

Leveraging External Sources of Innovation: A Review of Research on Open Innovation*

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This paper reviews research on open innovation that considers how and why firms commercialize external sources of innovations. It examines both the “outside-in” and “coupled” modes of open innovation. From an analysis of prior research on how firms leverage external sources of innovation, it suggests a four-phase model in which a linear process—(1) obtaining, (2) integrating, and (3) commercializing external innovations—is combined with (4) interaction between the firm and its collaborators. This model is used to classify papers taken from the top 25 innovation journals, complemented by highly cited work beyond those journals. A review of 291 open innovation-related publications from these sources shows that the majority of these articles indeed address elements of this inbound open innovation process model. Specifically, it finds that researchers have front-loaded their examination of the leveraging process, with an emphasis on obtaining innovations from external sources. However, there is a relative dearth of research related to integrating and commercializing these innovations.

Research on obtaining innovations includes searching, enabling, filtering, and acquiring—each category with its own specific set of mechanisms and conditions. Integrating innovations has been mostly studied from an absorptive capacity perspective, with less attention given to the impact of competencies and culture (including “not invented here”). Commercializing innovations puts the most emphasis on how external innovations create value rather than how firms capture value from those innovations. Finally, the interaction phase considers both feedback for the linear process and reciprocal innovation processes such as cocreation, network collaboration, and community innovation.

This review and synthesis suggests several gaps in prior research. One is a tendency to ignore the importance of business models, despite their central role in distinguishing open innovation from earlier research on interorganizational collaboration in innovation. Another gap is a tendency in open innovation to use “innovation” in a way inconsistent with earlier definitions in innovation management. The paper concludes with recommendations for future research that include examining the end-to-end innovation commercialization process, and studying the moderators and limits of leveraging external sources of innovation.

Introduction

For much of the 20th century, the practice of technological innovation was ascribed to a corporate research and development (R&D) lab embedded in a vertically integrated commercialization infrastructure (e.g., Chandler, 1977; Freeman, 1982). Whether AT&T, DuPont, or IBM, the role of the successful large corporation in the Schumpeterian (“Mark II”) formulation—as defined by Malerba and Orsenigo (1995)—was to

develop new technologies and bring them to market (Schumpeter, 1942).

Beginning with Schumpeter’s (1934) “Mark I” theory of economic development, others have examined the non-integrated model of innovation, as when smaller firms can (and should) commercialize innovations without the scope and assets of the Mark II corporations (Teece, 1986). However, the firms that outsource commercialization need a willing partner in such efforts. If Teece’s (1986) key question was when (and how and why) firms should utilize external downstream commercialization assets, here the focus is on the flip side—when (and how and why) firms that have such assets should utilize external upstream sources of innovation.

This paper analyzes and synthesizes prior research on utilizing such external sources. It focuses on the well-defined and emerging body of research on open innovation as defined by Chesbrough (2003a), which postulates that the assets necessary for creating innovation will not

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necessarily be collocated with those for commercializing them, and thus offers a “new paradigm” to explain why firms should commercialize external sources of innovation (Chesbrough, 2006a).¹

It begins with a brief summary of the research on external sources of innovation. From this summary, it develops a four-phase model of how firms obtain, integrate, and commercialize innovations from external sources, as well as those interactive paths beyond the stylized linear model that incorporate feedback and ongoing interactions with external sources. The model is used to categorize research from a systematic sample of 291 publications related to open innovation to identify the contribution and gaps of prior research in each phase of the model. The paper concludes by discussing broader gaps in open innovation research—notably the absence of business models and the confounding of innovation with its antecedents—as well as suggesting topics for future research.

Leveraging External Sources of Innovation

Prior Research on External Innovation Sources

Various researchers have considered how firms with commercialization complementary assets might use those assets to profit from external sources of innovation. One of the largest bodies of such research is the “inbound” or “outside-in” mode of open innovation (Chesbrough and

Crowther, 2006; Enkel, Gassmann, and Chesbrough, 2009). This research on open innovation is a large and increasingly influential body of research. For example, according to Google Scholar, the original Chesbrough (2003a) book had more than 2000 citations in the first eight years, and his subsequent academic book (Chesbrough, Vanhaverbeke, and West, 2006) had more than 1000 citations over five years.

In contrast to earlier research, “Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas . . . as they look to advance their technology” (Chesbrough, 2006a, p. 1). In addition to the “new paradigm” conception, a second major emphasis by Chesbrough (2003a, 2006b; Chesbrough and Rosenbloom, 2002) is that successful commercialization efforts by a firm—whether from internal or external sources—need to be aligned to the firm’s business model (cf. Zott, Amit, and Massa, 2011).

Many of these principles were the subject of earlier research, as researchers considered how firms obtained innovation outside the firm, whether from individuals, customers, suppliers, or universities. Firms differ in their degree of organizational integration for acquiring external R&D (Granstrand and Sjölander, 1990; Vanhaverbeke, Duysters, and Noorderhaven, 2002) which might include technology sourcing and acquisition (Arora, Fosfuri, and Gambardella, 2001; Nicholls-Nixon and Woo, 2003; Veugelers, 1997), strategic alliances with external suppliers of technology (Lambe and Spekman, 1997; Narula and Hagedoorn, 1999), or a collaborative R&D joint venture (Peck, 1986). The drivers of external sourcing emphasize two types of motivations: improved efficiency through scale economies and access to innovations (or innovation-producing capabilities) not held by the focal firm. Universities are a special source of external innovations, and research has measured the benefits of university technology to be commercialized by firms, whether in the aggregate (Jaffe, 1989) or at the firm level (Link and Rees, 1990).

Other research has examined the role of innovation created outside the firm by individuals. In some cases, the firm is explicitly present and collaborating in organizing or producing the innovation for its own financial benefit, as with cocreation (Pralhad and Ramaswamy, 2004) or crowdsourcing (Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010; Poetz and Schreier, 2012). In other cases, the firm is explicitly absent (von Hippel, 2007). The largest category of such research emphasizes the creation of innovations by users who utilize their own scarce knowledge to provide utility for their own benefit (Bogers, Afuah, and Bastian, 2010), which may be har-

¹ Less commonly, open innovation research also examines how firms externally commercialize their internal innovations, but such research is outside the scope of this study.

BIOGRAPHICAL SKETCHES

Dr. Joel West is a professor of innovation and entrepreneurship at the Keck Graduate Institute of Applied Life Sciences, one of the seven Claremont Colleges. His research examines the strategic use of openness in areas such as open innovation, open source software, and open standards. He is author of the open innovation blog (oiblog.net) and coeditor of *Open Innovation: Researching a New Paradigm* (Oxford: 2006) and *Open Innovation: New Frontiers and Applications* (Oxford: 2014). He has a Ph.D. in management from UC Irvine and an S.B. in interdisciplinary sciences from MIT.

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nessed for the benefit of firms (Morrison, Roberts, and von Hippel, 2000), or in direct competition with firms (Baldwin and von Hippel, 2011).

