

The Open Innovation Research Landscape: Established Perspectives and Emerging Themes Across Different Levels of Analysis¹

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Forthcoming in Industry and Innovation (2017)

ABSTRACT

This paper provides an overview of the main perspectives and themes emerging in research on open innovation. The paper is the result of a collaborative process among several open innovation scholars—having a common basis in the recurrent Professional Development Workshop (PDW) on “Researching Open Innovation” at the Annual Meeting of the Academy of Management. In this paper, we present opportunities for future research on open innovation, organized at different levels of analysis. We discuss some of the contingencies at these different levels, and argue that future research needs to study open innovation—originally an organizational-level phenomenon—across multiple levels of analysis. While our integrative framework allows comparing, contrasting, and integrating different perspectives at different levels of analysis, further theorizing will be needed to advance open innovation research. On this basis, we propose some new research categories as well as questions for future research— particularly those that span across research domains that have so far developed in isolation.

KEYWORDS

Open innovation; review; research; theory; contingencies; knowledge; collaboration

INTRODUCTION

The field of open innovation (OI) has experienced a strong increase in scholarly attention (e.g., Dahlander and Gann 2010; Chesbrough and Bogers 2014; Randhawa, Wilden, and Hohberger 2016), leading to important insights into how companies use inflows of knowledge to accelerate internal innovation and outflows of knowledge to expand the markets for external use of innovation (Chesbrough 2006). The term “open innovation” was coined by Henry Chesbrough (2003), who highlighted several factors that eroded the boundaries within which innovation takes place and catalyzed a move toward more open models of innovation.

Chesbrough and Bogers (2014) redefine OI as “a distributed innovation process based on purposively managed knowledge flows across organizational boundaries” (p. 17), in which OI is essentially a concept that resides at the level of the organization. Accordingly, they suggest aligning the OI process with the organization’s business model. While the original concept of OI is firm-centric, the literature links it to various related innovation phenomena, such as users as innovators (Bogers, Afuah, and Bastian 2010; Piller and West 2014), innovation communities (Fleming and Waguespack 2007; West and Lakhani 2008) or open source software development (Shah 2006; von Krogh et al. 2012) that do not necessarily consider the firm as the focal level of analysis.

Such broad embrace of OI research presents opportunities for conceptualizing and understanding the OI processes further. Certainly, recent studies highlight a variety of perspectives that relate to different forms of OI such as knowledge sourcing (Laursen and Salter 2006; Spithoven, Clarysse, and Knockaert 2011), crowdsourcing and distributed problem solving (Jeppesen and Lakhani 2010; Afuah and Tucci 2012), inter-organizational alliances (Stuart 2000; Faems et al. 2010), licensing agreements (Arora, Fosfuri, and Gambardella 2001; Bogers, Bekkers, and Granstrand 2012), as well as collaborations with and within communities, crowds or networks of individuals (including users, citizens,

scientists, etc.) (cf. von Hippel 2005; Jeppesen and Frederiksen 2006; Fabrizio and Di Minin 2008; Murray et al. 2009; Poetz and Schreier 2012; Perkmann et al. 2013; Franzoni and Sauerermann 2014; Levine and Prietula 2014). However, while these perspectives deliver unique insights into the understanding of specific distributed innovation processes, there are only limited connections across them.

This observation underpins the four main reasons that motivate the conception of this paper. The first is that since relevant studies analyze an increasing number of contexts and use different levels of analysis, the OI literature runs the risk of becoming internally disconnected and somewhat incoherent. In our view, a broad framework that combines the insights from earlier research with the prevailing relationships between the most important variables would be useful. We offer an integrative framework that allows comparing, contrasting, and integrating these different perspectives. The second reason is that while OI is a phenomenon and not a theory per se, arguably, research on OI—or important parts of it—has not been sufficiently theorized (see for instance, Bogers, Afuah, and Bastian 2010). Accordingly, one of the aims of this paper is to promote the idea that theory development should be more at the center stage of the contributions within the OI literature. The third reason is that OI is a field of research that is under (rapid) development with the result that work in the field is concentrated on a few particular areas, leaving others under-researched. This paper identifies some of the gaps within and across different research streams, thereby pinpointing new areas for research—in particular, we propose new research questions that span across collaborative innovation concepts and across levels of analysis that have so far developed in parallel. Finally, but related, we want to advocate that there is a need for a better understanding of the multi-level nature of OI. OI is relevant and has implications for how innovation activities take place at the individual, organization, inter-organizational and even higher levels of analysis, such as regions or industries (Chesbrough and Bogers 2014; West et al. 2014). A multi-level

