

Chapter 1

Explicating Open Innovation: Clarifying an Emerging Paradigm for Understanding Innovation

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Abstract

We explore the growth, scope and impact of the academic literature that has arisen since the publication of *Open Innovation* back in 2003. Moreover, we further clarify and develop the conceptualization of open innovation, which we define as a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model. On this basis, we then discuss divergent views on open innovation and we call for greater consistency in future research. Next, we address some of the critiques on the notion and development of open innovation as they have emerged in the literature so far. Finally, we consider the progress open innovation research has made, relative to the research agenda identified in Chesbrough, Vanhaverbeke, and West (2006), and extend the possible research subjects and units of analysis.

Keywords

Open innovation; Literature; Review; Research; Practice; Definition; Spillovers; Critiques; Agenda

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1. Introduction

In this chapter, we survey the considerable academic literature that has arisen since the publication of *Open Innovation* (Chesbrough, 2003a) in April 2003. According to Google Scholar, there have been over 6,000 citations to this book since its publication a decade ago. Moreover, a number of academic and practitioner journals have organized special issues that were inspired by the book and the subsequent scholarship it motivated. These journals include *R&D Management Technovation*, *Research Policy*, and *Research-Technology Management*. Stimulating more academic scholarship in open innovation was the explicit intention of an edited volume by Chesbrough, Vanhaverbeke, and West (2006).

This academic scholarship has been more than matched by the response of industry to the book and its subsequent work. Google now reports millions of page links in response to the term “open innovation”. Many consulting firms now feature an open innovation practice area in their work. Job titles like Manager or Director or VP of Open Innovation are becoming more common in many industries.

In this chapter, we seek to provide an overview of the work that has led to this broad acceptance. Informed by an analysis of academic citations, we show the growth of the academic research in the domain of open innovation (including the growing breadth of open innovation research in other fields), identify key areas of significant progress of open innovation research, and consider understudied areas. By highlighting the more general themes and development of the broad body of research related to open innovation, we aim to complement existing literature reviews in this area (e.g., Bogers and West, 2012; Dahlander and Gann, 2010; Elmquist, Fredberg, and Ollila, 2009; Huizingh, 2011; van de Vrande, Vanhaverbeke, and Gassmann, 2010; West and Bogers, 2013).

Our other goal for this chapter is to further clarify the concept of open innovation, which Chesbrough (2006b) defined as “the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively.” (p. 1) In discussing the underpinnings of open innovation, we also aim to link it more clearly to the pre-existing literature in economics and management of innovation. We particularly address the notion of R&D spillovers and propose that purposively structuring mechanisms to manage such spillovers is a uniquely defining characteristic of the open innovation concept. Accordingly, we conclude that open innovation ought to be conceptualized as a distributed innovation process that involves purposively managed knowledge flows across the organizational boundary. We also link this definition to the main types of open innovation, namely Outside-In (inbound), Inside-Out (outbound) and the combined Coupled type, as well as the associated mechanisms, including pecuniary and non-pecuniary flows.

Building on our aim to foster greater consistency around the definition of open innovation within the broader innovation literature, we moreover discuss divergent views on open innovation, we pay particular attention to the confusion that has emerged between “open innovation” and “open collaborative innovation”, and we discuss the differences and complementarities among these perspectives. In this way, we hope to encourage our academic colleagues to adopt a consistent definition of the concept, so as to retain coherence of the research in this area (and in other areas as well).

Next, we summarize and address some of the critiques of open innovation that have emerged in the literature. Such scholarly criticism is important to the development of any domain of academic work, and so we respond to the most prominent critiques in hopes of advancing the

debate around the open innovation concept. Finally, we consider the progress this research has made, relative to the research agenda identified in Chesbrough et al. (2006).

2. A Review of 10 Years of Open Innovation Research

2.1 Growth of Open Innovation

Open innovation has been growing rapidly since the term was coined by Chesbrough (2003a). When that book appeared, a Google search on the term *open innovation* yielded roughly 200 page links, most of which merely had the two words near each other in a sentence, such as “company X opened its innovation office at location Y”. There was not yet any specific meaning to the two words together as a phrase. By contrast, a search on the same search engine in April of 2012 generated 483 million links, which, by scanning through some of the links, generally seemed to address this new and very different model of innovation. This suggests that open innovation has become widely known.

Within academic research, the citations to “open innovation” in Google Scholar as a term and/or to the Chesbrough (2003a) book have also been growing, as shown in Figure 1 below. However, as can also be seen in the figure this growth in annual citations (the second derivative) is beginning to slow down in the past couple of years. Nonetheless, the figure shows several thousands of new scholarly contributions each year.

Insert Figure 1 about here

Due to the framing of the 2003 book, the audience for Open Innovation has included both academics and managers from its inception. In contrast to the slowing rate of new scholarly articles year over year, the number of books on open innovation is accelerating year over year

(Table 1). This suggests that open innovation is being translated beyond academic research into industry practice at an increasing rate.

Insert Table 1 about here

2.2 The Scope and Breadth of Open Innovation Research

Next, we more specifically explore the academic research on open innovation that has been published in peer-reviewed journals so far. Our aim here is to provide an overview of the importance of open innovation as a research area by investigating the growth of related academic research, the areas in which open innovation has attracted most attention, and the breadth of open innovation in influencing other areas than business and management within social science as well as other areas outside of social science.

In order to identify relevant research, we searched for articles within the Thomson Reuters(formerly ISI) Web of Science¹ that have “open innovation” in the title, abstract or keywords and/or cite the original Chesbrough (2003a) book. Compared to some other reviews (e.g., Dahlander and Gann, 2010; West and Bogers, 2013), we opted for a broad and general approach by also including articles (1) that did not explicitly address or adopt the definition of open innovation as suggested by Chesbrough (2003a, 2006b)and (2) that were listed as editorial material, review or meeting abstract. Moreover, we searchedfor relevant articles not only in the Social Science Citation Index (SSCI) but also in the Science Citation Index² (SCI) and the Arts and Humanities Citation Index (A&HCI).

Figure 2 shows the growth of the number of publications related to open innovation with a total number of 941 articles³within all fields of SCI, SSCI and A&HCI (shown as All). Open innovation research began in the Business and Management journals, and soon expanded to other social science journals in 2005, with a growing number of publications in the broader social

science journals emerging by 2006.⁴ By 2008, a further growth in the journals publishing open innovation research emerges in the natural and physical sciences (and to a lesser extent in the arts and humanities).

