantly lower barriers to entry for start-up firms (Henkel, 2006) or lower development costs for the software components of high-tech products (Gruber and Henkel, 2006).

Concluding Remarks

Our synthesis of the OI literature includes a diverse set of issues investigated, constructs considered, and relationships. However, because most studies are exploratory in nature, relying upon small samples and primarily qualitative data, there remains significant opportunity for theory development and empirical investigation. Specifically, many of the constructs remain loosely or undefined, creating underspecified research models. In fact, the few comprehensive empirical studies have generally addressed a narrower set of questions concerning a limited set of practices or firm characteristics. In the next section, we present a comprehensive typology of OI strategies which will resolve these shortcomings in the OI literature.

A Typology of Open Innovation Strategies

Firms enact strategies, such as adopting new business models, to best position themselves with changes in their external environment. Consistent with research on strategic positioning and fit, (Ansari, Fiss, and Zajac, 2010; Siggelkow, 2002), firm adoption of and efficacy with OI is a function of (i) the flow of knowledge within an industry, (ii) an industry's product life-cycle, (iii) and what activities the firm currently performs within the industry's value chain. Firms' pursuit of OI is highly contextual; they employ various OI strategies, which evolve over time to meet changes in the external environmental. Given OI's contextual nature, firms will implement different strategies within an industry value chain, and will adopt these strategies at varying rates

and magnitudes (Almirall and Casadesus-Masanell, 2010). In building a framework to explain OI adoption and performance, we identify four distinctive strategies rooted in inter-firm exchange incorporated in the various transactions within an industry's value chain: *innovation seeker*, *innovation provider*, *intermediary,* and *open innovator*.

Within an industry's value chain, an *innovation seeker* is a firm searching for innovation solutions beyond its boundaries. Firms purchase technological solutions in markets for innovation to supplement or complement existing technology portfolios (Teece, 2000). Examples of *innovation seekers* firms abound; software companies participate in open source communities to gain access to critical innovative solutions. Similarly, pharmaceutical companies procure solutions by jointly developing technologies with strategic partners or by acquiring smaller companies which developed them (Dahlander and Wallin, 2006; Higgins and Rodriguez, 2006).

The counter party to an innovation seeker is an *innovation provider*; an organization[1] which sources innovation solutions. These organizations exploit their technological discoveries not to build commercial solutions, but rather to sell them as "products" to partners, who then reconfigure the technologies to package them as final products (Markman, Gianiodis, and Phan, 2009b). Such organizations leverage their technologies to gain access to complementary assets and better market access (Christensen et al., 2005). Further, partnering with larger firms provides access to innovation networks, which can play a fundamental role in the success of small-to-medium enterprises (SMEs).

[1] We designate *innovation providers* as organizations rather than firms to reflect the broad nature of research-focused entities including universities, government labs, non-profit think tanks, as well as private firms.

At the center of many innovation seeker and innovation provider exchanges is an *intermediary*; a firm which acts as an innovation broker (Terwiesch and Xu, 2008). The presence of intermediaries helps explain the explosive growth of OI by firms across various industries and economic regions; they act as catalysts for market exchange, and have influenced shifts in many firms away from the traditional closed model of innovation. Although some intermediary firms have gained strong market positions - Innocentive, Yet2.com, Nine Sigma, just to name a few - researchers have yet to fully incorporate the role of intermediaries in models of OI, or empirically examine their affect on OI adoption or performance (Almirall and Casadesus-Masanell, 2010).

The last distinct OI strategy, what we term *open innovator*, is actually an aggregation of the three other strategies. Firms, especially multi-unit conglomerates, can create synergies between internal and external knowledge creation activities, which facilitate occasions where they act as innovation seekers (i.e. to "fill" technology gaps), and innovation providers (i.e. to appropriate a non-core technology or divest a particular technological trajectory). These firms leverage their extensive partnerships to continuously exchange knowledge through boundary expanding activities (Teece, 2000). Table 3 summarizes important features of the four distinct OI strategies including: sources, attributes, mechanisms and outputs generated by each strategy. In the next section, we elaborate further on these important characteristics of each of the four strategies and their position within an OI network.

TABLE 3 HERE

Innovation Seeker

The innovation seeker strategy is a product of increased worker mobility and the diffusion of knowledge, which makes firm reliance solely upon internal R&D more difficult. In addition, research suggests that external environmental pressures, stemming from technological discontinuity or entrance of potential rivals, often trigger external search (Markman, Gianiodis, and Buchholtz, 2009a). Firm boundary spanning provides opportunities to expand the scope and range of ideas and potential innovative solutions, and also opens pathways to help stimulate internal R&D efforts. Many firms do not have the capacity needed to sustain competitive advantage and must rely upon external sources to fill critical capability and product gaps (Almirall and Casadesus-Masanell, 2010). OI seeking behavior has only intensified due to drastic changes in how firms manage their internal R&D, which has evolved into a center of coordination and assimilation of external knowledge (Chesbrough, 2003a). Research has indentified three principal mechanisms of exchange employed by OI seekers: leveraging user-based innovation, innovation outsourcing & strategic alliances, and integrating acquired firms (Cassiman and Veugelers, 2006; Higgins and Rodriguez, 2006). In general, OI seekers' external search starts with their existing network; they engage suppliers, strategic partners, and other affiliated network members, who are familiar with the focal firm's technology portfolio and innovation systems. Not surprisingly, OI adoption is generally enhanced when a firm has an expansive network of partner relationships.

Firms leverage users to help them enhance existing offerings or develop new product or service extensions. Although not entirely new, the employment of user-based innovation has experienced significant growth during the last decade (Von Hippel, 2005).

User forums such as online communities, clubs or blogs constitute new repositories of potential ideas that complement the traditional ways of interacting with customers (Dahlander, Frederiksen, and Rullani, 2008). Examples abound in which user communities or individual "lead' users have provided innovative solutions to improve current product offerings or new products under development (Lettl et al., 2006). For example, BMW provided customers user "toolkits" as a means to improve in-car online services, and Staples held a customer-focused competition that generated 8,300 submissions by actual customers (Von Hippel, 2005). Thus, firms should ignore user-based innovation at their peril; in the kayak industry, when incumbent firms passed on important user-based innovations, a select group of user-innovators started new ventures and successfully competed based upon these innovations (Hienerth, 2006).