perspective is crucial for advancing theoretical concepts as it allows breaking these concepts into multiple component elements and then tracing links among them at different levels of analysis (Salvato and Rerup 2011). For instance, understanding factors at different levels of analysis seems particularly important, as elements at one level of analysis (e.g., structures and processes that facilitate OI at the organizational level) may result in contingencies at higher or lower levels of analysis (e.g., individual capacities to implement OI or interdependencies between organizations and various stakeholders in an innovation ecosystem setting).

AN “OPEN” WAY TO WRITE AN OPEN INNOVATION PAPER

In this paper, we present the results of a collaborative—and thereby “open” to some extent—initiative where we develop an overview of relevant OI themes across different levels of analysis based on a two-year experience of organizing a Professional Development Workshop (PDW) at the Academy of Management Meetings in Philadelphia (2014) and Vancouver (2015). In terms of process, the two lead authors (Bogers and Zobel) initiated the first PDW and brought together a number of scholars who provided their input to the PDW proposal and to the PDW itself as facilitators and discussants. Based on the success of the PDW (it attracted a “full house” with more than 100 participants), the PDW was organized again in the following year with some minor changes in terms of scope, content, and people involved. The main objective for the PDW was to find experts that represent the existing research landscape of OI at different levels of analysis. Pooling the expertise of leading OI scholars allowed establishing and discussing OI as a multi-dimensional concept that resides at different levels of analysis.

After the second PDW, the two lead authors invited the contributors to the two PDWs to join in a collaborative effort to write this paper. The ones who accepted to contribute wrote

a short paragraph on OI at their respective level of analysis, as they discussed during the PDW, which then contributed to the core of the paper.

In order to enable some consistency across the different paragraphs, the two lead authors provided some guidelines that aimed at determining the scope of the contributions. These guidelines entailed four main questions. First, how would you conceptualize and describe OI at your level of analysis? Second, how does OI relate to various theoretical perspectives at your level of analysis? Third, under which conditions is OI (according to your conceptualization) relevant? Fourth, what are future research directions regarding OI at your level of analysis? This input was revised and integrated by the lead authors, and was then subject to several rounds of iteration. Parts of the text went back and forth between all authors, depending on the scope and extent of the revisions that were necessary. Interestingly, substantial feedback and discussion took place across the different authors and levels of analysis, thereby enabling a better connection and integration of the different perspectives on OI. In addition, the lead authors initiated and managed the process of developing the introduction, background, discussion, and conclusion of the paper. This was also an iterative process, largely guided by inputs by the authors to the core of the paper, and all authors had the opportunity to check, revise and comment on those parts of the paper as well. This process involved a large number of iterations and significant coordination and revisions were necessary to align the different perspectives and styles.

Based on this process, we essentially translated our ideas and learnings related to the PDWs into this paper, while new ideas also emerged in the paper writing process. Our objective was to identify, discuss and specify promising theoretical approaches, at different levels of analysis, for future research in the domain of OI. In particular, in line with the above-mentioned gaps in existing OI research, the objectives for this paper are the following. First, we aim at enabling heterogeneous perspectives on the concept of OI, while collecting

them in one piece of work. Second, we aim at identifying theories, concepts, and empirical settings that are helpful for further developing OI. Third, we pursue the development of a multi-level understanding of OI. While some of the identified perspectives relate to the traditionally considered level of analysis of the organization, this paper will show how others levels are concerned with the determinants, processes and outcomes within the organization, outside of the organization, between organizations, or at the larger context of industries, innovation systems, and societies. In addition, many themes reside in between different levels of analysis. In sum, addressing these three objectives will allow us to develop a future research agenda for OI. Below, we consider these respective levels and map out specific research opportunities in the context of OI. On this basis, we highlight emerging research themes and relevant contingencies, and then discuss how these themes are shaping the emerging OI research landscape.