Insert Figure 2 about here

Table 2 shows this breadth of the influence of open innovation by presenting the number of articles in the various Web of Science Categories, which are used to classify journals and thereby the articles in them. The table shows that Management and Business are the most prominent. At the same time, other areas such as engineering, geography, computer science and chemistry are also well represented in open innovation research. Such publications generally include case studies or more general discussions of open innovation in particular industries, such as the chemical, pharmaceutical and food industry (although we may note that low-tech industries are still under-studied). Also represented are proposals for how open innovation can solve larger social problems, such as neglected diseases.

Insert Table 2 about here

2.3 The Impact of Open Innovation Research

We now consider the most cited open innovation-related research. Table 3 shows the 20 most cited articles that are in our sample; such citation counts are biased towards earlier publications and cannot identify more recent work that will be influential in the future.

Insert Table 3 about here

The table lists articles that we would consider to be within the domain of open innovation as well as those that do not address open innovation per se. For the latter, there are a number of

articles that do not advance our understanding of open innovation itself but instead rely on the open innovation concept to further advance the understanding of other areas. The most cited article, Teece (2007), is much more focused on advancing theories of business strategy than it is about theories of industrial innovation. Teece argues that embracing open innovation is an important part of firms' dynamic capabilities—thus bringing open innovation explicitly into the domain of theories of firm strategy. A similar argument, although less pronounced, could be made for Rothaermel and Hess (2007); other articles in this list also apply open innovation to advance the understanding of business strategy. Table 3 classifies these 20 articles into seven categories, based on our analysis from reading each of the articles in detail.

While some articles specifically address product development models—such as Cooper (2008) who discusses reinventing his stage-gate model for use with open innovation—most articles address some aspect of the innovation process. This includes Laursen and Salter's (2006) article on the (optimal) use of external knowledge for innovation performance, the most cited journal article that is at its core about open innovation. Other articles that specifically deal with the role of universities—such as university-industry relationships or openness from the university's perspective—and environmental context have a less explicit focus on the core open innovation concept. It is moreover important to note that only few of these influential articles specifically address the limits, risks and costs of open innovation. Finally, a number of articles consider the role of technology and users in innovation. An interesting example here is the Fleming and Waguespack (2007) article on what they call “open innovation communities”, although they do not explicitly refer to the Chesbrough (2003a) notion of open innovation.⁵

2.4 *Topics in Open Innovation Research*

We now address some of the main themes that have emerged in the literature on open innovation. To complement our general understanding of this literature and what we know from other recent reviews, we scanned through the articles in our database to iteratively construct patterns of recurrent themes and we developed a word cloud as a tool to find the most frequently recurring words in the articles' titles, abstracts and keywords.⁶

Figure 3 provides a word cloud with the most commonly occurring words in the abstracts of the 941 articles in our sample. It is no surprise here that “open” and especially “innovation” occur frequently here. At the same time, words like “firms”, “knowledge” and “technology” are also frequently used. Moreover, the appearance of words like “performance”, “value”, “strategies” and “management” reinforce the observation that open innovation research commonly deals with (typically large) for-profit firms.

Insert Figure 3 about here

As a complement, Figure 4 presents a word cloud based on the most frequently occurring words in the articles' keywords (instead of the articles' abstracts in Figure 3).⁷ Here we take out the words “open” and “innovation” in order to get a better understanding of the related themes within open innovation. Based on our analysis, we find that a large amount of research investigates the outside-in (inbound) side of open innovation. This research deals with how firms can leverage external knowledge and technology to accelerate internal innovation. There is often a focus on R&D with a prominent role of absorptive capacity. There is generally less focus on the inside-out (outbound) side of open innovation, although the growing interest in this area is reflected by the research on for example intellectual property (IP), licensing and selective revealing. This also relates to a growing interest in business models and business model

innovation. Moreover, again only partly reflected in Figure 4, the broad literature on open innovation addresses several mechanisms, tools and processes to identify and leverage external innovation sources, such as networks, communities, and innovation contests, often with an interest in the role of users in innovation. More recently, the notion of broadcast search through crowdsourcing has attracted particular attention in the scholarly community. Finally, open innovation research is expanding to other domains, such as low-tech industries and services, while it is also increasingly being linked to other themes, such as outsourcing and (academic) entrepreneurship, although the exact linkages with open innovation are typically not yet fully developed.

Insert Figure 4 about here

3. What Open Innovation Is and Is Not

We anchor open innovation in the prior economics and management of innovation literature, and accordingly further develop and clarify the conceptualization of open innovation, while also proposing a refined definition. Based on this, we then juxtapose open innovation to other related concepts, and discuss their differences and complementarities.

3.1 Clarifying the Open Innovation Concept

At the most fundamental level, open innovation is embedded in the notion that the sources of knowledge for innovation are widely distributed in the economy. As such, the idea that most smart people work for someone else, popularized as Joy's Law, harkens back to Hayek's (1945) view of knowledge as being distributed across the society. When Chesbrough (2003a) inaugurated the popular use of the term open innovation, it described a phenomenon of companies making greater use of external ideas and technologies in their own business, and

letting unused internal ideas and technologies go outside for others to use in their business. The book proposed “erosion factors” that undercut the logic of the earlier “closed innovation” model of R&D and developed the logic of an open innovation model. These erosion factors, such as increased mobility of workers, more capable universities, declining US hegemony, and growing access of startup firms to venture capital, changed the conditions under which firms innovate. Here we propose yet another erosion factor that allows firm to leverage increasingly distributed knowledge sources, namely the rise of the Internet (and the related rise of social media), which has brought the knowledge access and sharing capabilities of previously firm-specific internal ICT networks to the World Wide Web. These erosion factors are at the core of why open innovation reflects a paradigm shift as they challenge the basic assumptions, problems, solutions and methods for the research and practice of 21st century industrial innovation (cf. Kuhn, 1962).

Following the introduction of the open innovation concept, Chesbrough’s (2006b) “purposive inflows and outflows of knowledge” definition of open innovation was intended to make the definition more formal and to connect it to previous academic work. Accordingly, open innovation refers to an innovation model that emphasizes purposive inflows and outflows of knowledge across the boundary of a firm in order to leverage external sources of knowledge and commercialization paths, respectively. Here we provide further motivation for this conceptualization.