Finally, other research has focused on open-source software. Some research ignores the firm and is explicitly in the user innovation tradition (e.g., Lakhani and von Hippel, 2003). However, other research has shown how firms use open-source communities to, e.g., provide commodity technology (West, 2003), to engage in informal knowledge sharing (Henkel, 2006), and to develop potential improvements to existing products (Dahlander and Magnusson, 2008).

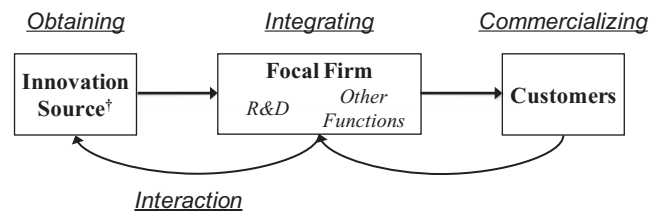
An Integrative Model

A four-phase-integrated model of how firms profit from external innovation was created to guide the systematic literature review. The model creation began by considering models of how a technology is developed, converted into a product, and brought to market. This included traditional models of integrated innovation—the Freeman (1982) model of industrial innovation and various conceptions of the new product pipeline (e.g., Ding and Eliashberg, 2002)—as well as the open innovation “funnel” (Chesbrough, 2006a, p. 3) and the downstream commercialization activities of Teece (1986). The resulting model was then compared with existing models of how firms use external sources of innovation: acquisition, assimilation, transformation, and exploitation (Zahra and George, 2002); strategy, sourcing, integration, and metrics (Chesbrough and Crowther, 2006); motivating, integrating, and exploiting (West and Gallagher, 2006); and want, find, get, and manage (Slowinski and Sagal, 2010). This research and the application of the model to this sample were used to refine the boundaries between the phases and identified categories and topics within each phase.

This review consistently suggested three major steps in the process from the creation of the external innovation to its delivery to the customer:

1. *Obtaining innovations from external sources*, including search, sourcing, enabling, incentivizing, and contracting.² This is the “inbound” step of inbound open innovation.
2. *Integrating innovations*, including factors that enable integration, those that act as barriers to integration, and those that explain how that activity changes (and is changed by) the organization and its competencies.

² The initial classification separated the search for external sources of innovations from the acquisition, but upon further examination, it was clear that it was impossible to separate these processes and roles for many of the papers in the sample.



[†]Sources may include suppliers, rivals, complementors, and customers.

Figure 1. A Four-phase Process Model for Leveraging External Sources of Innovation.

3. *Commercializing innovations*, which is often implied for research on external sources of innovation, but an explicit part of conventional models of industrial R&D.

Many activities (such as crowdsourcing) will entail integrating activities across all three phases. However, the unidirectional linear path is not a complete model of how innovation is conceived in either practice or research: there are reverse flows, bidirectional interactions, and other paths beyond the stylized progression of the linear model. Therefore, the model was extended with a fourth phase to include (4) *interaction mechanisms*, which may occur at any phase of the innovation process. This four-phase model (Figure 1) was used for the subsequent analysis of the papers in the sample.

Research Design

Sample

To better understand leveraging external sources of innovation, this paper uses a systematic sample of articles that include inbound paths for open innovation. To establish a corpus of such research, articles were selected from the top 25 most-cited technology and innovation management journals (Table 1) as calculated by Linton and Thongpapanl (2004).³ Fifteen of these 25 journals are also among the 45 used by the *Financial Times* for ranking global business schools (FT.com, 2010).

The Social Science Citation Index (SSCI) was used to make two lists of articles published from 2003 to 2010. One was a list of 195 articles that included “open innovation” in the title, keywords, or abstract, of which 132 (67%) were published in these 25 journals. The second was a list of 415 SSCI articles that cited the earliest open innovation reference (Chesbrough, 2003a), of which 231

³ Linton and Thongpapanl (2004) report multiple rankings, but—to avoid possible citation inflation—here journals were selected using the ranking that ignores citations to the same journal.

Table 1. Top 25 Innovation Journals Searched for Literature Review^a

• <i>Academy of Management Journal</i> ^b (9)	• <i>Journal of Product Innovation Management</i> (7)
• <i>Academy of Management Review</i> ^b (8)	• <i>Long Range Planning</i> (19)
• <i>Administrative Science Quarterly</i> ^b (5)	• <i>Management Science</i> ^b (4)
• <i>California Management Review</i> ^b (10)	• <i>MIT Sloan Management Review</i> ^b (12)
• <i>Harvard Business Review</i> ^b (1)	• <i>Organization Science</i> ^b (15)
• <i>IEEE Transactions on Engineering Management</i> (14)	• <i>R&D Management</i> (11)
• <i>Industrial and Corporate Change</i> (21)	• <i>Research Policy</i> (3)
• <i>International Journal of Technology Management</i> (18)	• <i>Research-Technology Management</i> (6)
	• <i>Strategic Management Journal</i> ^b (2)
	• <i>Technological Forecasting and Social Change</i> (25)
	• <i>Technovation</i> (20)

^a The ranking of the top 25 journals for technological innovation research, as reported by Linton and Thongpapanl (2004). No articles were found in six of these journals: *American Economic Review*, *Economic Journal*, *Journal of Marketing*, *Journal of Marketing Research*, *Journal of Political Economy*, and *MIS Quarterly*

^b Also on the *Financial Times* list of 45 top research journals (FT.com, 2010).

(56%) appeared in these 25 journals. While the former group of articles was about open innovation in some form, the latter group included many articles that made only passing reference to the topic. As shown in Table 2, this generated a list of 287 unique articles in 19 of the 25 journals. The SSCI database did not include two earlier articles by Chesbrough that met the selection criteria, nor a special issue on open innovation that occurred late in 2010. Articles were added to the database if they met all the inclusion criteria.

To this list were added a list of business-related publications listed by Google Scholar that include the phrase

“open innovation” in the title of the article and had more than 100 citations as of January 2011. Not surprisingly, the most highly cited was the original Chesbrough (2003a) book with more than 2200 citations. In this category were 15 publications: 11 articles already in the database, 3 books authored or coauthored by Chesbrough (Chesbrough, 2003a, 2006b; Chesbrough et al., 2006), and 1 book chapter by Chesbrough (2006a).⁴ The four

⁴ If instead of 100 citations, the Google Scholar threshold was set to 50 (or 25) citations that provided 28 (40) total publications, of which 15 (20) were new.