OPPORTUNITIES FOR RESEARCHING OPEN INNOVATION AT DIFFERENT LEVELS OF ANALYSIS

Researching Open Innovation Across Levels of Analysis

OI has been researched from a number of perspectives, although linkages to established theories and related phenomena are still emerging (Dahlander and Gann 2010; Vanhaverbeke and Cloudt 2014; West and Bogers 2014; Randhawa, Wilden, and Hohberger 2016). Extant research on OI predominantly addresses the firm (or business unit) as the unit of analysis, while there is a growing recognition that other units of analysis need to be considered as well in order to get a more detailed understanding of the antecedents, processes and outcomes of OI (West et al. 2014). Adopting the multi-level framework by Chesbrough and Bogers (2014), these emerging perspectives can be organized with respect to determinants, processes and outcomes within the organization, outside of the organization,

between organizations, or at the broader context of industries, innovation systems, and societies. Table 1 summarizes the different levels of analysis and delivers some examples of extant studies addressing factors at different levels of analysis. While the Appendix provides a brief overview that provides some literature background of OI at various levels of analysis (complementing Table 1), we refer to other papers for more comprehensive and systematic literature reviews of OI (Dahlander and Gann 2010; West and Bogers 2014; Randhawa, Wilden, and Hohberger 2016).

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Cutting across these levels of analysis, an important theme is the effectiveness of OI, particularly in terms of its implications for innovation and overall firm performance. Empirical studies demonstrate variance in the extent to which OI contributes to innovation performance (e.g., Laursen and Salter 2006; Sofka and Grimpe 2010; Parida, Westerberg, and Frishammar 2012; Pullen et al. 2012; Cheng and Huizingh 2014), R&D project performance (e.g., Du, Leten, and Vanhaverbeke 2014), new product creativity and success (e.g., Salge et al. 2013), or community-level outcomes (e.g., Balka, Raasch, and Herstatt 2014). Given such variance in the effectiveness of OI, there has been increasing interest in its context dependency (di Benedetto 2010; Huizingh 2011). So far, only few studies investigate contingencies of the openness-performance relationship, including the strategic orientation of firms (Cheng and Huizingh 2014), individual-level characteristics (e.g., Salter et al. 2015), or new product development (NPD) project characteristics (e.g., Salge et al. 2013), or the integration of key individuals (Lüttgens et al. 2014). Given this need for a contingency perspective and a multi-level understanding of OI, it seems relevant to explore how factors residing at one level of analysis constitute contingencies for applications of OI at higher or lower levels of analysis. The fourth column of Table 1 lists the experts who have contributed to this paper and it assigns them to the different levels of analysis. In the following, these

experts elucidate various perspectives, contingencies, and future research opportunities for OI at their respective levels of analysis.

Intra-Organizational Level of Analysis

The effectiveness of firms' OI strategies strongly depends on the individuals tasked to bring those strategies to fruition. Particularly in firms in transition to more open models of innovation, employees typically face a number of challenges that firms need to allude to in order to realize the potential of OI (Salter, Criscuolo, and ter Wal 2014). To date we know relatively little about how individuals within a firm handle the new challenges of OI strategies. For example, these challenges relate to how to handle the not-invented/sold here syndrome (Burcharth, Knudsen, and Søndergaard 2014), how R&D employees should not only be allocated, but also allocate their time for innovation within and/or outside the firm (Dahlander, O'Mahony, and Gann 2016), and how all employees in a firm can become involved in the development of firm priorities for innovation and in development and implementation of innovative ideas (Bogers and Horst 2014). As such, there are several areas where individual-level research may contribute to advancing our understanding of OI.