The definition of “purposive inflows and outflows of knowledge” hearkens back to a vibrant economic literature on spillovers that arise from the firm’s investment in research and development. Because firms cannot fully specify the outcomes of this investment in advance, R&D inevitably produces outcomes that were not expected *ex ante*. These outcomes spill over beyond the ability of the investing firm to benefit from them, hence the term “spillovers”. Richard

Nelson observed back in 1959 that basic research generated many spillovers, and that firms who funded this research had only limited ability to appropriate value from these spillovers (Nelson, 1959). Kenneth Arrow (1962) also took note of this spillover problem, recognizing that these spillovers meant that the social return to R&D investment exceeded that of the private return to the firm undertaking the investment. Hence, he reasoned, private firms will underinvest in R&D from a social perspective. It is reasonable in this context for the public to provide a subsidy for R&D investment, in order to stimulate further R&D to move closer to the socially ideal level. Cohen and Levinthal (1990) in turn wrote about the importance of investing in internal research in order to be able to utilize external technology, an ability they termed “absorptive capacity”. Nathan Rosenberg asked the related question, why do firms conduct basic research with their own money (Rosenberg, 1990), and answered that this research enhanced the firm’s ability to use external knowledge. It is important to note, however, that the specific mechanisms to enable companies to absorb external knowledge were not identified by these scholars. Nor was there any consideration of companies opting to move unused internal knowledge out to the wider environment.

This prior research points out the presence of spillovers, and the benefits of being able to utilize them when they exist in one’s surrounding environment. Throughout this literature, however, spillovers are deemed a cost to the focal firm of doing business in R&D, and are judged to be essentially unmanageable. This is the critical conceptual distinction made by the open innovation concept, which proposes that, in the open innovation model of R&D, spillovers are transformed into inflows and outflows of knowledge *that can be purposively managed*. Firms can develop processes to seek out and transfer in external knowledge into their own innovation activities. Firms can also create channels to move unutilized internal knowledge from inside the

firm out to other organizations in the surrounding environment. Specific mechanisms can be designed to direct these inflows and outflows of knowledge. Thus, what was unspecified and unmanageable before can now be specified and managed in the open innovation model.

These elements then give a basis to refine the definition of open innovation. Also following the original and more recent conceptualizations (Chesbrough, 2003a, 2006b; Gassmann and Enkel, 2004; Dahlander and Gann, 2010; West and Bogers, 2013), we define open innovation as a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model. These flows of knowledge may involve knowledge inflows to the focal organization (leveraging external knowledge sources through internal processes), knowledge outflows from a focal organization (leveraging internal knowledge through external commercialization processes) or both (coupling external knowledge sources and commercialization activities), as we further discuss below. In this definition, innovation refers to the development and commercialization of new or improved products, processes or services, while the openness aspect is represented by the knowledge flows across the permeable organizational boundary, as also shown in Figure 5. As an organizational construct, it is moreover the business model, which may be implicit or explicit, that puts the distributed innovation process into the organizational realm as it describes not only how value is created within the value network but also how it is captured by the involved organization(s).⁸

Insert Figure 5 about here

3.2 Types and Mechanisms of Open Innovation

Following the above conceptualization of open innovation, the purposive management of knowledge spillovers essentially implies two directions of knowledge flows across the boundary

of the firm or organization more generally: Outside-In (or Inbound); and Inside-Out (or Outbound) open innovation. Following Gassmann and Enkel (2004), to these we add a third type, namely Coupled open innovation, which implies combined knowledge inflows and outflows between actors in the innovation process. Figure 5 provides an illustration of these different types of open innovation. The figure shows different paths that knowledge or technology may follow within and across the boundaries of the firm. It also extends the open innovation model from upstream R&D to manufacturing and marketing (as examples of functional areas) to thereby highlight the importance of more downstream activities in the overall innovation process (Bogers and Lhuillery, 2011) and to emphasize the importance of considering all activities from invention to commercialization in order to create *and* capture value from ideas and technologies (Chesbrough, 2006a; West and Bogers, 2013).

As shown in the analysis above, extant academic research and industry practice has paid most attention to Outside-In open innovation, while the Inside-Out and Coupled types are less well understood. For example, in a review of 165 open innovation articles, West and Bogers (2013) find 118 addressing Outside-In open innovation, in contrast to 50 articles addressing the Inside-Out type. Moreover, while 70 articles in their sample address Coupled open innovation, there remains a lack of understanding of the interactive and reciprocal nature of such coupled innovation processes.

The Outside-In type of open innovation involves opening up a company's own innovation processes to many kinds of external inputs and contributions, for example through acquiring or sourcing, following Dahlander and Gann (2010), while West and Bogers (2013) identify obtaining, integrating and commercializing as phases of the inbound open innovation process. The company's business model, in turn, determines which external inputs and

contributions will be taken forward into the market. In open innovation (Chesbrough, 2003a, 2006a), a variety of mechanisms are identified that help firms manage purposive inflows of knowledge: scouting, licensing IP, university research programs, funding startup companies in one's industry, or collaborating with intermediaries, suppliers and customers, and utilizing nondisclosure agreements. Subsequent research has identified additional mechanisms, including: crowdsourcing, competitions and tournaments, communities, and spin-ins or spin-back.

The Inside-Out type of open innovation requires organizations to allow unused and under-utilized ideas and assets to go outside the organization for others to use in their businesses and business models (cf. Arora, Fosfuri, and Gambardella, 2001a; Maarse and Bogers, 2012; Tranekjer and Knudsen, 2012). Following Dahlander and Gann (2010), interactions in this type of open innovation can involve either selling or revealing. The business model for the idea often will differ from that of the company from which it came, and often the business model must be discovered, in order to take the idea to market. The mechanisms for managing outflows of knowledge from the firm as also identified by Chesbrough (2003a, 2006a; Chesbrough and Garman, 2009) include: outlicensing IP and technology, donating IP and technology, spin-outs, corporate venture capital, corporate incubators, joint ventures and alliances (i.e., becoming a supplier to or a customer of a new initiative, vs. executing the initiative internally).