Table 2. Potential Articles Identified from Top 19 Journals

Journal	Articles with “Open Innovation” in Title, Abstract, or Keywords	Articles Citing Chesbrough (2003a)	Unique Articles
<i>Academy of Management Journal</i>		4	4
<i>Academy of Management Review</i>	1		1
<i>Administrative Science Quarterly</i>		1	1
<i>California Management Review</i>	5	9	11
<i>Harvard Business Review</i>	2		2
<i>IEEE Transactions on Engineering Management</i>	1	3	3
<i>Industrial and Corporate Change</i>	2	10	10
<i>International Journal of Technology Management</i>	20	29	34
<i>Journal of Product Innovation Management</i>	6	17	18
<i>Long Range Planning</i>		10	10
<i>Management Science</i>	2	6	6
<i>MIT Sloan Management Review</i>	3	4	6
<i>Organization Science</i>	3	8	10
<i>R&D Management</i>	36	40	52
<i>Research Policy</i>	15	32	38
<i>Research-Technology Management</i>	22	24	39
<i>Strategic Management Journal</i>		4	4
<i>Technological Forecasting and Social Change</i>	2	6	8
<i>Technovation</i>	12	24	30
Totals (18 journals / all SSCI journals)	132/195	231/415	287 ^a

^a Does not include four highly cited publications added from Google Scholar.

new publications increased the potential sample to 291 publications.

Classifying Articles

Given the focus on external sources of innovation, the authors manually reviewed abstracts for each of the 291 publications in the sample, to determine whether each related to the study and which phase(s) of the process model it discussed. When an abstract was inconclusive or unavailable, the full paper was examined (in particular, the introduction and discussion sections) to see if it claimed to contribute to this topic.

Two categories of articles were removed. First, 22 articles were removed because they were not research articles, including book reviews, news items, commentaries, and editorial introductions that did not include a discussion of research. Next, 104 articles were removed that did not focus on open innovation as defined by Chesbrough (2003a, 2006a); most of these made only passing reference to Chesbrough's work, as when Huang and Murray (2009, p. 1216) wrote that "This focus resonates with the current interest in 'open innovation' strategies (Chesbrough, 2003a) but provides a broader, more institutionally focused framework for considering such issues."

This left 165 articles about open innovation, of which 118 articles included some form of inbound open innovation, 50 had some form of outbound innovation, and 70 articles considered the cocreation process combining inbound and outbound flows that Enkel et al. (2009) term the "coupled" model of open innovation (Figure 2). From these 165 articles, the sample of articles for this literature review was created by identifying 151 articles that were

about inbound or coupled open innovation modes (or both). This sample of articles is listed in the Online Appendix.

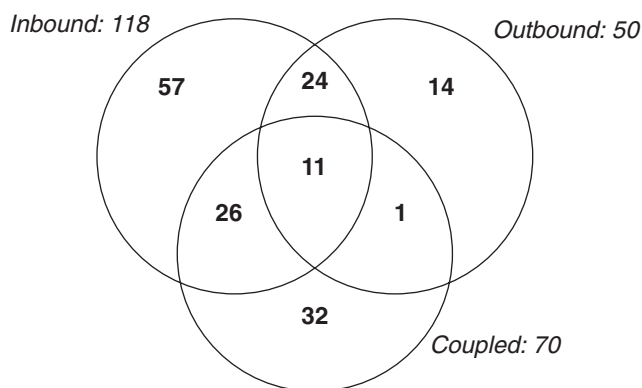
Each article in this sample was then classified as to whether it discussed innovation activities corresponding to one or more of the phases. This classification was supplemented with a keyword search of the downloaded articles for key terms (such as "search" or "absorptive capacity"), and then the matching articles were manually reviewed to identify studies that used such concepts in the context of using external sources of innovation. The classification was used to make an initial list of topics within each of the four phases in the process model. The review of the articles included a process of iterative refinement (cf. Eisenhardt, 1989) to revise this list—and the grouping of the topics into similar areas—until the stable classification of phases, categories, and topics listed in Table 3 was obtained.

The articles in the sample were supplemented with a list of other research related to the production and use of external innovations. This included highly cited articles on related areas such as cocreation, innovation communities, R&D alliances, R&D joint ventures, technology acquisition, technology brokering, university research, and user innovation. A broader search for related research was used for topics in the model that were not well covered by the sample.

Obtaining Innovations from External Sources

Obtaining innovations from external sources requires two steps: firms must first find external sources of innovation and then bring those innovations into the firm.

Researchers have offered various typologies of the process of obtaining innovations from external sources, as when Dahlander and Gann (2010) established a distinction between pecuniary and nonpecuniary inflows of innovation. In terms of empirical context, studies on obtaining innovations from external sources originally focused on large firms in high-tech industries, although there has since been some research on firms in low-tech industries (Chesbrough and Crowther, 2006; Grimpe and Sofka, 2009; Spithoven, Clarysse, and Knockaert, 2010) and an increasing body of research on small- and medium-sized enterprises (Barge-Gil, 2010; Hung and Chiang, 2010; Lee, Park, Yoon, and Park, 2010; van de Vrande, de Jong, Vanhaverbeke, and de Rochemont, 2009; Zeng, Xie, and Tam, 2010). Firms may source actual innovations, technical inventions or knowledge, market knowledge, components, or other useful



Note: The outside-in (inbound), inside-out (outbound), and coupled modes are as defined by Enkel et al. (2009)

Figure 2. Count of Open Innovation Articles by Mode.

Table 3. Key Categories for Research on Leveraging External Sources of Innovation

Phase	Category	Open Innovation Topic	Representative Articles
1. Obtaining	Searching	<ul style="list-style-type: none"> • Sourcing • Technology scouts • Limits 	Dodgson et al. (2006); Laursen and Salter (2006)
	Enabling/ Filtering	<ul style="list-style-type: none"> • Brokerage • Contests • Intermediaries • Toolkits • Platforms • Gatekeepers 	Jeppesen and Lakhani (2010); Piller and Walcher (2006); Whelan et al. (2010)
	Acquiring	<ul style="list-style-type: none"> • Incentives to share • Contracting • Nature of the innovation 	Ceccagnoli et al. (2010); Dushnitsky and Shaver (2009)
2. Integrating		<ul style="list-style-type: none"> • Absorptive capacity • Culture and “Not Invented Here” • Incentives to cooperate • Competencies 	Du Chatenier et al. (2010); Emden et al. (2006); Herzog and Leker (2010)
3. Commercializing		<ul style="list-style-type: none"> • Commercialization process • Value creation • Value capture 	Belderbos et al. (2010); Lau et al. (2010); Rothaermel and Alexandre (2009)
4. Interaction	Feedback	<ul style="list-style-type: none"> • R&D feedback • Customer/market feedback 	Berkhout et al. (2006); Hughes and Wareham (2010)
	Reciprocal	<ul style="list-style-type: none"> • Cocreation • Communities • Value networks 	Dittrich and Duysters (2007); Faems et al. (2010)

information to support firm innovation efforts (Bogers and West, 2012).

The discussion below summarizes the studies within the sample that deal with the major activities of obtaining innovation from external sources: searching, enabling and filtering, and acquiring.

Searching for External Sources of Innovation

The first step of obtaining innovations from external sources into the firm is the process of identifying and sourcing these innovations. Researchers have studied the general role of external sources of innovation as a means to add to or complement the firm’s internal knowledge base (Chuma, 2006; Laursen and Salter, 2006; Witzeman et al., 2006).