One suggestion is that research should aim for a more detailed understanding of the factors that motivate internal R&D employees and managers to enact open models of innovation as well as of their ability to deliver the 'fruits' of OI. Socio-cognitive theories of resistance to change (Ford, Ford, and D'Amelio 2008), for example, may help shed light on why certain individuals are more keen than others to embrace OI in their ways of working (Alexy, George, and Salter 2013). In terms of individual ability, research has shown that individuals working with external knowledge in the context of inbound OI face approval and integration costs, which may undermine their ability to effectively absorb the knowledge (Salge et al. 2013; Salter et al. 2015). Moreover, there is an opportunity for researchers to further study how managers select among and subsequently manage multiple inbound OI

opportunities and initiatives (Alexy, Criscuolo, and Salter 2012). Further research could draw on the emerging literature on absorptive capacity at the individual and group level as well as learning theories more broadly to unveil why individuals differ in their ability to contribute to effective identification of external knowledge, its assimilation and integration with internal knowledge and its eventual utilization in organizational innovation outputs.

Moreover, research is needed on the structure that allows firms to adapt to changes suggested by employees. Much emphasis is placed on how OI may be imposed on individuals by corporate strategies developed in the executive suite, whereas OI implemented from the bottom up is largely overlooked. Research in this area will help to shed light on organizational paradoxes such as between stability and learning (Nelson and Winter 1982; Leonard-Barton 1995), between hierarchy and heterarchy (Hedlund 1994; Crumley 1995), and between employees' simultaneous engagement in production and innovation (Rosenberg 1982; Bogers 2016). Because of a more open process of innovation, the traditional managerial toolbox needs to be extended to incorporate revisions to internalized structural distinctions within the firm to accommodate innovative suggestions from sources both internal and external to the firm. One opportunity for research in this vein is to examine how projects, middle management or strategic initiatives at an intermediate organizational level support OI activities at the firm level.

Research on individual identity may also help advance understanding of the risks and merits of OI. Considerations of identity at the individual level could move OI research towards a more refined understanding of the process by which organizations become more open or closed. One may think of a contingency model of organizations in which individual employees, managers, and organizational systems need to move through several growth stages before being fully able to engage comfortably in OI. For example, employees may initially perceive a move towards OI as a threat to their job, which they feel may be replaced

by external sources of innovation—in line with the so-called “Not-Invented-Here” syndrome (Antons and Piller 2015; Burcharth and Fosfuri 2015), although this may depend on the extent to which synergies between the inside and outside are being achieved. Considering this connection, it may moreover be useful to more specifically investigate impact of the division of innovation labor—e.g., the presence of technology scouting units, and the adoption or involvement of different organizational structures in the external search process—on the success rate of development, identification, and integration of external knowledge. Identity research inspired by research in organizational behavior could also address the question if employees in R&D departments who gradually become more involved in activities outside the boundaries of their main employer begin to develop a stronger allegiance towards people within their profession relative to their own organization. OI strategies potentially lead employees to establish a more professional commitment as opposed to organizational commitment (cf. Wallace 1995). For people working on the edge of the organization, losing part of their organizational identity may have negative effects on the quality and focus of their innovation activities. Likewise, research and development personnel working on the boundary of the organization—moving from a role identity of problem solvers to become solution seekers (Lifshitz-Assaf 2015)—could develop decreasing levels of job satisfaction since they may begin to question where they actually belong. Jointly, these social, cognitive, and structural factors determine the effectiveness of OI.