A third type of open innovation links Outside-In and Inside-Out open innovation processes (Bogers, 2012; Enkel et al., 2009; Gassmann and Enkel, 2004). This Coupled type of open innovation involves combining purposive inflows and outflows of knowledge to collaboratively develop and/or commercialize an innovation. Coupled open innovation involves two (or more) partners that purposively manage mutual knowledge flows across their organizational boundaries through joint invention and commercialization activities (Bogers,

2011; Bogers, Bekkers, and Granstrand, 2012). While Coupled open innovation may in principle involve any combination of the respective mechanisms for Outside-In and Inside-Out open innovation, companies may implement specific mechanisms, such as strategic alliances, joint ventures, consortia, networks, ecosystems and platforms, all involving complementary partners.

3.3 Divergent Views on “Open” Innovation

There have emerged various perspectives that build on the distributed nature of innovation sources (cf. Bogers and West, 2012). Despite some common ground and complementarities, there are also stark differences between some of these perspectives. These definitional disputes matter to the further development of academic research in this area. Clay Christensen, a sympathetic outside observer of an Academy of Management symposium⁹ from August 2012, reported the following observation about the confusion resulting from different ways open innovation was being defined:

“There is also a major downside to being *imprecise* in the definition of open innovation. An imprecise definition not only makes open innovation more difficult to understand, because little research is done on the actual phenomenon, but it also makes it more difficult to implement, because there are a lot of people who claim to talk about “open innovation” but are actually talking about something else.” (Christensen, 2012)

The most notable complementary perspective to open innovation relates to the distributed social division of labor as pioneered by Eric von Hippel (1988, 2005). This perspective emphasizes the public good nature of much of the innovations that have been described by von Hippel and others, a conceptualized through notions as “open, distributed innovation” (von Hippel, 2005), “open source innovation” (Raasch, Herstatt, and Balka, 2009) and “open collaborative innovation” (Baldwin and von Hippel, 2011). However, we observe that the divergent use of terminology for open innovation has contributed to some confusion in the

literature. For example, the term “open” has been used as a synonym for “user-centric”, as exemplified by von Hippel’s use of the terms:

“In this book I explain in detail how the emerging process of user-centric, democratized innovation works.... Open, distributed innovation is “attacking” a major structure of the social division of labor.”(von Hippel, 2005, p.2)

His specific perspective on open innovation has more recently been described as follows:

“An innovation is “open” in our terminology when all information related to the innovation is a public good—nonrivalrous and nonexcludable. ... It differs fundamentally from the recent use of the term to refer to organizational permeability.” (Baldwin and von Hippel, 2011, p. 1400).

While this schism in definitions may to some extent reflect a fundamental difference in the conceptualization of innovation, this difference may be more a matter of emphasis than reflecting incompatible perspectives. On the one hand, “open innovation” entails purposefully managing knowledge flows across the organizational boundary as well as the associated business model as defining features. On the other hand, “open collaborative innovation” and related notions refer to an innovation model that emphasizes low-cost or free production of public, non-rivalrous, non-excludable goods. There are indeed some signs of convergence in that these perspectives are becoming part of a larger holistic research domain that draws on the notion of distributed sources of knowledge for innovation (cf. Bogers and West, 2012). For example, Dahlander and Gann (2010) have developed a useful integration of the two definitions, yielding a framework based on inflows and outflows of knowledge, while also respecting both pecuniary and non-pecuniary motivations for participation. As such, firms may selectively reveal some of their knowledge, thus relying on “best of both worlds” (von Hippel and von Krogh, 2003). More fundamentally, some business models support open source development methods, and publishing one’s discoveries has become an important part of IP management strategy (Chesbrough

and Appleyard, 2007). The different perspectives moreover appear to reflect complementary perspectives on the innovation process given that users may be particularly important sources of innovation in the early phases of industry development, while firm involvement is typically needed for the further development and scaling up in the industry (cf. Baldwin, Hienerth, and von Hippel, 2006; Bogers, Afuah, and Bastian, 2010; Shah and Tripsas, 2007). In other words, after the initial inventions by users, business models help to further advance the relevant products and processes by capturing some of the public good knowledge, attracting capital, scaling the innovations, and thereby creating an economically sustainable business or industry.

4. Responding to Critiques on Open Innovation

One result of the growing academic attention that open innovation has received is the emergence of critiques of the concept. These academic critiques are an invaluable part of the scholarly process. They challenge weak or unsupported arguments. They highlight errors in logic or gaps in supporting evidence. It is only appropriate, therefore, to discuss these critiques, evaluate their main arguments, and provide a response that can guide future scholars in their own assessment of open innovation.

In general, the critiques are broadly characterized by two main arguments. First, some have argued that open innovation, as it has been introduced by Chesbrough (2003a), is not in fact a new phenomenon. This implies that open innovation does not rise to the standard of being a valid, novel insight into innovation. One critique summarizes its viewpoint with its pithy title, “Old Wine in New Bottles” (Trott and Hartmann, 2009), while the other states in its title, “Plus Ça Change...” (Mowery, 2009). A second, different contention is that open innovation is explaining something new, but these new phenomena can be explained by an already established

concept. This implies that we don't need a new concept or theory to account for the phenomenon. This critique claims that open innovation may be a "communication barrier for theory development" (Groenand Linton, 2010).

4.1 Old Wine in New Bottles?

Trott and Hartmann (2009) engage the Chesbrough (2003a) book at some length, and subject it to a rhetorical analysis. They argue that the concept of Closed Innovation was a rhetorical strawman that no company ever followed. They claim that companies have always been open in their innovation processes, so that there was no real change in innovation paradigms from Closed to Open. There are, however, specific points in the 2003 book that do explicate a novel phenomenon. Chesbrough (2003a) identified erosion factors that influence the conditions under which innovation takes place (e.g., increased mobility of workers, more capable universities, declining US hegemony, and growing access of startup firms to venture capital) have changed, giving rise to a new paradigm in which firms need to be and benefit more from being open for innovation. This does not imply that individual elements of open innovation were absent in the earlier paradigm, but rather that they now combine to form a new paradigm to manage innovation. These points, however, are not discussed in Trott and Hartmann's analysis.

Trott and Hartmann also complain that the book took insufficient account of prior academic literature in its development of open innovation. We would note that many of the 174 footnotes in Chesbrough (2003a) cite prior academic research. And we would observe that Trott and Hartmann adopt their own rhetorical strawman in their critique by considering only one work in a much larger stream of research. That is, their criticism is based entirely on the Chesbrough (2003a) book, which was aimed at managers as well as academics. In contrast to

managers, who need frameworks to make sense of complex phenomena (and have only a limited tolerance for prior academic work), scholars are a different kind of audience, requiring limits and caveats to a new concept, as well as extensive references to prior literature. These are all present in the Chesbrough et al. (2006) treatment and the many academic papers that were subsequently inspired by this work, but none are thoroughly engaged in this 2009 critique.