Sourcing from external stakeholders. Firms can identify or search for external sources of innovation by collaborating with a variety of external stakeholders or seeking out specialists with useful knowledge (e.g., Ili, Albers, and Miller, 2010; Nieto and Santamaría, 2007; Tether and Tajar, 2008); firms may also passively obtain innovation that is “pushed” by external stakeholders (Spaeth, Stuermer, and von Krogh, 2010). Researchers have identified specific sources of external knowledge

including suppliers (Li and Vanhaverbeke, 2009; Schiele, 2010), customers (Gassmann, Sandmeier, and Wecht, 2006; Grimpe and Sofka, 2009), competitors (Lim, Chesbrough, and Ruan, 2010), or universities (Cassiman, Di Guardo, and Valentini, 2010; Fabrizio, 2009; Harryson, Kliknaite, and Dudkowski, 2008). Factors that influence the use of external sources of innovation include not only the characteristics of the external source, but also internal factors such as R&D capabilities and complementary assets (Ceccagnoli, Graham, Higgins, and Lee, 2010; Teirlinck, Dumont, and Spithoven, 2010).

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

Various factors have increased the potential and decreased the costs of searching for innovation from external sources. One of the most important factors has been the growing availability of information and communication technologies, which Dodgson, Gann, and Salter (2006) term “innovation technologies.” More specifically, the rise of the Internet has played an important role in

enabling searches for external sources of innovation, by facilitating technology intelligence (Veugelers, Bury, and Viaene, 2010), online communities (Dahlander and Wallin, 2006; Füller, Matzler, and Hoppe, 2008), crowdsourcing or broadcast search⁵ (Ebner, Leimeister, and Krcmar, 2009; Jeppesen and Lakhani, 2010), and Internet platforms such as blogs and virtual worlds (Droge, Stanko, and Pollitte, 2010; Kohler, Matzler, and Füller, 2009).

Limits to search. Despite the benefits of obtaining external innovations, there can be significant costs involved as well. Laursen and Salter (2006) find that beyond an optimal level, firms that rely on an increasing variety of external sources of innovation have decreasing returns in terms of innovation performance. Thus even though broad search may be beneficial (see also Jeppesen and Lakhani, 2010), there may be limits to search effectiveness. Moreover, Stuermer, Spaeth, and von Krogh (2009) show that when a firm relies on external sources of innovation, it may face hidden costs related to communication and control. Another possible trap is that overly positive attitudes toward external sources of innovation may hamper search effectiveness. All in all, firms must confront a trade-off between the benefits and costs of obtaining innovation from external sources by aligning search breadth and depth, which potentially allows them to overcome some of the impediments of relying on external sources of innovation (Keupp and Gassmann, 2009).

Enabling and Filtering Innovation from External Sources

Firms seeking to increase the external supply of innovations can use third party actors (such as innovation intermediaries) to enable and facilitate such innovations (Jeppesen and Lakhani, 2010; Lee et al., 2010; Mortara et al., 2010; Sieg, Wallin, and von Krogh, 2010; Spithoven et al., 2010). As such, different types of brokerage can serve as a means to balance the incentives of internal and external stakeholders and thereby promote linkages across the value chain (Benassi and Di Minin, 2009; Jacobides and Billinger, 2006; Sandmeier, 2009).

Researchers have identified two key mechanisms that encourage innovation creation outside of the boundaries of the firm. The first is encouraging external innovators by providing effective incentives, whether monetary

⁵ Howe (2008) argues that firms can tap “the wisdom of crowds” as a way to search for innovative ideas, but Jeppesen and Lakhani (2010) argue that the key theoretical issue of crowdsourcing is the decision by firms to broadcast their search to potential contributors.

incentives (extrinsic benefits) such as awards and innovation contests (Terwiesch and Xu, 2008) or nonmonetary incentives/intrinsic motivation as often found in open-source software (West and Gallagher, 2006). A second is establishing formal tools and processes that provide a platform for external stakeholders to produce and possibly share innovations (cf. Gawer, 2010). While such a platform accelerates the innovation process, this might be combined with the provision of incentives, as with innovation toolkits that include awards distributed based on the quality of the submission (Piller and Walcher, 2006).

A major challenge for firms relying on external sources of innovations is how to effectively identify the most valuable innovations. This identification might take place inside the firm (Jeppesen and Lakhani, 2010; Poetz and Schreier, 2012), by an external intermediary (Nambisan and Sawhney, 2007), or even by the community of external contributors (Ebner et al., 2009). For firms that rely on employees for filtering, the role of the gatekeeper is increasingly shared and distributed within the organization (Ettlie and Elsenbach, 2007; Fichter, 2009), while Whelan, Teigland, Donnellan, and Golden (2010) concluded that this decentralization has been increased by the growth of the Internet.

Acquiring Innovation from External Sources

Acquiring innovation from external sources usually involves explicit contracts and licensing agreements, which give stronger opportunities for technology exploration (Ili et al., 2010; Laursen, Leone, and Torrisi, 2010). However, the effectiveness of licensing or other means of knowledge acquisition depends on factors such as the strength of the intellectual property protection regime (Chesbrough, 2003b; Dushnitsky and Shaver, 2009). Acquiring innovation from external sources may be through the acquisition of knowledge or technology, or through the use of acquisitions of the innovation suppliers. Acquiring external innovations tends to be done by less innovative firms, although these acquiring firms tend to become more innovative after the acquisition (Ceccagnoli et al., 2010; Zhao, 2009).

Summary

The research on obtaining innovations is the largest and most vibrant in open innovation, with a particular emphasis on accessing the widest possible supply of innovations; only recently have researchers considered the challenges of too many innovations. The emphasis on

this phase may be because it most directly matches Chesbrough's (2003a, p. xxxi) call for an innovation process that "eagerly seeks external knowledge and ideas." Or it may be because the external search and sourcing are more easily observed and measured than subsequent integration and commercialization efforts—as exemplified by the use of databases such as the Community Innovation Survey (e.g., Grimpe and Sofka, 2009; Laursen and Salter, 2006; Spithoven et al., 2010) and other datasets that are generally more based on an input–output model than on the internal processes (e.g., Jeppesen and Lakhani, 2010; Piller and Walcher, 2006).

However, this work has largely emphasized organizations (whether firms or universities) as external sources. Consistent with West, Vanhaverbeke, and Chesbrough (2006), more research is needed on individuals as sources of innovation, and what open innovation tells us that is not covered by existing user innovation research—as when Piller and Walcher (2006) analyzed idea contests from a user innovation perspective.

Integrating Innovations

Identifying and acquiring innovations from external sources is only half the battle. In order for firms to profit from the external sources of innovation, the innovations must be fully integrated into the firm's R&D activities. This requires a compatible culture in the R&D organization to overcome tendencies toward "not invented here" barriers, as well as the technical capability to assimilate innovations obtained from external sources.