OI seekers also tend to outsource, to a varying degree, their R&D processes. Substantial costs to maintain large R&D units compel firms to seek more efficient solutions. Outsourcing can take the form of an initial bid on the open market, considering all possible sources, or firms can restrict their search to existing partners and suppliers. While open bids may yield greater savings, appropriation considerations render this approach far from risk-free. In fact, research suggests that OI seekers are more likely to work with trusted partners, who are already knowledgeable about the firms' innovation systems (Cassiman and Veugelers, 2006). Despite the risks, outsourcing innovation outside the circle of existing relationships can yield novel solutions, which may not be readily available to competitors (Terwiesch and Xu, 2008). Three broad methods for outsourcing innovation exist: (1) direct contact with a specified innovation provider; (2) organize a contest or an auction in the open market; or (3) use an

intermediary to act as a filter between the innovation seeker and the provider (Saur-Amaral and Amaral, 2008). OI seekers most often use an intermediary because it is more efficient; outsourcing the search process enables them to focus their R&D efforts, enhancing their existing core competencies (Christensen, 2006; Teece, 2000).

In addition to outsourcing innovation seeking activities, firms engage in OI via strategic alliances and mergers & acquisitions. Strategic alliances afford firms the ability to tap into complementary technologies, capabilities, and assets, which can enhance both early value chain activities (i.e. R&D), as well as product and service offerings (Markman et al., 2009b). Many OI seekers employ strategic partnerships to gain access to intellectual property, which may hold up R&D efforts or product offerings of the focal firm. In addition, alliance partners provide asset complementarity yielding greater R&D efficiencies. Mergers and acquisitions broaden product and market scope, and enable firms to gain efficiencies from combined synergies. For example, in industries as varied as pharmaceutical, consumer products, and information technology, firms have procured external innovation through mergers and acquisitions (Higgins and Rodriguez, 2006; Oliveira, Roth, and Ponte, 2003). In the context of OI, the preferred method has been the acquisition of SMEs who have pioneered a promising technology but do not have sufficient resources to fully exploit their discoveries. In general, SMEs lack financial capital or adequate infrastructure to independently commercialize many of their discoveries, which makes selling to innovation seekers an efficient way to appropriate their inventions (Oliveira et al., 2003).

What distinguishes innovation seeking behavior is the efficacy of a firm's absorptive capacity; firms must be able to assimilate, deploy, and exploit externally

acquired innovation to be innovation seekers (Zahra and George, 2002). Firms that have drastically stripped down their internal R&D activities (except for rare cases, like CISCO) have greater difficulties in incorporating third party solutions into technology portfolios and product offerings. Also, the often cited "Not Invented Here" syndrome plays a substantial role in the internal resistance to external innovation solutions (Lichtenthaler and Ernst, 2006). The transition to an OI strategy, like any paradigm change, requires a substantial change in a firm's culture (Dodgson et al., 2006). In order to play the OI game in a substantive way, the company – even a company only interested in acquiring external technologies – has to develop a set of skills and practices that rotate around the absorption and integration of external knowledge.

Innovation Provider

Innovation providers, the second OI strategy, evolved from heavy investment in R&D during much of the 20th century; these firms have a wellspring of innovation solutions waiting for a champion or partner to commercialize them. OI providers are trying to tap into heretofore underused pathways to appropriate their R&D (Markman et al., 2009b). OI providers broadly fall under two types of organizations: large, global firms, and SMEs, including non-profit organizations. The first group consists of large (i.e., Fortune 500-level), global firms such as Xerox and IBM, who have extensive IP portfolios which contain underutilized technologies. These IP portfolios are the outcome of extensive R&D investment; yet, for a variety of reasons, these investments yielded technologies that the firms were unable to commercialize independently. These firms now view their large IP portfolios as potential cash cows, and they seek partners to either sell the IP directly or to jointly develop commercially viable products.

Large firms are susceptible to significant changes to strategic focus, where R&D projects are either temporarily shut down or completely abandoned. Yet, these projects often yield viable technologies, which may only need complementary assets from strategic partners to produce marketable products. The deployment of venture financing shapes innovation providers, especially global firms. Venturing consists of financing new enterprises based on technology generated by joint R&D efforts. The firm has a financial stake in the new venture; the founders of the new company usually come from the parent company; and often, the technical staff and the board of directors are composed by former or current members of the parent (Bray and Lee, 2000; Chesbrough, 2003b; Van de Vrande et al., 2006). Hence, global firms have extensively employed licensing strategies, launched "spin-off" companies and financed SMEs to tap into underutilized revenue sources derived from their large IP portfolios.

The second group includes SMEs with strong technological positions in niche markets; such providers seek to fully exploit their IP across multiple domains. As noted, SMEs lack adequate financial capital and infrastructure assets to launch extensive product lines, and must rely external financing to broaden their business scope. They employ OI provider behavior by transacting with intra-industry and/or inter-industry partners willing to exploit their IP. Unlike global firms, SMEs leverage venture capital to conduct boundary spanning via strategic alliances; it is a systematic way of bringing technologies to market (Chesbrough, 2003b). The second group also consists of non-for-profit organizations with broad research missions. For example, research universities are a major source of technological discoveries because of their extensive research infrastructure – faculty scientists, labs, graduate students, etc. – enabling them to

perform research exploration activities. However, like SMEs, they lack the requisite infrastructure – organizational structure, mission, culture, etc. – to commercialize their discoveries (Markman, 2009b; Perkmann and Walsh, 2007). Like global firms, which possess large IP portfolios, universities have accumulated an extensive cache of technologies and need external partners to commercialize them[2].

Regardless of the type of provider, one thing is certain; an extensive IP portfolio is a necessary condition for implementing an innovation provider strategy. The search for external paths to market arises from the realization that most of IP held is under-deployed. Organizations realize that without external partners there is little chance of these technologies reaching the market because their current business models or strategic focus do not support commercialization (Christensen et al., 2005). For example, research found that in global firms such as Procter & Gamble and Dow Chemicals more than 80% of their patents went unused (Chesbrough et al., 2006). Enacting an innovation provider strategy in response to this business opportunity requires formal organizational processes characterized by: adaptive organizational structure, active management (i.e. systematic review) of IP portfolios, and dedicated OI function (Chesbrough 2006a). Out-licensing is the most common outcome of OI provider activity because it provides two primary benefits: residual income from an underutilized asset, and low risk that the strategic partner will encroach the licensing firm's core technology domains. In addition, the OI provider generally has limited involvement with the strategic partners and, thus limited control on the technological trajectory of the licensed technology.