Finally, Trott and Hartmann piece together prior literature from a wide variety of fields in their critique of open innovation. In our view, this actually shows one of the benefits of the open innovation concept, namely that it is a novel synthesis of many previously disparate points. Trott and Hartmann acknowledge this in their closing paragraphs, in which they themselves highlight the value of the open innovation concept in reaching “new audiences ... that the innovation and R&D literatures failed to reach for so many years” and in creating “real-life laboratories” for studying the mechanisms of open innovation.

4.2 Plus Ça Change?

Mowery's (2009) article provides a different, and in many ways contrasting, critique of open innovation than that offered by Trott and Hartmann. As his title suggests, Mowery's thesis is that the developments of the past generation are returning innovation to a model not unlike that which prevailed during the latter part of the 19th and early 20th century. Mowery's discussion of open innovation, regrettably, is quite superficial, with little notice taken of any of the evidence or the analysis offered in the Chesbrough (2003a) book, such as the change in erosion factors noted above. Nor does he, like Trott and Hartmann, consider the subsequent open innovation research.

However, his detailed analysis of the US innovation system over the past century is quite well done and actually provides further evidence for some of the erosion factors noted by

Chesbrough (2003a). His analysis is based on secondary data sources, most of them from the level of the US economy, while the Chesbrough (2003a) volume was supported primarily from qualitative studies of specific firms' R&D processes using primary data sources. Yet, though the evidence and methods of the Mowery article differ substantially from the Chesbrough (2003a) book, his article confirms that the process of industrial innovation has indeed changed in the past 40-50 years. This stands in stark contrast to Trott and Hartmann's critique, which asserts that little has changed.

Mowery's critique also overstates his argument. There is indeed some continuity between the innovation systems of a century ago and the systems of today. The large-scale industrial research laboratories that arose during the last century have receded. But to state that we have returned to innovation conditions of a century ago overlooks a great deal that is new. The roles of startup firms, of venture capital, the growth of federally funded university research, of Bayh-Dole IP rules for university ownership of that taxpayer-funded research, the strengthened IP protection arising from the creation of a dedicated federal circuit court, and the growth of R&D activity in SMEs relative to R&D activity today in large companies—all of these differ substantially from the period of the second industrial revolution (when some of the large companies of that era were monopolies, such as railroads, oil companies, telegraph and telephone companies, etc.).

There is however a very good comment made in this otherwise inadequate critique. Institutional context is important to the operation of innovation processes in general and to open innovation in particular. Mowery is right to emphasize that this needs to be included in any analysis of innovation, including open innovation. This implies that open innovation will work

differently in different institutional environments, and may not work effectively in at least some of them. This remains an important area for future research in open innovation.

4.3 Communication Barrier?

Finally, Groen and Linton (2010) critique open innovation from a very different perspective from either earlier critique. They acknowledge that much has changed about industrial innovation over the past generation, but question whether one need resort to a new concept like open innovation to explain it. The concept of the supply chain covers everything open innovation covers, in their view. They propose that the term “open innovation” may be “hindering growth in research and understanding [because it may create] false barriers that inhibit communication between different groups of academics.” (Groen and Linton, 2010: p. 554).

This critique revolves again around definitions. Innovation is about the creation of new products, services and processes, while the supply chain is about the management of existing products, services and processes throughout the value chain. Open innovation also includes many more innovation actors than does the concept of the supply chain from raw material to the final consumer. Universities, research consortia, spin-offs, false negatives, business models, venture capital, IP management, ideation contests, innovation communities—to name a few of the open innovation stakeholders and processes—have no place in the supply chain literature.

While open innovation has some overlap with supply chain management (and also with product development models like Robert Cooper’s Stage Gate model), we come to the opposite conclusion of Groen and Linton (2010), as open innovation (1) deals specifically with the creation of new products, services and processes and (2) covers a much broader range of possible

stakeholders, which provides value in using the term open innovation as distinct from supply chain management.

5. Addressing the Research Agenda for Open Innovation

In the earlier book, Chesbrough et al. (2006) devoted a final chapter to the topic of a research agenda for open innovation. It is useful to briefly review that chapter, and assess the research reported in this chapter according to the agenda articulated earlier.

5.1 Levels of Analysis

West, Vanhaverbeke, and Chesbrough(2006) outlined five different levels of analysis for future open innovation research. They were:

1. Individual and Groups
2. Firm/Organization
3. Inter-organizational Value Networks
4. Industry and Sector
5. National Institutions and Innovation Systems

The authors concluded that extensive work had been conducted at the organization level of analysis, and suggested that more research was needed in these other areas of analysis.

The articles examined in this chapter allow us to update our perspective on the research conducted to date under each level of analysis. Using the top-20 most cited articles in the past decade, Table 3 above documents the primary level(s) of analysis for each paper.¹⁰As the table shows, the Firm/Organization level of analysis remains the most examined in these highly cited articles, while the Network level has received significant attention as well. The other levels of analysis have by comparison not received a similar amount of attention.

Since 2006, a few new possible levels of analysis have arisen that may offer a more fine-grained framework for open innovation research. For example, West and Lakhani(2008) argued

that communities are a distinct level of analysis, given that communities are in essence an extra-organizational set of actors and thus different than the notion of inter-organizational networks as proposed by West et al. (2006). Moreover, there may be a number of intra-organizational units of analysis that show important heterogeneity with respect to firm's open innovation performance, such as business units, functional areas or innovation projects. For example, Bogers and Lhuillery (2011) showed how innovation in R&D, manufacturing and marketing were each correlated with a distinct set of external sources of knowledge. On a higher level, we may also consider the society at large given the opportunities of open innovation in the public commons, through for example initiatives like open government and open data. As such, the erosion factors noted above need to be supported by public policy, along with for example appropriate policies toward IP, and access to university research funded from public sources (Chesbrough and Vanhaverbeke, 2012; de Jong, Kalvet, and Vanhaverbeke, 2010).

Table 4 offers a larger list of possible units of analysis and research objects that could be further explored in future research. Some of the open innovation research, which we reviewed here, would embed multiple units of analysis or recombine multiple research objects, although a more comprehensive understanding of the interaction across various levels of analysis is generally still lacking (cf. Gupta, Tesluk, and Taylor, 2007).