Antecedents and Barriers to Integration

Organizational culture plays an important role in the willingness and ability of an organization to successfully profit from external sources of innovation. The earliest mention of cultural impediments to the success of using external sources of innovation is the potential "not invented here" attitude of many successful R&D organizations (e.g., Chesbrough, 2003a; Laursen and Salter, 2006; West and Gallagher, 2006). Cultural changes are often needed to successfully utilize innovation from external sources and collaborate with external partners, particularly for organizations with a successful record of internal innovation (Dodgson et al., 2006; Schiele, 2010). Such changes can be used to shift the focus from "not invented here" to an outlook that views the external environment as the firm's technology base (Witzeman et al., 2006) and is more tolerant of entrepreneurial risk taking (Herzog and Leker, 2010).

In some cases, the best way to integrate external innovations is to fully internalize them, removing any further external interactions. For example, the most successful strategies of using external sources of innovation in Christensen, Olesen, and Kjær (2005) were enacted by firms that acquired external suppliers and then used those acquisitions as the basis of a closed innovation strategy. The opposite approach is to hold the technology at arm's length—to source the technology as a black box component for systems integration (Jaspers and van den Ende, 2010).

Absorptive Capacity and Substitution Effects

The largest single body of integration research is on absorptive capacity: more than 80 articles in the sample mention this phrase. Following Cohen and Levinthal (1990), they look at the effect that internal R&D capabilities have upon the ability to utilize external knowledge. As in the earlier studies, research on external sources of innovation tends to proxy absorptive capacity as R&D intensity or total R&D expenditure; Li and Vanhaverbeke (2009) sought to use size as a proxy for absorptive capacity but did not find significant effects. Other researchers have supplemented R&D expenditures with the proportion of employees with graduate education or a scientific-technical graduate education (Grimpe and Sofka, 2009; Tether and Tajar, 2008).

Most research using the Cohen–Levinthal conception have hypothesized that higher internal absorptive capacity helps firms capitalize on external sources of innovations. These hypotheses fall into two categories: firms with high absorptive capacity will be more likely to use innovations from external sources, or that firms will be more successful in such use.

Researchers have conflicting predictions about the effect of absorptive capacity on collaboration: some suggest that absorptive capacity reduces the need for collaborations (Barge-Gil, 2010), while others argue that it increases the likelihood that firms will do so (De Faria, Lima, And Santos, 2010). Perhaps more frequently, scholars have argued that absorptive capacity makes remote collaboration more effective (de Jong and Freel, 2010), and firms with a broader knowledge base are more likely to externally source technologically "distant" technologies (Laursen et al., 2010).

The results of absorptive capacity on performance are more consistent. Absorptive capacity amplifies the benefits of external innovation sourcing both on innovativeness and on financial performance (Rothaermel and

Alexandre, 2009). It speeds the assimilation of external knowledge and commercialization of such knowledge (Fabrizio, 2009) and provides more benefits for firms seeking knowledge from customers rather than from competitors (Grimpe and Sofka, 2009).

However, these results could also be interpreted as a substitution effect: firms with strong internal R&D are less likely to have interest in external technology. This presents competing hypotheses: absorptive capacity suggests decreased external sourcing or sourcing effectiveness for low R&D firms, while substitution suggests increased external sourcing for such firms. Again, there are two types of substitution effects: does strong internal R&D (measured by expenditures, intensity, skills, or capabilities) reduce the interest in using innovation from external sources, or does it reduce the value of such use? The two could be related, if firms correctly perceive internal and external investments as competing rather than complementary: adopting an inbound open innovation strategy could allow financially conscious managers to use it as an excuse to cut internal innovation resources, subject to the need to maintain enough absorptive capacity to evaluate and integrate external innovations.

The earliest research on this substitution effect was mixed. Chesbrough and Crowther (2006, p. 235) found that using external innovation sources was “not employed primarily as a rationale for cost reduction or outsourcing of the R&D function.” While Witzeman et al. (2006) found external sourcing of innovation was distinct from outsourcing R&D, they reported that much of the resistance to using external sources came from managers who saw expenditures on external and internal innovations as a zero-sum game. Larger sample studies suggest moderators as to when external sourcing substitutes for or complements internal capabilities. Laursen and Salter (2006) unexpectedly found that increased R&D intensity reduced the benefits of breadth and depth of innovation search. Ceccagnoli et al. (2010) concluded that external sourcing was driven by a lower R&D productivity, and that such sourcing could be used to improve such productivity. In a survey of 141 U.S. manufacturing firms, Rothaermel and Alexandre (2009) conclude that the optimal financial performance comes from a mix of 61% external and 39% internal sourcing.

Implications for Competencies

Externally sourcing innovations could change the R&D competencies of the firm, both directly and indirectly. On the one hand, resources allocated to sourcing innovations from external sources could directly reduce the resources

made available for internal innovation. On the other hand, external sourcing can improve internal R&D capabilities (Ceccagnoli et al., 2010).

Indirectly, a decision to pursue an external innovation sourcing strategy would normally cause firms to seek the competencies necessary to make such a strategy effective. Du Chatenier, Verstegen, Biemans, Mulder, and Omta (2010) used exploratory interviews and focus groups to identify individual-level skills for professionals working with external innovations, including interpersonal skills, project management, and ability to manage the collaborative innovation process.

Firms that have high levels of confidence in their competencies will tend to use internal innovations and bypass external sources in areas that overlap their core competencies (Dittrich and Duysters, 2007). However, Christensen (2006) predicts that in an open innovation world, deep technological competencies will play less of a role in firm success, but instead firms will need integrative competencies necessary to integrate externally sourced innovation.

Summary

Considerable research has studied the role of absorptive capacity (measured by internal R&D investments) as a complement for utilizing external innovation, but more research is needed on the substitution effects. Meanwhile, despite its early identification, the role of organizational culture on integration has rarely been studied—with Herzog and Leker (2010) offering a notable exception.

An important opportunity would be to combine these two topics: does the organizational culture predict whether internal R&D investments facilitate integration rather than reduce interest in same? Another opportunity would be to develop a theory and evidence about the development and application of competencies for integrating innovation from external sources, and how these are similar to or different from their inwardly focused counterparts.

Commercializing Innovations

A key difference between earlier work and Chesbrough’s view of using external sources of innovation is the latter’s unwavering focus on how firms make money from innovations. In the view of Chesbrough (2003a, 2006a, 2006b), such profit requires both the choice of an innovation and its commercialization strategy to be fully aligned to a firm’s business model. For example, Chesbrough (2003a, p. xxiv) wrote: “Open Innovation

combines internal and external ideas into architectures and systems whose requirements are defined by a business model.”