[2] Since the passage of the Bayh-Dole Act of 1980 granting American universities the right to exploit inventions derived from federally funded research, there has been explosive growth in technology transfer activity. Other countries (most notably within the EU), have also followed this public policy program.

Intermediary

The third OI strategy, *intermediary*, is a product of the first two OI strategies; OI seekers and providers often need a third party to help broker the exchange. Intermediaries, or innovation brokers, facilitate search and make markets for innovation much like investment banks make markets for trading other commodities. Intermediaries are specialist firms creating a point of contact between OI seekers and providers (Teece, 2000). In a recent review of innovation brokerage, Winch and Courtney (2007) defined an innovation broker as "an organization acting as a member of a network of actors in an industrial sector that is focused neither on the generation nor the implementation of innovations, but on enabling other organizations to innovate" (p. 751). Innovation brokers have a unique set of capabilities consisting of human capital with (a) an understanding of basic and applied science; (b) marketing expertise to gauge commercial potential, able to discriminate which innovations are potentially useful to solve specific problems, coupled with the ability to link problems and solutions in different industries, and (c) network contacts, who occupy an adequate position in the network, and be able to find complementarities across multiple partners.

There is an extensive literature which has explored the role of brokers in formal innovation systems and networks, especially diffusion of cutting-edge technology (Burt, 2004; Gould and Fernandez, 1989). By filling structural holes in the network, brokers are able to connect nodes that were heretofore not engaged (Burt, 2004). Innovation brokers, much like most human capital-intensive services (e.g., consulting), take two organizational forms: generalists and specialists. Generalists build expertise in multiple industries, adopting cradle-to-grave service in facilitating the technology exchange. For

example, Ninesigma advises SMEs on how best to protect their IP and identify potential partners most likely to purchase their innovation. In contrast, specialist firms focus on one particular industry, or a few exclusive technology domains. For example, Pharmalicensing works exclusively in the life sciences industries. The literature has recognized the difference in organizational forms and formal strategies arising from the span of the brokerage activity. Organizations that connect entities in the same industries are said to perform within-group brokerage (Winch and Courtney, 2007), while organizations that links entities in different industries, markets or sectors are said to engage in between-groups brokerage (Gould and Fernandez, 1989). In the latter case, the ability to identify breakthrough solutions across varying contexts is most important.

Although research on innovation brokers is rapidly growing, most research has been conducted at the network level, and their impact on strategies of OI seekers and providers has not yet been systematically examined. Intuitively, it is likely that intermediaries influence the efficacy of OI performance; both OI seekers and providers can enhance their positions by employing specialist innovation intermediaries. Organizational theory supports this notion; OI intermediaries are liken to boundary spanning knowledge brokers in organizational research (Pewlowski and Ourso, 2004). The social networks literature demonstrates how brokers create connections between different communities without being a full member of them (Brown and Duguid, 1991). The same theoretical basis can be applied to innovation brokers, who boundary span established communities of practice, create weak ties in multiple communities, and translate knowledge coming from different environment (Pawlowski and Ourso, 2004).

Open Innovator

An *open innovator* is a product of increased scaling of OI practices; these firms behave both as OI seekers and providers. They possess both access to technology (i.e. IP portfolios), and the requisite capabilities (i.e. absorptive capacity), and gaps in their innovation systems, which make them buyers and sellers of innovation. Open innovators are usually large, global firms, which have dedicated R&D divisions, while at the same time looking for external technologies to incorporate. Xerox, the focus of much of Chesbrough's first book, is a good example of a firm employing this strategy (Chesbrough, 2003a). Given that such companies are often big corporation, they tend to finance spin-offs in order to bring some of their innovations to market, while relying on mergers and acquisitions to procure interesting innovations (Chesbrough, 2003b).

Conclusions and Future Perspectives

Our review of extant literature posits that firms may enhance their innovation capabilities and outcomes through the effective management of inflows and outflows of knowledge and innovation. Critical to this view is (i) the logical separation of the locus of idea generation, new product development, and commercialization within an industry's value chain and (ii) the recognition that each of these stages of innovation may occur within or outside a firm's boundaries. In aggregate, we find that previous research considers many determinants of OI adoption and innovation performance; however, our review suggests that construct definitions, the operationalization of constructs, and large-scale empirical study of relationships amongst constructs are in the formative stages of development. Further, because OI research is at the formative stage of development, studies tend to be theory building, employing interviews and case-based methodologies,

rather than theory testing in nature. As such, the OI stream of research represents a rich area for future scholarly investigation.

The empirical investigation of OI strategies represents a promising avenue for future research. Building on a tradition of OI studies that espouse the importance of inflows and outflows of knowledge and innovation acquisition and exploitation, we develop a typology that is comprised of four OI strategies. In contrast to previous research, however, we explicitly recognize the intermediary strategy in addition to innovation seeker and providers. While our typology draws from previous research, we suggest that new insights may be gained by operationalizing these strategies and studying the linkages amongst these strategies, the requisite capabilities that support these strategies, and the context (i.e. rate, magnitude, etc.) in which firms adopt each strategy. Additionally, including the intermediary function in OI models may surface how: (i) the linkage between search and innovation affects performance (Laursen and Salter, 2006), (ii) the complementary relationship between internal R&D and absorptive capacity affects OI adoption and performance (Cassiman and Veugelers, 2006), and (iii) the various costs associated with each OI strategy - innovation seeker, innovation provider, and open innovators – affect firm performance (Almirall and Casadesus-Masanell, 2010). Similarly, the rise of intermediaries may significantly impact the horizontal and vertical structure of extant supply chains.

Firms adopt OI practices in order to develop new or enhance existing streams of revenues. However, extant literature suggests that firms may also leverage OI mechanisms to influence the development of standards (Fleming and Waguespack, 2007), spin-off new ventures that support the former parent's primary business (Chesbrough,

2003b), and distribute the risks associated with costly investment in new product development (Christensen et al., 2005). Further, extant literature provides little guidance into the substitutability of various mechanisms to achieve given strategic goals. For example, our review indicates many innovation sources (e.g., universities, research institutions, customers, suppliers, and lead-users) use various mechanisms to transfer technologies (e.g., outsourcing, acquisition, strategic alliance, licensing, acquisitions, and auctions); yet, it remains unclear if or when (i.e., level of product-market competition, complexity of the technology, level of market or technical uncertainty) specific source-mechanism combinations yield superior innovation performance.