Insert Table 4 about here

5.2 *Conclusion*

Much has been written since the advent of open innovation a decade ago. Thousands of articles, which have received numerous citations, attest to the growing academic interest in open innovation. Some of this research is highly cited, suggesting that open innovation is not simply old wine in new bottles—there is a new paradigm being constructed for the conception of

industrial innovation in the 21st century. Yet there have been disparate definitions employed during the past decade for open innovation, and the research that has been done is less coherent as a result.

We propose the following definition of open innovation, in hopes of unifying future work in this area: open innovation is a distributed innovation process based on purposefully managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with each organization's business model. These flows of knowledge may involve knowledge inflows to the focal organization (leveraging external knowledge sources through internal processes), knowledge outflows from a focal organization (leveraging internal knowledge through external commercialization processes) or both (coupling external knowledge sources and commercialization activities).

We know from studies of the role of standards in innovation that establishing standards can help to direct further innovation in more efficient, productive ways (Shapiro and Varian, 1998). Adopting a consistent definition of open innovation, and building upon that shared definition, would help accelerate our understanding of this new approach to innovation. We hope that our compilation of open innovation research in this chapter, along with our discussion of definitions and critiques, will help us move in this direction as a community of scholars.

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7. Figures and Tables

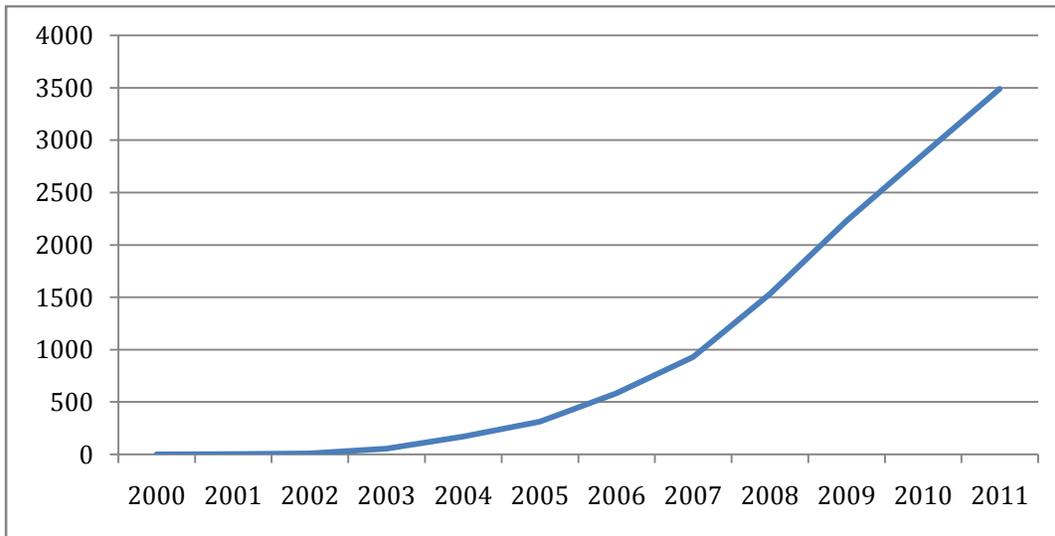


Figure 1: Annual citations to open innovation in Google Scholar (search criteria: “open innovation”, Chesbrough)

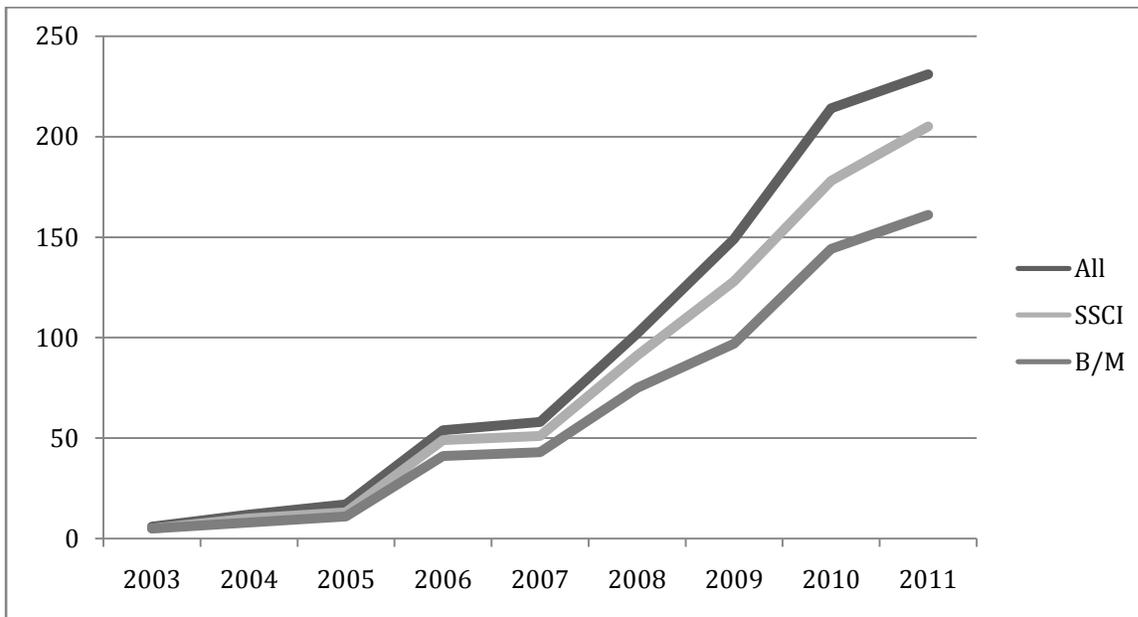


Figure 2: Growth of publications on open innovation in Web of Science

Notes: Search criterion: “open innovation” in title, abstract or keyword or citing Chesbrough (2003a); All = SCI, SSCI and A&HCI; SSCI = Social Science Citation Index; B/M = Business or Management category (within SSCI)



Figure 3: Word cloud based on abstracts, top-30 words (generated with Wordle.net)



Figure 4: Word cloud based on author keywords, top-50 words excluding “open” and “innovation” (generated with Wordle.net)