Articles in the sample rarely mentioned a “business model”: the phrase appears in only about 30% of the final sample of articles, and (as Joyce and Winch, 2004, and Zott et al., 2011, found more generally) many were merely passing references. Despite the efforts of Chesbrough (2003a, 2006a, 2006b), it appears that business models are a central concern for researchers and practitioners only when considering outbound open innovation or a combination of inbound and outbound open innovation (as in Hung and Chiang, 2010). However, business model concepts are implicit in research on the commercialization phase: if two key goals of a business model are value creation and value capture (Chesbrough, 2003a; Chesbrough and Rosenbloom, 2002), research on the former was much more common than the latter.⁶

Measures of Value Creation

Early case studies provided evidence that firms were relying on external sources of innovation to create value using externally sourced technology—both high-technology industries, including semiconductors (Chesbrough, 2003a), software (West and Gallagher, 2006) and mobile phones (Dittrich and Duysters, 2007; Stuermer et al., 2009), as well as low-technology industries like construction and textiles (Spithoven et al., 2010). Other research describes how firms externally sourced knowledge, ideas, market needs, or other information (e.g., Dodgson et al., 2006; Lau, Tang, and Yam, 2010; van de Vrande et al., 2009).

Research has sought to quantify the benefits of value creation to innovation output and financial performance, frequently using standard metrics for new product development studies. Examples include rate of new product releases (Boudreau, 2010), product performance (Lau et al., 2010), revenue growth (Chesbrough and Crowther, 2006), the fraction of revenues attributable to radical innovations (Laursen and Salter, 2006), the fraction of revenues attributable to new products (Grimpe and Sofka, 2009; Laursen and Salter, 2006), or the revenues per employee because of new products (Frenz and Jetto-Gillies, 2009). Other studies use patenting as a way to compare innovation output based on external technol-

ogy (Rothaermel and Alexandre, 2009). Holmes and Smart (2009) discuss how open innovation could meet the success criteria of nonprofits. Value creation was also studied by one of the few simulation-based studies on external sources of innovation (Almirall and Casadesus-Masanell, 2010), who, in their study of partnering strategies by system integrators, found that external collaboration was at times superior for a wide range of products, while in other cases, it was superior only for less complex products.

Measures of Value Capture

Utilizing external sources of innovation can improve firm profitability either by reducing costs or by increasing prices. Chesbrough and Crowther (2006) found that cost reduction was a “secondary” motivation, while a survey of firms of 10–500 employees found that cost reduction was a less frequent goal, compared with improving innovation outputs, gaining external knowledge, or tracking changes in market demands (van de Vrande et al., 2009).

If internally sourced innovations are unique to the firm and thus potentially create differentiation, then relying on externally sourced innovations might reduce that differentiation and thus a firm’s competitive advantage. Ways to avoid this problem have included limiting sourcing to commodity inputs (West and Gallagher, 2006), sourcing on an exclusive basis (Chesbrough and Crowther, 2006), or acquiring the supplier (Christensen et al., 2005).

A handful of studies measure the benefits of external sources of innovations upon financial performance. In a survey of U.S. manufacturing firms, Rothaermel and Alexandre (2009) concluded firms had the maximum return on equity with about 61% external sourcing. Meanwhile, Belderbos, Faems, Leten, and van Looy (2010) found that an increased share of collaboratively held patents *decreased* financial performance as measured by Tobin’s Q, indicating reduced value capture from this approach to external sourcing of innovation—perhaps due to unobserved factors that drove firms to seek external partners. Similarly, Faems, de Visser, Andries, and van Looy (2010) concluded that relying on external sources of innovation decreased profitability because the cost increases of external collaborations exceeded the incremental value creation.

Summary

The research in the sample has consistently established the value creation potential of external sources of innovation—perhaps due to a broader pattern of firm and

⁶ While management researchers in general have found inconsistent use of the business model concept (Seddon, Lewis, Freeman, and Shanks, 2004; Zott et al., 2011), the concept seems more consistently used in open innovation. This may be, as Christensen et al. (2005) argue, because open innovation inherently requires joint value creation across the value chain and that the firm captures enough value to assure its viability.

researcher interest in finding new sources of innovation. However, more research is needed on capturing value from such sources—particularly research that resolves the conflicting findings regarding the performance benefits of such sourcing.

Interaction Mechanisms

The original open innovation conception of leveraging external sources of innovation (e.g., Chesbrough, 2003b, 2006a; also Kirschbaum, 2005) emphasizes a linear model, like that shown in Figure 1. However, other models of utilizing external sources of innovations have developed that include feedback loops, reciprocal interactions with cocreation partners, and integration with external innovation networks and communities. These interactive processes link or span multiple phases of the commercialization model shown in Figure 1.

Feedback Mechanisms

While Chesbrough (2003b, 2006a) augments the linear vertically integrated model of innovation commercialization with external sourcing, other models of industrial innovation include feedback loops, whether in general terms (Kline and Rosenberg, 1986) or to address specific needs. An example of the latter is the “probe and learn” model to gain iterative market feedback while commercializing radical innovations (Lynn, Morone, and Paulson, 1996).

The Dodgson et al. (2006) study of Procter & Gamble described a hybrid innovation process containing feedback loops, where a search for innovations among external sources was grafted upon a standard market-feedback model. Mortara et al. (2010) describe the iterative feedback process during the search phase of obtaining innovation from external sources. Similarly, Hughes and Wareham (2010) note that knowledge exploitation creates the same feedback loops to learning in using external sources of innovation as it does for closed innovation strategies. More generally, Berkhout, Hartmann, van der Duin, and Ortt (2006) emphasize the cyclical nature of the innovation process, replacing the more linear view of innovation with a chain of activities.

Reciprocal Innovation Processes

In addition to the feedback loops identified for single-firm strategies based on external sources of innovation, an iterative process can be found in the reciprocal exchange

of knowledge in cocreation and other collaborative innovation processes that take place outside the firm. Corresponding to the “coupled” processes of Enkel et al. (2009), these involve collaboration between the focal firm and single or multiple actors.⁷

Dyadic cocreation. The most common type of research on external sources of innovation is the dyadic interaction between two actors, usually between the innovation creator and a firm seeking innovations from external sources (West et al., 2006). However, in this sample, only about half of the coupled papers involved dyadic collaboration across the boundary of the firm.

Much of this research attempts to extend the perspective on external sources of innovation by studying the benefits of coupled processes such as R&D collaborations and technology alliances (Faems et al., 2010; Un, Cuervo-Cazurra, and Asakawa, 2010). Dyadic collaborative ties are frequently observed for stakeholders such as suppliers (Aylen, 2010; Li and Vanhaverbeke, 2009), competitors (Lim et al., 2010), and universities (Bercovitz and Feldman, 2007; Cassiman et al., 2010); other partners include nonprofit organizations (Holmes and Smart, 2009). Recent research examines the relative importance of the respective collaborators (Neyens, Faems, and Sels, 2010; Un et al., 2010) and, more generally, the partner selection process (Emden, Calantone, and Droge, 2006; Slowinski and Sagal, 2010).

While many studies explore bidirectional flows or cocreation more generally (Berkhout et al., 2006; Gillier, Piat, Roussel, and Truchot, 2010; Hughes and Wareham, 2010), others focus on spillovers that occur through collaboration. For example, De Faria et al. (2010) noted that firms that were best able to capitalize on incoming knowledge spillovers were most likely to engage in collaborative innovation, and could do so without reducing their ability to prevent outbound spillovers.