Finally, we acknowledge that we have bounded our review to include only those studies of OI that adopt a strategic view of this phenomenon. While the OI literature is in its formative stages of development, we note that several mature streams of research lie adjacent to this field. For example, studies of OI have drawn from the social network (Fleming and Waguespack, 2007), entrepreneurship (Chesbrough, 2003b), exploration/exploitation (Dittrich and Duysters, 2007), and absorptive capacity (Christensen et al., 2005) streams of literature. However, other overlapping mature streams of research, such as studies of supplier involvement in new product development, have not made substantive inroads into OI discourse. Consistent with the principals of OI, future researchers should continue to integrate insights from related streams of literature into their empirical studies. Only when OI research fully incorporates these research streams will it achieve a theory which fully explains how firms develop, acquire, assimilate, and exploit existing and potential innovation portfolios.

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Figure 1. Overview of Research Contributions

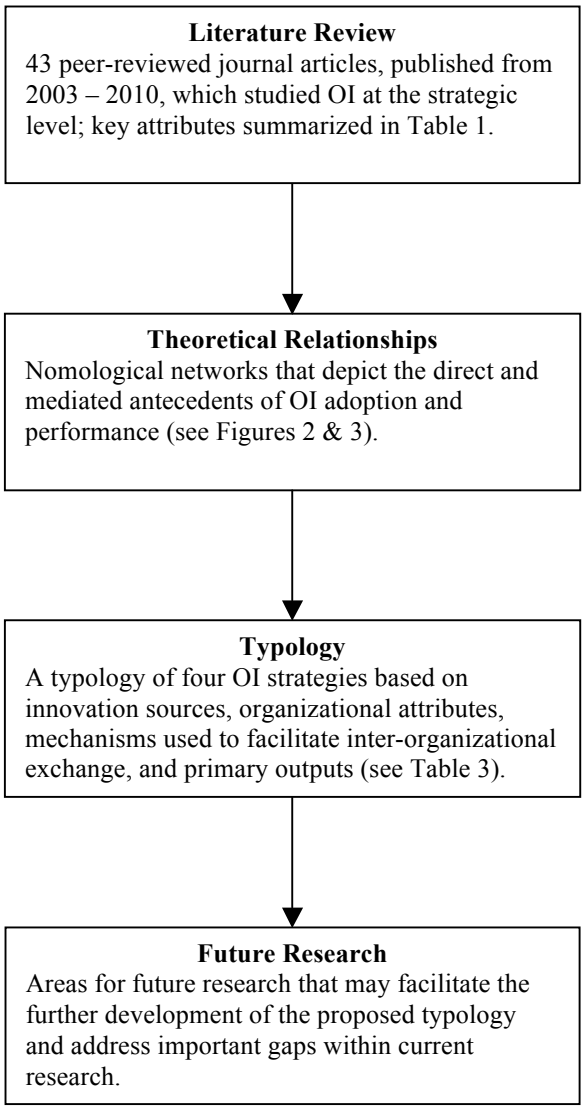

Figure 2. Antecedents of OI Adoption

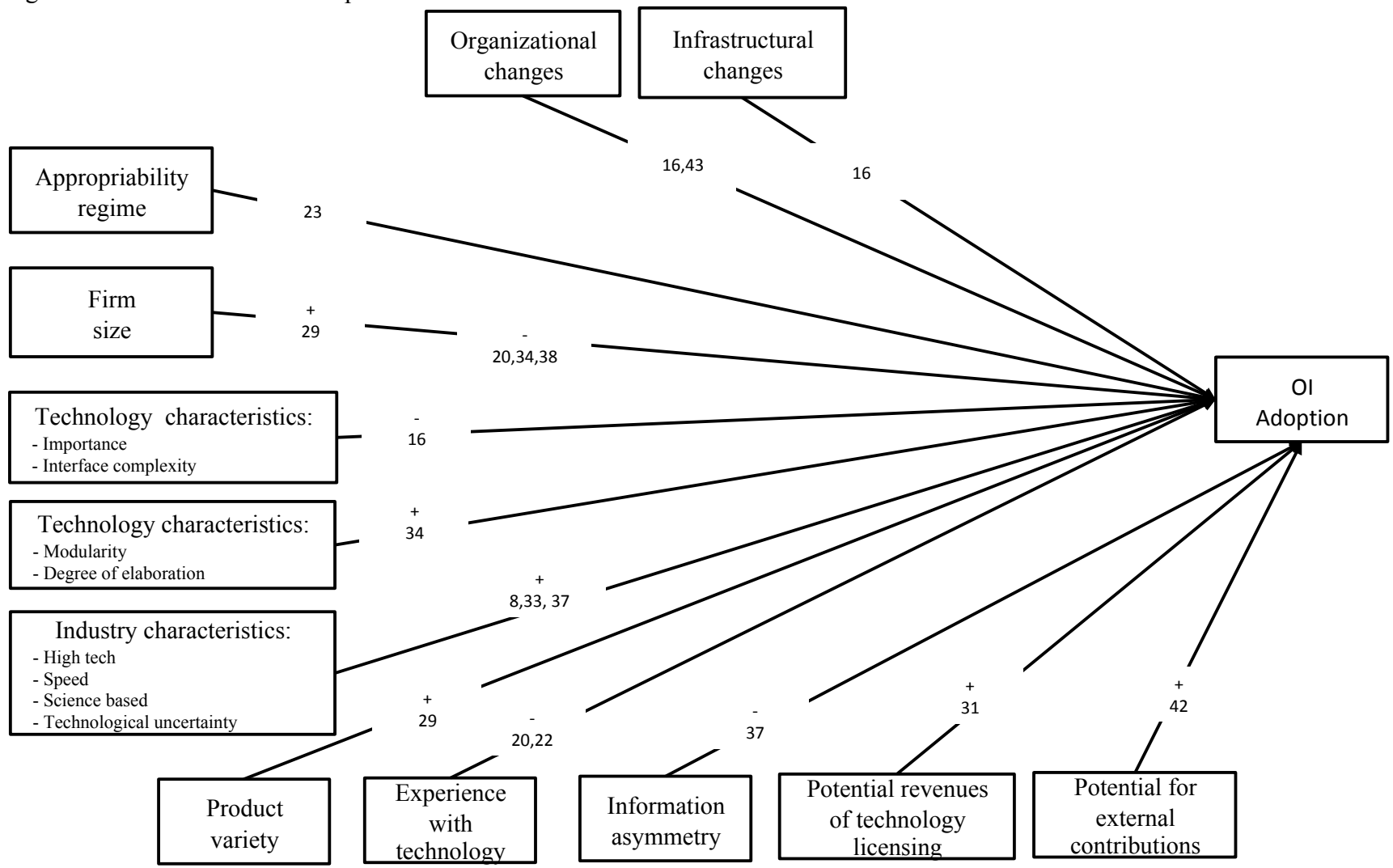

Figure 3. Antecedents of innovation performance

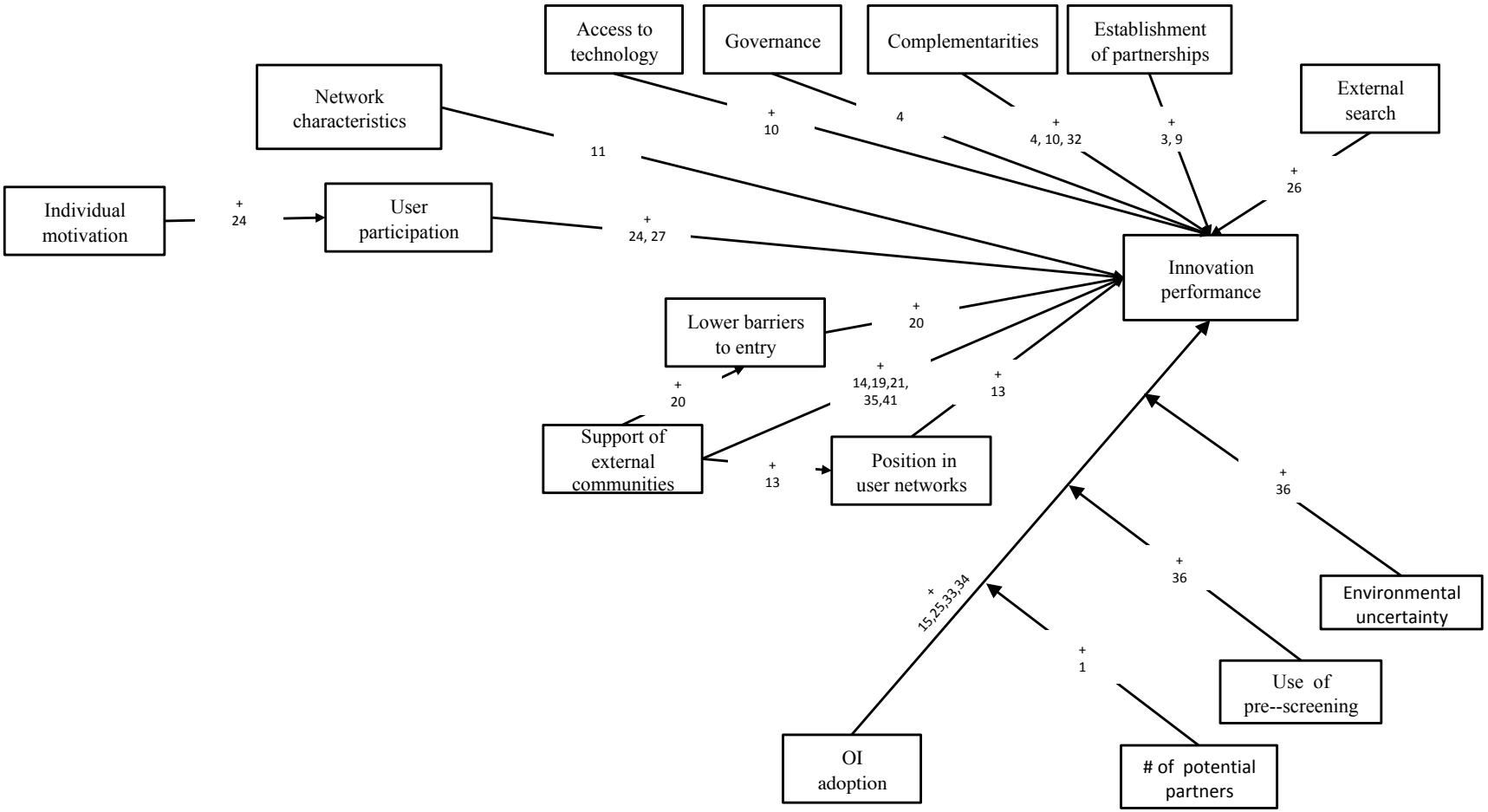

Table 1. Literature Review

No.	Author (year)	UoA[3]	Exchange Partners[4]	Sample Frame	Theoretical Lens	Method[5]	Constructs	Discipline	Locus of innovation	Research Focus	Findings
1	Almirall and Casadeus-Masanell (2009)	N/C	F-F (H)	-	Evolutionary (NK landscapes)	A	Innovation Strategy Partnership type (fixed/flexible) Complexity	Strategy	Both	Investigate the benefits and costs of OI in different situations	When changing partner is not an option, open innovation leads to better performance if complexity is low When it is possible to change partners, as the partner opportunity set expands so does the minimum level of complexity, and open innovation leads to better performance