Organizational Level of Analysis

At the organizational level of analysis, OI is associated with entrepreneurial opportunities, processes and outcomes. OI holds important implications for entrepreneurial activities in both new ventures and corporate ventures. Specifically, OI can help entrepreneurs in identifying opportunities that are distant to their own knowledge endowments (distant search) and, thus, to acquire superior vision of the opportunity landscape available to the

entrepreneur (Gruber et al., 2013). Furthermore, OI approaches enable and create entrepreneurial opportunities for diverse types of organizations and in diverse types of contexts. For example, a platform-based OI strategy creates opportunities for new ventures that involve developing products and services that complement the platform, i.e., platforms become the venue for entrepreneurial pursuits (Zahra and Nambisan 2011). Similarly, an inbound OI strategy on behalf of large companies creates entrepreneurial opportunities that involve the front-end of innovation (e.g., OI strategies of large pharmaceutical companies create opportunities for biotech new ventures).

All of this implies the potential relationship between OI approaches and the nature of entrepreneurial opportunities formed and enacted. Importantly, such a relationship between OI and entrepreneurship will be contingent on several sets of conditions. For example, the greater the extent of digitization of the opportunity (Lusch and Nambisan 2015), the more accessible the opportunity will be to diverse types of external entities (Aldrich 2014). Similarly, the characteristics of the innovation architecture (e.g., degree of modularity) as well as those of the associated ecosystem (e.g., governance, intellectual property (IP) rights management) (e.g., Bresnahan and Greenstein 2014) could shape the intensity and scope of the generated entrepreneurial opportunities as well as how readily they are pursued and enacted. Further, successful enactment of the associated opportunities may also be contingent on a broader set of institutional and infrastructural arrangements in OI (e.g., OI intermediaries, crowdsourcing and crowdfunding platforms, 3D printing platforms, makerspaces, etc) (e.g., Mortara and Parisot 2014; Rayna, Striukova, and Darlington 2015). Finally, entrepreneurial success may also be contingent on entrepreneurs (and their new ventures) acquiring a new set of capabilities or competencies that would enable them to navigate in the different OI contexts (e.g., Nambisan and Baron 2013). Thus, more broadly, future research should focus on examining organizational-level issues that overlap (or

connect) OI and entrepreneurship as well as the contingencies that predicate success in such environments. Such research would involve theories and constructs drawn from both fields and contribute to a deeper understanding of how varied OI approaches lead to varied types of entrepreneurial opportunities, processes and outcomes.

A further organization-level concept that addresses how OI shapes opportunity identification, creation and exploitation is the business model. In particular, the business model as a unit of analysis connects value creation with value capturing that may or may not be located within one organization (Osterwalder and Pigneur 2010; Zott, Amit, and Massa 2011; Afuah 2014). For managers, the business model functions as a cognitive device linking theory with data, design with activity (Baden-Fuller and Morgan 2010). A central contingency on this level lies in the interface between the collaboration that involves knowledge flows across organizational boundaries and the value creation and capture process that is implied in the business model. Following Teece and Chesbrough and others (see e.g., Chesbrough and Rosenbloom 2002; Teece 2010), business models focus on the interface with the customer: customers are more and more part of complex networks rather than only passive payers. Customers co-create and expect to be integrated in networks of services that may or may not involve them directly. A further contingency emerges when business models work as platforms that connect multiple customers, some of whom pay, others who receive services for free, and yet others still who contribute knowledge for free. Whereas OI focuses on the direction, nature, and conditions of knowledge flows, the business model captures the sustainability of the economic activity. Simple service or product business models can be implemented without much technology or innovation, consider a barbershop or a bakery. Yet, implementing more complex business models requires capabilities that include orchestrating information technology, insights into multiple customer groups' preferences, and parallel pricing in different markets. Rochet and Tirole (2006) explained the economics of multi-sided

platforms but much research is still needed to understand the strategic choices inherent in such complex business models regarding the use of technology and the network interactions that often include OI practices. Hence, the business model is a useful theoretical perspective for explaining the effectiveness of OI.