Networks. Embedded in networks through geography, existing industry relationships, and with public research networks, firms have both the opportunity to utilize networks as an external source of innovations, and to employ them to promote the commercial success of their own internally and externally sourced innovations (Vanhaverbeke, 2006).

⁷ A firm may choose to be “free riders” rather than engage in coupled open innovation processes with external communities. However, research on open-source communities identified how instead of free riding, firms authorize employee contributions to the community’s innovation efforts to gain legitimacy and access to community innovations (e.g., Dahlander and Wallin, 2006; Henkel, 2006).

As many studies argue that collaborative networks positively affect innovative performance for various types of firms (Dittrich and Duysters, 2007; Nieto and Santamaría, 2007; Zeng et al., 2010), there is an interest among researchers to better understand how to create effective networks and/or ecosystems (Birkinshaw, Bessant, and Delbridge, 2007; Rohrbeck, Hölzle, and Gemünden, 2009). Some studies have also shown how the benefits from collaboration networks can affect regional innovation performance (Belussi, Sammarra, and Sedita, 2010; Komninos, 2004).

Communities. Open innovation communities are defined as an ongoing voluntary association of individuals (or even organizations) that are organized or leveraged by for-profit actors (West and Lakhani, 2008). They differ from networks in having membership, identity, and group loyalty (von Hippel, 2007).

Some of the earliest research on extra-firm communities examined how firms leverage open-source software. West and Gallagher (2006) identify firm-to-firm collaboration as a way of pooling innovation resources, while Dahlander and Wallin (2006) examine the interactions and relative influence of hobbyists and firm employees in open-source communities. Subsequent researchers have identified the trade-offs for firms between the resources they donate to the communities and the innovations they obtain from them (Spaeth et al., 2010; Stam, 2009). Firms also have to balance the benefits from sharing against the potential loss of information, control, and differentiation to the community and potential rivals (Stuermer et al., 2009). Although open-source communities vary dramatically in their degree of firm involvement, preliminary research on extending open source principles to the production of tangible goods suggests an even greater role for firms in such communities (Raasch, Herstatt, and Balka, 2009).

Meanwhile, both Füller et al. (2008) and Ebner et al. (2009) found that willingness to participate in and contribute to firm-hosted communities were more a function of individual differences than attributes of the community or its sponsor (other than the brand reputation). Finally, Fichter (2009) identified the effect and motivation of boundary spanners who bridge between various firms, the value network, and the community activities.

Summary

A considerable body of research has examined how firms have an ongoing cooperative innovation processes with individuals, other firms, networks, and communities.

Some of this draws on the recently emerging literature on cocreation processes, while other literature (often building on Vanhaverbeke, 2006) considers why firms create or engage external networks and communities. However, more research is needed on the motivation of the external collaborator—particularly in cases where the collaboration is driven by nonpecuniary motivations (as highlighted by West and Gallagher, 2006, and Dahlander and Gann, 2010).

Discussion

Based on a review of 291 publications, this study provides a process model of how firms leverage external sources of innovation. It was elaborated and refined using a systematic review of recent research on inbound modes of open innovation. This paper complements other recent reviews by focusing on the strategic implications for firms' open innovation strategies.

This review and synthesis suggest convergence, divergence, and gaps across the work on leveraging external sources of innovation. This section highlights five major gaps in this literature: (1) alignment to business model, (2) comprehensive view of all (especially later) phases of the commercialization process, (3) the nonlinear nature of the process model, (4) the definition of "innovation," and (5) limits and moderators of the process model.

Business Models and Firm Success

If anything distinguishes Chesbrough's (2003a) conception of open innovation from earlier research on using external sources of innovation, it is the requirement that such innovations be aligned to a firm's business model. However, explicit reference to the firm's business model was rare in the sample. Many researchers focus on sourcing innovations while ignoring profiting from those innovations—much like user innovation researchers who emphasize the distributed creation of innovations rather than firm exploitation of such innovations (cf. Baldwin and von Hippel, 2011). Research on sourcing external innovations should make explicit the role of the business model, whether as a constraint on how external innovations are used, or the need to modify existing business models to better utilize external innovations (cf. Chesbrough, 2006b; Chesbrough and Rosenbloom, 2002). While a successful business model included both value creation and value capture, research on external sources of innovation has emphasized the former. Thus, more research is needed on capturing value from external sources, including explaining the difference in value capture between projects and firms.

Some of the articles in the sample explicitly tie external sourcing to specific measures of the firm's strategic success, whether the production of patents or new products (Aylen, 2010; Fabrizio, 2009), the proportion of new products (Grimpe and Sofka, 2009; Laursen and Salter, 2006; Spithoven et al., 2010), or firms' financial performance (Faems et al., 2010; Rothaermel and Alexandre, 2009). However, many more leave the linkage implicit, suggesting not only that future researchers should do a better job establishing the benefits of inbound strategies, but also seek opportunities for testing what are the most appropriate metrics for such strategies.

Examining the Entire Process

From the sample, it appears that researchers more often focus on obtaining innovations, rather than the subsequent phases of integrating and commercializing those innovations. Even within the initial phase, searching for innovations appears of greater interest than incentivizing their supply (particularly nonmonetary incentives) or contracting for their use. Filtering external ideas is also an important managerial and research challenge, with Riedl, Blohm, Leimester, and Krcmar (2010) offering an early example of how the process can be automated at a large scale.

The research on cultural barriers to integration has rarely gone beyond acknowledging the “not invented here” syndrome—Herzog and Leker (2010) being the exception—and has ignored the extensive literature on the role of culture for highly innovative organizations (e.g., Schein, 2003). As some researchers have observed, a different culture is required for successful utilization of such innovations (Dodgson et al., 2006; Witzeman et al., 2006). Generalizability requires a more systematic analysis of the effects of culture: a testable proposition is that many of the key elements of a culture that integrates external innovations would also be found in previous characterizations of high-performance R&D organizations.

However, there is more to integration than just culture. Firms have explicit processes and systems which may encourage or discourage the use of external sources of innovation, as when Ebner et al. (2009) examined the alignment of a firm's innovation sourcing to the motivations of internal stakeholders. More fundamentally, future research could test whether the competencies used for developing internal innovations need to be augmented when it comes to productizing externally sourced innovations.

Research on the final commercialization phase of the process model is especially scarce. Although research on the acquisition and use of innovation from external sources implicitly assumes externally sourced technology is commercialized the same way as internally developed technology, is this true in practice? Do these externally sourced innovations have the same impact on profitability? Is externally sourced technology more or less strategic than that developed internally?