2	Chesbrough, (2003a)	P	-	Across	Innovation	E(C)	-	Strategy	Both	Show examples of companies that launched OI experiments	Many different approaches to OI are possible. The examined experiments were highly successful.
3	Chesbrough (2003b)	F	F-F (V)		Innovation	E(C)	Partnership	Strategy	Both	Illustrate how companies like Adobe are successful by establishing a standard	Adobe was successful because it leveraged partnerships to create a platform Traditional measures of innovation performance (such as number of patents) do not capture the dynamics of these innovation processes
4	Chesbrough (2003c)	F	F-F (H)	Within	Innovation	E(Qt)	Spin-off performance Complementarities (Market and Technical) Governance	Strategy	Internal	Identify the drivers of spin-off success in relation to governance choice	The presence of people from Xerox in the board of the spin-off is more important for the performance than the equity structure
5	Chesbrough (2003d)	F	-	-	Innovation	T	-	Strategy	Both	Provide a general introduction to the concept of OI	The role of R&D extends beyond the boundaries of a single firm
6	Chesbrough (2003e)	F	-	-	Innovation	T	-	Strategy	Both	Describe OI	Relying solely on internal R&D is no longer viable in the current environment
7	Chesbrough (2006)	F	-	-	Innovation	T	Technical and market uncertainty Innovation performance	Strategy	Both	Development of metrics to manage open innovation	New metrics are needed to manage false positives and to react to the environment
8	Chesbrough and Crowther (2006)	F	-	Across	Innovation	E(C)	Openness Practices adopted	Strategy	Both	Identify and interview early adopters of OI outside high tech industries	Approaches to OI in non high tech markets: - Using external technology to reduce time-to-market - Identifying potential areas in which the next breakthrough will come

[3] Unit of Analysis. C: Community; D: Dyad; F: Firm; N: Network; P: OI Program; Pj: Project.