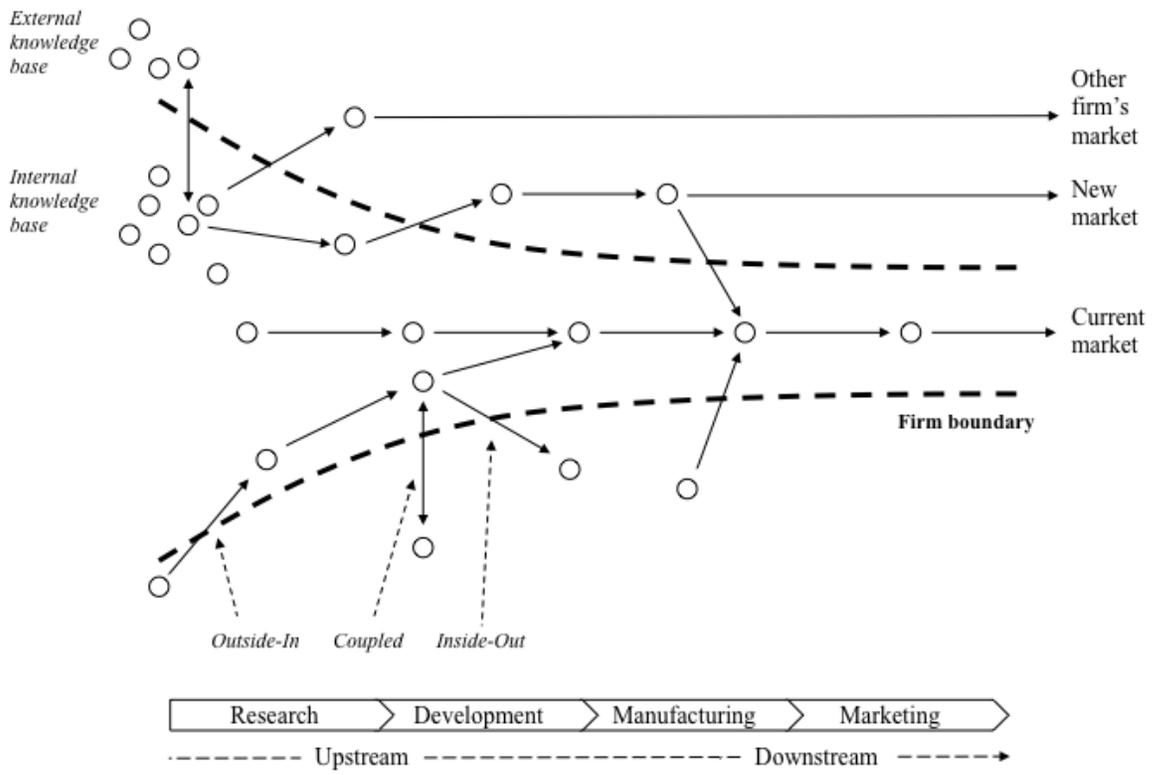


Figure 5: The open innovation model

Table 1: Books with open innovation in the title since 2003

Author(s)/Editor(s)	Title	Year Published
Chesbrough	Open Innovation: The New Imperative for Creating and Profiting from Technology	2003
Chesbrough	Open Business Models: How to Thrive in the New Innovation Landscape	2006
Chesbrough, Vanhaverbeke, and West	Open Innovation: Researching a New Paradigm	2006
Gaule	Open Innovation in Action: How to Be Strategic in the Search for New Sources of Value	2006
OECD	Open Innovation in Global Networks	2008
Fasnacht	Open Innovation in Financial Services: Growing Through Openness, Flexibility and Customer Integration	2009
Hafkesbrink, Hoppe, and Schlichter	Competence Management for Open Innovation	2010
Lindegaard	The Open Innovation Revolution: Essentials, Roadblocks, and Leadership Skills	2010
Bingham and Spradlin	The Open Innovation Marketplace: Creating Value in the Challenge Driven Enterprise	2011
Chesbrough	Open Services Innovation	2011
Dahlander, Frederiksen, and Rullani	Online Communities and Open Innovation: Governance and Symbolic Value Creation	2011
Kinoshita	Service Entities in Open-Closed Innovation	2011
Rahman and Ramos	SMEs and Open Innovation: Global Cases and Initiatives	2011
Sloane	A Guide to Open Innovation and Crowdsourcing: Advice From Leading Experts	2011
Brem and Tidd	Perspectives on Supplier Innovation: Theories, Concepts and Empirical Insights on Open Innovation and the Integration of Suppliers	2012
dePablosHeredero and Lopez	Open Innovation in Firms and Public Administrations	2012
Lyons, Coronado Mondragon, Piller, and Poler	Customer-Driven Supply Chains: From Glass Pipelines to Open Innovation Networks	2012
Spithoven, Teirlinck, and Frantzen	Managing Open Innovation: Connecting the Firm to External Knowledge	2012

Note: Based on search on amazon.com for books up to 2012 with search term “open innovation” in the title. Inclusion of books is determined by relevance to the practice and research of open innovation, while largely excluding pure “academic publishing”, such as theses or dissertations.

Table 2: Fields represented by journals in sample

Field (Web of Science Category)	Number of articles
Management	603
Business	338
Industrial Engineering	173
Operations Research & Management Science	129
Planning & Development	123
Economics	72
Engineering, Multidisciplinary	47
Information Science & Library Science	43
Geography	32
Environmental Studies	29
Computer Science, Information Systems	26
Urban Studies	22
Chemistry, Multidisciplinary	20
Multidisciplinary Sciences	20
Engineering, Electrical & Electronic	15
Computer Science, Software Engineering	14
Public Administration	14
Computer Science, Interdisciplinary Applications	13
Pharmacology & Pharmacy	13
Computer Science, Artificial Intelligence	11
Engineering, Manufacturing	11
Chemistry, Medicinal	10
Computer Science, Theory & Methods	10
Biotechnology & Applied Microbiology	9
Food Science & Technology	9
Telecommunications	9
Education & Educational Research	8
Social Sciences, Interdisciplinary	8
Applied Psychology	7
Sociology	7
Art	5
Biochemistry & Molecular Biology	5
Engineering, Chemical	5
(Topics with 4 publications or less)	105
Total	1965

Note: One journal may be listed in multiple categories, which explains why the total number of categories is higher than the total number of articles in the sample.