Clarifying “Innovation”

This study found considerable disagreement (if not confusion) within the sample about what constitutes “innovation” (cf. Bogers and West, 2012). Much of the research was not actually about innovation as previously defined in innovation research (e.g., Chesbrough, 2003a; Freeman, 1982). In particular, the “innovation” studied by researchers in the sample may focus on antecedents (van de Vrande et al., 2009), processes (Chiaroni, Chiesa, and Frattini, 2010), or outcomes (Almirall and Casadesus-Masanell, 2010). Moreover, the focus is often not confined to merely “innovation”—with some research emphasizing ideas (Piller and Walcher, 2006), problems (Terwiesch and Xu, 2008), or knowledge (Laursen and Salter, 2006).

One commonly studied antecedent is the technology or technical invention. Garcia and Calantone (2002, p. 112) state that innovation “comprises the technological development of an invention *combined* with the market introduction of that invention to end-users through adoption and diffusion.” Thus, a patent or other measure of technology may measure potential innovations, but in reality what firms are often sourcing are ideas, inventions, technologies, or latent innovations (Bogers and West, 2012).⁸ An even more common and problematic confusion comes when knowledge is referred to as “innovation,” rather than (as in Thornhill, 2006) as a resource that is utilized in the process of creating innovations. Many of the articles in the sample talk about external knowledge as “external innovation”: in some cases, merely changing “innovation” to “knowledge” would solve the problem. However, in most cases, knowledge alone is not innovation: commercially valuable innovations are often created through the novel recombination of existing knowledge (Galunic and Rodan, 1998; Khilji, Tomasz, and Bernstein, 2006).

⁸ Among the earliest goals of using patents was as “a reliable proxy measure of innovative activity” such as R&D spending (Acs and Audretsch, 1989, p. 172; see also Griliches, 1990, p. 1670). In the Schumpeterian distinction between invention and innovation, patents are thus a convenient way to measure the output of technical invention activities.

Some of this confusion would be naturally resolved through research that extends beyond obtaining innovations to include integrating and commercializing them. More generally, researchers on the outside-in process could examine the various tangible and intangible antecedents to innovation success, as Rothaermel and Hess (2007) did for biotech companies.

Beyond the Linear Process

The original Chesbrough model of open innovation is a sequential, linear model. However, the Enkel et al. (2009) concept of a “coupled” practice—two-way interaction between firms and innovative actors outside the firm—is one example that goes beyond this linear model to include reverse flows of knowledge beyond what is predicted by the linear model.

Communities and value networks have long been identified as an important source of innovations for firms sourcing external innovations (Chesbrough et al., 2006; Jeppesen and Frederiksen, 2006; West and Lakhani, 2008). However, such research has emphasized the value created by the inbound flows of innovations, and not the direct or indirect costs of the outbound portion of the coupled process. Future research on open innovation communities and their associated firms should both assess the collective costs and benefits to firms of participating in such a community, as well as the innovation flows between firms through the community. (The data availability of open-source software makes it a particularly attractive venue for such research.) Other research could examine such costs, benefits, and flows in dyadic cocreation between firms and external partners, including drawing more sharply the boundaries between complementary and competing cocreation efforts. Similarly, researchers need to examine how efforts to capture value from outbound open innovation strategies may hinder collaboration with network or community partners (cf. Alexy, Criscuolo, and Salter, 2009).

More generally, few researchers (e.g., Burcharth, Knudsen, and Søndergaard, 2012) have examined firms that practice both outside-in and inside-in innovation, despite the original exemplar of IBM described by Chesbrough's (2003a) original study. A decade later, researchers know very little about why or how often these two activities coexist in one firm, let alone how they are linked within the firm. Future research should accordingly further investigate whether how and why firms implement combinations of open innovation modes, and to what extent they complement or substitute each other. And while this review highlights the prevalence of studies

of the different open innovation modes, there is a particularly strong dearth of research that takes a holistic perspective by studying (the combination of) inbound, outbound, *and* coupled modes.

Finally, feedback loops have long been identified as a way to incorporate customer or marketing feedback into the innovation process. How does this change our understanding of how firms profit from external sources of innovation? Is the feedback more or less effective, efficient, or even feasible for externally sourced innovations than for internal ones? Under what conditions are firms willing to export such flows to innovation suppliers outside the boundaries of the firm, rather than the traditional market research feedback inside a firm?

Moderators and Limits

Some research designs only consider the benefits of utilizing external sources of innovation, not the risks or costs. In some cases, the use of external innovations appears to improve performance, but only up to a point. For example, both Laursen and Salter (2006) and Belderbos et al. (2010) found a curvilinear benefit for firms searching for external sources of innovation, suggesting limits to leveraging external sources of innovation. A few researchers have identified negative impacts of external sourcing strategies, whether through reduced output or because improvements failed to exceed the cost of such strategies. Dahlander and Gann (2010), and Faems et al. (2010) are among the few to identify these effects, which can include increased costs because of coordination and integration, and risks of knowledge leakage and entry by rivals.

Research that identifies moderators of the benefits of external innovation is scarce. Wincent, Anokhin, and Boter (2009) found that the size of a firm's external network moderated the impact of supervisory board turnover upon the benefits of utilizing external knowledge. Another key question for acquiring external technology is how the price compares to the value that the acquiring firm can realize. Ransbotham and Mitra (2010) thus identified the moderators of acquisition price for firms buying technology by acquiring telecommunications start-ups. Moderation effects may be derived from the interaction between internal and external cooperation (Hillebrand and Biemans, 2004) as in line with the role of internal organization in shaping the ability to leverage external sources of innovation (cf. Bogers and Lhuillery, 2011; Foss, Laursen, and Pedersen, 2011; Song, Montoya-Weiss, and Schmidt, 1997). Other moderators or limits to the value of external sources may be found by

examining contexts beyond product innovation, including services (Chesbrough, 2011) and process innovation (Bogers and Lhuillery, 2011).

Moderators could also be measured as within-firm effects. Many papers operationalized “open” as a firm-level decision rather than one for a specific project (or even component within a project). A comparison of multiple open innovation decisions (or outcomes) within firms would reduce confounds and thus could help identify some of these potential moderators.

Finally, little is known about the failures of open innovation. Chesbrough speculates that this is because companies and consultants are trumpeting their successes and hiding their failures, thus making it difficult for researchers and managers to learn from those failures (Pop, 2012).

Conclusions

In one of the first efforts to define an agenda for open innovation research, West et al. (2006) suggested opportunities for open innovation research at different levels of analysis. In particular, they called for research into how internal firm incentives impacted the ability of firms to utilize external innovations, a topic that remains underresearched.

This review has shown an extensive body of research on the front end of the process of externally sourcing innovation, but leaves major gaps on how such innovation is integrated and ultimately commercialized. As such, it remains unclear how external innovations travel from the outside to a commercial product through the firm’s business model and to what extent it requires distinct innovation strategies.

This more general model of how firms leverage external innovations suggests a broader research opportunity: what happens to innovations once they come into the firm? Decades of new product development research have examined what happens to product ideas as they work their way through the pipeline, but such research has only just begun for open innovation.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Online Appendix: Inbound and Coupled Open Innovation Articles.