[4] F-F: Firm to Firm relationship; F-C: Firm-Community relationship; F-UC: Firm-User Community relationship; F-U: Firm- University relationship.V: Vertical relationship (e.g. buyer-supplier); H: Horizontal relationship.

[5] A: Analytical; E: Empirical; Qt: Quantitative; Ql: Qualitative; C: Case study; GT: Grounded Theory; T: Theoretical.

No.	Author (year)	UoA[3]	Exchange Partners[4]	Sample Frame	Theoretical Lens	Method[5]	Constructs	Discipline	Locus of innovation	Research Focus	Findings
9	Chesbrough and Schwartz (2007)	N	F-F (H&V)	-	Innovation	E(C)	Partnership objective Business requirements Implications for design Capabilities	Strategy	Both	Evaluate the potential of co-development practices	Few companies articulate what they expect to gain from their network and how they will secure gains. Leveraging network through co-development partnership can be an important source of innovation.
10	Christensen, Olesen, and Kjær (2005)	D	F-F (V)	Within	Other (Industrial dynamics)	E(C)	Access to technology Complementary assets	Entrepreneurship	Internal	Study the role of complementarities in the implementation of OI strategy	The small technology firms had access to university research, but lacked the complementary assets to bring the technology to maturity: they had to integrate into the existing value chains and choose niche markets.
11	Cooke (2005)	N/C	-	Across	Social Networks Dynamic Capabilities	E(C)	Characteristics of Network - Specialization - Diversification	Strategy	-	Highlight the importance of local networks to be able to succeed in global competition	Microcosms enable macrocosm to function: globalization can work only with strong localization
12	Dahlander, Frederiksen, and Rullani (2008)	-	F-C	-	Social Networks	T	-	Entrepreneurship	External	Examine the issues of firm exploitation of online communities	Online communities are a valuable source of innovation Governance and Symbolic Value creation are the main themes in the literature on managing open communities from a firm's perspective
13	Dahlander and Wallin (2006)	D	F-C (H)	Within	Social Networks	E(Qt)	Centrality Prestige Eigenvector (connection to central individuals) Firm Connection Type of affiliation	Policy	External	Understand the dynamics of OS networks, and the differences between industry-sponsored participants and regular ones	- Users communities can be seen as complementary assets, which enable firms to take advantage of knowledge outside of the firm. - Firm-sponsored individuals have a resource advantage compared to hobbyists, which allows them to reach a centrality position in the network. - Individuals from companies that have incorporated OS in their business model have a significant influence in the community - In a situation like FOSS neither integration nor contractual strategies are feasible, and the boundaries between core and complementary assets are blurred.
14	Di Maria and Finotto (2008)	F	F-UC (V)	Across	User Innovation	E(C)	-	Marketing	External	Study the impact of user communities by unifying marketing and innovation literature	The development of brand communities or other types of user communities can be a valuable source of innovation
15	Dittrich and Duysters (2007)	N/C	F-F (V)	Within	Learning Social Networks	E(Qt)	Exploration/Exploitation- Partner's capabilities- Type of partner- Alliance type	Management	-	Investigate how rapid technological change can be faced with the establishment of innovation networks	- Nokia tends to produce internally technologies that are considered to be part of their core (mobile handsets, network technology and middleware). - With the advent of UMTS, Nokia established many agreements characterized by weak ties, indicating a growth in the importance of exploration activities. - Nokia has moved from formal buyer-supplier relationships to a networking activity characteristic of open innovation.

No.	Author (year)	UoA[3]	Exchange Partners[4]	Sample Frame	Theoretical Lens	Method[5]	Constructs	Discipline	Locus of innovation	Research Focus	Findings
16	Dodgson, Gann, and Salter (2006)	P	-	Within	Learning	E(C)	Organizational Changes Technical changes	Strategy	Both	Explore the challenges that P&G had to face to move towards an OI model	- Innovation Technologies (IvT) impact the creation of knowledge. - Moving towards OI required organizational and technological changes.
17	Fetterhoff and Voelkel (2006)	P	-	Within	Innovation	E(C)	Five stages of OI 1. Seeking opportunities 2. Evaluating market potential 3. Recruiting partners 4. Capturing value 5. Extending the innovation offering	Strategy	External	Explore an effective method of employing OI	Pressures to incorporate external knowledge are increasing. Many companies will have to face the challenges of OI.
18	Gassmann, Sandmeier and Wecht (2006)	P	F-UC (V)	Within	User Innovation	E(C)	Creativity Resource efficiency Effectiveness of front-end	Strategy	Both	Integrate customer inputs in NPD front-end	An effective NPD front-end enables both creativity and resource efficiency XP (Extreme Programming)-type methodologies can be used to resolve the tension between creativity and resource efficiency (systematic probe and learn approach involving customer)
19	Gruber and Henkel (2006)	F	F-C (H)	Within	Evolutionary (Organizational Ecology)	E(Qt)	Liabilities of newness Liabilities of smallness Market entry barriers Participation in OSS	Entrepreneurship	Both	Explore how OSS-based new companies are affected by three challenges of venture management	Participation in OSS forums (the choice to open proprietary software) helps in offsetting liabilities and market barriers
20	Henkel (2006)	F	F-C (H)	Within	Other (Information trading)	E(Qt)	Share of code revealed to the public Firm Size Firm policies Proprietary complementary assets Experience in embedded Linux Support factors Reputation GPL	Strategy	Internal	Understand the dynamics of "free revealing" in embedded Linux firms	Firm size negatively impacts share of code revealed Firm policies only partially impact sharing Complementary assets do not affect sharing Experience significantly impacts sharing Reputation and development reasons impact sharing GPL and marketing reasons are not significant
21	Hienerth (2006)	N/C	F-UC (V)	Within	NPD	E(C)	Stages of user innovations commercialization: Stage I) Start Stage II) Community building Stage III) Commercialization Stage IV) Market expansion	Entrepreneurship	External	Understand the dynamics of user innovation development and evolution	User innovators commercialize their own innovations under certain conditions: - Individual needs, competitive ambitions - Lead users are the ones that may end up commercializing their innovations - Ability to offset economies of scale by creating a niche