Table 3: Top 20 most cited articles in sample with forward citations, main topics and levels of analysis

Author (year)	Title	Journal	Citations	Main topics							Level of analysis						
				Strategy	Product development	Innovation process	Toolkits/users	Limits/risks/costs	University	Environmental context	Individual/Group	Firm/Organization	Network	Industry/Sector	National/Institutional		
Teece (2007)	Explicating dynamic capabilities: The nature and microfoundations of (sustainable) enterprise performance	Strategic Management Journal	324	•									•				
Laursen and Salter (2006)	Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms	Strategic Management Journal	284			•		•					•				
Chesbrough (2003b)	The era of open innovation	Sloan Management Review	214		•	•				•			•				
Rothaermel, Agung, and Jiang (2007)	University entrepreneurship: A taxonomy of the literature	Industrial and Corporate Change	101			•				•				•			
Chesbrough and Crowther (2006)	Beyond high tech: Early adopters of open innovation in other industries	R&D Management	86		•	•							•		•		
Gassmann (2006)	Opening up the innovation process: Towards an agenda	R&D Management	85			•							•		•		
Cooke (2005)	Regionally asymmetric knowledge capabilities and open innovation exploring 'Globalisation 2': A new model of industry organisation	Research Policy	70									•					•
Perkmann and Walsh (2007)	University-industry relationships and open innovation: Towards a research agenda	International Journal of Management Reviews	70			•				•			•	•			
Henkel (2006)	Selective revealing in open innovation processes: The case of embedded Linux	Research Policy	68		•	•	•	•					•	•			
Rothaermel and Hess (2007)	Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects	Organization Science	65	•		•							•	•	•		

Piller and Walcher (2006)	Toolkits for idea competitions: A novel method to integrate users in new product development	R&D Management	64		•		•					•	•			
Christensen, Olesen, and Kjaer (2005)	The industrial dynamics of Open Innovation: Evidence from the transformation of consumer electronics	Research Policy	63	•		•				•			•	•	•	
Dodgson, Gann, and Salter (2006)	The role of technology in the shift towards open innovation: The case of Procter & Gamble	R&D Management	63			•	•						•			
Thrift (2006)	Re-inventing invention: New tendencies in capitalist commodification	Economy and Society	62			•							•			•
Nieto and Santamaria (2007)	The importance of diverse collaborative networks for the novelty of product innovation	Technovation	61		•	•		•						•		
Fleming and Waguespack (2007)	Brokerage, boundary spanning, and leadership in open innovation communities	Organization Science	56			•	•						•	•		
West and Gallagher (2006)	Challenges of open innovation: The paradox of firm investment in open-source software	R&D Management	55	•		•	•	•					•	•	•	
Jacobides, Knudsen, and Augier (2006)	Benefiting from innovation: Value creation, value appropriation and the role of industry architectures	Research Policy	55	•		•							•	•		
Cooper (2008)	Perspective: The Stage-Gate (R) idea-to-launch process-update, what's new, and NexGen systems	Journal of Product Innovation Management	54		•	•	•							•		
Chesbrough and Appleyard (2007)	Open innovation and strategy	California Management Review	51	•		•							•	•		
		Total for all 20 articles:	1951	6	6	17	6	4	4	4		5	16	9	3	2

Table 4: Possible units of analysis and research objects for open innovation research

Unit of analysis	Possible research object
Intra-organizational	Individual Group/Team Project Functional area Business unit
Organizational	Firm Other (non-firm) organization Strategy Business model
Extra-organizational	External stakeholders: individual, community, organization
Inter-organizational	Alliance Network Ecosystem
Industry	Industry development Inter-industry differences
Regional innovation systems	Local region Nation Supra-national institution
Society	Citizens Public policy

Notes

- ¹ We retrieved the database that serves as a basis for our analysis on July 10, 2012. We cleaned the database by completing missing data (e.g., missing abstracts) by obtaining that information from the publisher website.
- ² Specifically, the database we used was SCI-EXPANDED. We did not include conference proceedings, which are also indexed by the Web of Science.
- ³ Of these 941 articles, 731 cite Chesbrough (2003a) and 411 have “open innovation” in title, abstract or keywords.
- ⁴ Only looking at SSCI gives 679 articles that cite Chesbrough (2003a) and 337 with “open innovation” in title, abstract or keywords, which combined are 828 articles.
- ⁵ Notably absent from this list are the works of Eric von Hippel, a highly-cited innovation scholar who has written extensively on the sources of innovation. This absence can be attributed to the framing of his work, which represents a complementary perspective (more below) and which generally did not use the phrase “open innovation” or cite Chesbrough (2003a), thus not meeting the criteria to enter our sample—exceptions being von Hippel and von Krogh (2006) and the more recent Baldwin and von Hippel (2011).
- ⁶ For this purpose, we use Wordle.net, which relies on an algorithm to present word clouds that “give greater prominence to words that appear more frequently in the source text” (<http://www.wordle.net>; Accessed: July 9, 2012). As the relative size of the words is determined by the number of times it occurs, it is a useful tool to identify some of the recurrent themes in a body of research. Note that Wordle can automatically exclude stop words such as “the” and “and”.
- ⁷ This concerns the keywords as suggested by the authors in the articles themselves. We have also looked at the keywords as proposed by the Web of Science, which are based on recurring words in for example the articles’ references. Although there are some other dominant keywords/themes here (e.g., “alliances”, “biotechnology”, “science” and “systems”), the findings are roughly similar and reflected in our general analysis.
- ⁸ In our experience, public and nonprofit organizations often resist the notion that they somehow operate with a “business model”. Yet nonprofits have to sustain their operations financially over time, and need to procure resources from the environment to do this. And public organizations need to maintain political support from resource providers in order to continue their activities as well. Thus, in this broader context, nonprofit and public organizations need to create value and capture a portion of that value, in order to continue to operate.
- ⁹ Christensen reports on the symposium entitled “Open Innovation and the Theory of the Firm: (How) do Organizations and Boundaries (still) Matter?”, organized by Marcel Bogers and Teppo Felin (see <http://www.marcelbogers.com/?q=AOM2012-OpenInnovationTheory>).
- ¹⁰ Our coding is based on our assessment of which level of analysis provided the key variable(s) in the articles. In most cases, we can tie this coding scheme to the open innovation concept as defined above, although some articles are considered based on their complementary and indirect relevance given that definition. For example, even though Rothaermel et al. (2007) consider openness from the university (i.e., organization) point of view, we code it as a Network as it relates to a company’s innovation network and thereby potential of (dyadic) knowledge exchange.