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22	Higgins and Rodriguez (2006)	D	F-F (H)	Within	Other (Mergers)	E(Qt)	Desperation index Complementarities: - Prior set of experiences in therapeutic area - Alliance experience with target firm Cumulative abnormal returns Change in research pipeline	Finance	External	Understand how information on the target company before the acquisition contributes to the positive outcome of the acquisition (+ returns)	- The amount of information gathering activities performed prior to merger positively impacts performance after the merger - Level of desperation of the buying company has a negative impact on performance after the merger. - Acquisition is a viable strategy to acquire external innovations
23	Hurmelinna, Kyalaheiko, and Jauhiainen (2007)	F	-	Across	Appropriability regimes	E(Qt)	Strength of appropriability regime (IPR and tacitness of knowledge) Knowledge flows within a company Positive network externalities available Level of standardization	Strategy		Understand the impact of managerial decisions on appropriability regimes and subsequently on knowledge flows	A strong Intellectual Property Regime (IPR) increases internal knowledge sharing The stronger the appropriability regime, the more the company has positive network externalities
24	Kaiser and Müller-Seitz (2008)	N/C	F-UC (H)	Within	Social Networks Motivation (psych)	E(GT)	Extrinsic Motivation Intrinsic Motivation Degree of participation	Strategy	Internal	Understand the motivational drivers and performance outcome of the IT-mediated participation of lead users in software development	Flow states provide intrinsic motivation - Freedom to engage - Freedom of speech - Having impact - Reciprocal Social Exchange External motivation: - Ability to signal competence - Getting support
25	Kirschbaum (2005)	P	-	Within	Innovation	E(C)	Search strategy	Strategy	Both	Understand the drivers of OI success at DSM	DSM innovation strategy is based on: - Systematically scanning the environment for new opportunities. - The management of projects with an "intrapreneurial" mindset. - Leveraging the skills of experienced management when the projects reach maturity
26	Laursen and Salter (2006)	F	-	Across (manufacturing)	Social Networks Institutional theory Evolutionary economics	E(Qt)	External Search Novelty of innovation Openness Absorptive Capacity Innovative performance	Strategy	External	Empirically examine the impact of open innovation	- External search breadth is curvilienarly related to innovative performance (inverted U-shape) - External search depth is curvilinearly related to innovative performance (inverted U-shape) - No support for relationship between internal R&D and external search breadth and depth - Conclusions: External search provides advantages, but over-searching can negatively affect innovative performance. External search depth is associated with radical innovation"

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27	Lettl, Herstatt, and Gemuenden (2006)	P	F-UC (V)	Within	User Innovations	E(C)	- User characteristics - User roles - Interaction type between firm and user - Typology of knowledge gained from users - Outcomes	Strategy	External	Show how users can be an important source of innovation	- Users had a need and in all four cases looked for technologies outside their immediate field - Users had a highly entrepreneurial attitude and behavior, and exhibited ability in managing the extended networks of people involved. - Users also took over a developer or co-developer role in the innovation process - The firms that were able to incorporate users' efforts in their development benefited in terms of product innovation, process, and technology
28	Lichtenthaler (2006)	F	-	-	Exploration/ Exploitation	T	Internal Technology Exploitation External Technology Exploitation	Strategy	External	Develop an integrated approach to technology exploitation	Four technology exploitation strategies can be adopted in the context of OI: - Internal Technology Exploitation - Integrated Technology exploitation - No Technology Exploitation - External Technology Exploitation
29	Lichtenthaler (2008)	F	-	Within	Learning	E(Qt)	Extent of external technology acquisition Extent of external technology commercialization Industry Country Financial performance R&D Intensity Emphasis on radical innovation Diversification	Strategy	Both	Classify firms according to their innovation strategy	- Clusters: 1) Closed Innovators, 2) Closed Innovators that acquire a considerable part of their technologies from external sources, 3) Absorbing Innovators, 4) Desorbing Innovators, 5) Balanced Innovators, 6) Open Innovators - The largest cluster is still that of the closed innovators. - Firms with higher revenues, more product variety and a CV unit are more likely to be open innovators.
30	Lichtenthaler and Ernst (2006)	F	-	-	Other (Knowledge management)	T	Attitudes to externally carrying out knowledge management tasks: 1) Not-invented-here (NIH) 2) Buy-in (BI) 3) All-stored-here (ASH) 4) Relate-out (RO) 5) Only-used-here (OUH) 6) Sell-out (SO)	Strategy	Both	Expand the previous literature on NIH syndrome, by including other attitudes that play a role in technology adoption	The six syndromes identify overly positive or negative attitudes towards the external performance of knowledge management tasks. It is difficult to gain competitive advantage with a biased decision making process
31	Lichtenthaler and Ernst (2007)	F	F-F (H&V)	Across	Innovation	E(Qt)	Revenues from licensing and selling tech. Knowledge Strategic functions of outbound OI	Strategy	Internal	Provide a quantitative evaluation of the magnitude and characteristics of the External Technology Commercialization (ETC) phenomenon	Outbound OI is limited in comparison to traditional R&D Strategic role of OI is considered more important than monetary returns

No.	Author (year)	UoA[3]	Exchange Partners[4]	Sample Frame	Theoretical Lens	Method[5]	Constructs	Discipline	Locus of innovation	Research Focus	Findings
32	Lokshin, Belderbos and Carree (2008)	F	-	Across	Learning	E(Qt)	Ration of internal to external R&D (R&D Intensity, External and Internal) Labor productivity	Economics	Both	Analyze the role of complementa-rities between internal and external R&D	Increasing external R&D can be beneficial External and internal R&D are complementary: external R&D expenditure leads to diminished expenditure on labor productivity only in the presence of an adequate internal R&D expenditure
33	Perkmann and Walsh (2007)	D	F-U (H)	-	Social networks	T	University-Industry relationship types: - Research Partnerships - Research Services	Management	External	Creating a roadmap for research in F-U relationships in an open innovation context	The more a sector is science-based, the more it will use partnerships. Consulting (service) activities of the universities play an important role for SME
34	Piller and Walcher (2006)	P	F-UC (V)	Within	User Innovation	E(C)	Initiative characteristics (task specificity and degree of elaboration). Performance of user contribution	Strategy	External	Evaluate the effectiveness of TIC competitions in NPD	Users are willing to participate in development 2 ideas from the project are actually under development
35	Prugl and Schreier (2006)	Pj	F-UC (V)	Within	User Innovation	E(C)	Development toolkits available to users (openness)	Strategy	External	Understand how the development of tools that allow the users to modify the product affects the innovation process	Users spent an equivalent of 36.6 full time programmers time in development activities The most innovative designs came from users
36	Terwiesch and Xu (2008)	Pj	F-F (V)	-	NPD	A	Type of project- Expertise-based- Ideation projects- Trial and error projectsExpertiseEffortUncertaintyNumber of trials	Strategy	External	Understand what type of innovation problems are most suited for innovation contests Determine the optimal design of the innovation contest, given the type of innovation problem	High uncertainty can lead to solver underinvestment Using filtering mechanisms (like first-round screening), the seeker can reduce the underinvestment problem. In this case, a large pool of initial contestants can be beneficial.
37	van de Vrande,, Lemmens, and Vanhaverbeke (2006)	F	F-F (H&V)	-	Other (TCE, RO)	T	Governance mode Information Asymmetry Technological distance	Strategy	External	Understand when firms prefer alliances and partnerships over acquisitions	Under high uncertainty, companies will try to use reversible technology sourcing strategies The more the technological distance between firms, the more VC will be preferred to strategic alliances, and strategic alliances to acquisitions The more the information asymmetry, the less close the relationship
38	van der Meer (2007)	F	-	Across	Innovation	E(Qt)	Factors that hamper innovation Innovation Strategy	Strategy	Both	Analyze diffusion and perception of OI models in the Netherlands	- Very small diffusion of OI models, a part for a group of pioneers. - Innovative SME are more naturally suited to engage in OI

No.	Author (year)	UoA[3]	Exchange Partners[4]	Sample Frame	Theoretical Lens	Method[5]	Constructs	Discipline	Locus of innovation	Research Focus	Findings
39	von Hippel and von Krogh (2006)	F	-	Within	Other (Collective Action)	T	Model of Innovation incentives - Privete investment model - Collective action model - Private-Collective model	Strategy	Internal	Understand when do companies freely reveal their technological knowledge	There are several incentives that promote free revealing behavior. As an alternative to completely closed and completely open, a private-collective model is optimal
40	West and Lakhani (2008)	N/C	-	-	Social Networks	T	Community	Strategy	-	Generate a better definition for the community construct in OI literature	The term "community" is used many different ways in OI literature. The relative position of firms with respect to innovation communities is an area of increasing importance.
41	West and O'mahony (2008)	N/C	F-C (V)	Within	Social Networks	E(GT)	Form of openness - transparency - accessibility - proprietary model Dimensions of participation architecture - production - governance - intellectual property	Strategy	External	Understand how firm-sponsored innovation communities differ from autonomous ones	Sponsors of communities face tension between control and openness The choice on the three dimensions qualifies the way in which firms deal with the tension Three groups of communities classifiable according to degree of openness
42	West and Gallagher (2006)	F	F-C (V)	Within	Appropriability regimes	E(GT)	Motivation to contribute Incorporation of external knowledge OI approach	Strategy	Internal	Understand how and why firms commit their IP and HR investment in efforts that will benefit others (i.e. developing open technologies)	Classification of OI Through the structural relationship of R&D contributors: - Pooled R&D (Mozilla, OSDL) --> Firms donate IP to the project while reaping the common benefits (sale of a related product). Spillovers re not controllable. Contributions arrive from external participants who are not part of any of the consortium companies. - Spinouts: Transforming internal development processes in open external, more visible, ones.
43	Witzeman et al. (2006)	F	-	Across	Other (Strategic Planning)	E(Ql)	Approaches to levels of external technology sourcing - Cost and SCM - Strategic Partnering - Extended networks - Integrated external innovation	Strategy	External	Develop a framework for making OI decisions	Harnessing external innovation requires a change in the overall strategic planning process

Table 2. Open innovation definitions

Definition	Source
"Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology."	Chesbrough, Vanhaverbeke, & West, 2006, p.1
"Open innovation means that the company needs to open up its solid boundaries to let valuable knowledge flow in from the outside in order to create opportunities for cooperative innovation processes with partners, customers and/or suppliers. It also includes the exploitation of ideas and IP in order to bring them to market faster than competitors can."	Gassmann & Enkel, 2004, p.2
"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."	Lichtenthaler, 2008, p. 148
"The system is referred to as open because the boundaries of the product development funnel are permeable. Some ideas from innovation projects are initiated by other parties before entering the internal funnel; other projects leave the funnel and are further developed by other parties"	Dittrich & Duysters, 2007, p.512
"This means that innovation can be regarded as resulting from distributed inter-organizational networks, rather than from single firms"	Perkmann & Walsh, 2007, p.259
"We define open innovation as systematically encouraging and exploring a wide range of internal and external sources for innovation opportunities, consciously integrating that exploration with firm capabilities and resources, and broadly exploiting those opportunities through multiple channels"	West & Gallagher, 2006, p.320
"there exist a rapidly growing number of innovation processes that rely on the outside world to create opportunities and then select the best from among these alternatives for further development. This approach is often referred to as *open innovation*"	Terwiesch & Xu, 2008, p.1529

Table 3. Open innovation strategic positioning

OI Strategy	**Exemplar Firm**	**Sources**	**Attributes**	**Mechanisms**	**Outputs**
Innovation seeker	P&G Eli Lilly	External	Absorptive Capacity Exploration abilities (search)	Leveraging User Innovation Outsourcing & Alliances Mergers & Acquisitions	Product Process Service
Innovation provider	ICEPower	Internal	Valuable portfolio of innovation Internal innovation capabilities	Venture Capital Licensing & Alliances	Raw Innovation/ Technology Intellectual Property
Intermediary	Innocentive NineSigma	External	Connectedness Network embeddedness	Auctions Partnerships Membership	Match of seeker and provider
Open innovator	Xerox IBM	External Internal	Internal Innovation Capabilities or portfolio Absorptive Capacity Searching abilities Boundary spanning abilities	Outsourcing & Alliances Mergers & Acquisitions Venture Capital Licensing	Knowledge flows