Inter-Organizational Level of Analysis

From an inter-organizational perspective, the effectiveness of OI depends on more than just inter-organizational knowledge flows in the early stages of an innovation process (e.g., Dahlander and Gann 2010; Huizingh 2011; Chesbrough and Bogers 2014). OI often requires firms to organize or actively participate in innovation ecosystems that integrate a diverse set of innovation actors throughout the various stages of the innovation process (West and Bogers 2014). They collectively create novel and useful solutions to innovation problems, with or without a central keystone firm (Iansiti and Levien 2002; Adner and Kapoor 2010; Radziwon, Bogers, and Bilberg 2016). OI assumes various kinds of interactions and knowledge flows between different kinds of development as well as commercialization actors, even before a particular value creating ecosystem architecture is established. The need for an innovation ecosystem will depend on the complexity of the technology and business model (Baldwin and Woodard 2008; Chesbrough and Bogers 2014). Taking a network theoretical lens, OI depicts novel dynamic network structures that emerge from dynamic interactions of a diverse set of actors throughout the innovation process (Dhanaraj and Parkhe 2006). Thus, a central question related to the effectiveness of OI is the question of governance in these dynamic relationships (Tiwana, Konsynski, and Bush 2010). Indeed, a central question is how ‘open’ should such governance should be. New ‘dynamic’ theories are needed to explain how ‘open’ governance can affect the way, how multiple actors evolve throughout the innovation process in a self-organizing way where mechanisms of hierarchical control are absent (West 2003; Brunswicker and Almirall 2015). The literature on platform-based ecosystems, points

us to important dimensions of ‘openness’ of governance, such as control over IP, access to the technology, and also social factors such as transparent information policy (Kevin, 2010; Belian, 2015; Yoo et al., 2010).

Indeed, an increasing number of industries organize their activities along the structure of central platforms surrounded and/or complemented by networks/constellations of other organizations, which technologically and strategically depend upon the core platform (Gawer 2014; Gawer and Cusumano 2014). In today's context, increased pervasiveness of digital technologies and connectivity, combined with a global worldwide and distributed supply of ICT skills (Chesbrough and Bogers 2014), has made the platformization trend even stronger. Digitization has significantly lowered barriers to entry into innovative activities for an unprecedented number of innovators worldwide that can create software programs and connect their innovations to central platforms—also ensuing possibly self-sustaining network effects (Gawer and Cusumano 2014). Canonical examples include the Apple and Google ecosystems, while this trend is also happening in an increasingly large number of other sectors (such as payment, electronics, health, etc.) where the digitization of some elements of the value chain introduces new actors with divergent incentives. Hence, digitization emerges as an important enabling factor of OI as it facilitates the entry and collaboration of various new actors, as well as a relevant contingency factor to the effectiveness of OI as it supports connectivity between such diverse actors.

OI research is well positioned to contribute to important questions that rise in these contexts. The first set of such questions relates to the extent to which, and the conditions under which, OI can be complemented with IP protection to help stimulate vibrant innovation ecosystems. This would be particularly relevant to clarify and manage the trade-offs that arise in innovation contexts such as interdependent inter-organizational technological systems where multiple actors innovate (e.g., as in the case of mobile payment or 5G). In these

increasingly common settings, the nature of the organizational challenge is to innovate together and preserve the collective welfare as defined by the overall vibrancy or performance of the ecosystem, while at the same time preserving or enhancing the individual performance of ecosystem members in competitive markets (Lopez-Berzosa and Gawer 2014). A second set of questions relate to the specific challenges pertaining to the management of innovation in platform-based ecosystems in the presence of two types of competition: not only competition within platform-based ecosystems, but also competition across platform-based ecosystems themselves.

A particular way to access external knowledge for OI that is also driven by the digital transformation is crowdsourcing—the act of outsourcing a task to a “crowd,” rather than to a designated “agent” [...] in the form of an open call” (Afuah and Tucci 2012: 355). Crowdsourcing allows tapping into diverse, marginal and distant knowledge bases to provide more efficient solutions to a local problem (Jeppesen and Lakhani 2010; Afuah and Tucci 2012; Poetz and Schreier 2012). Crowdsourcing as an OI practice requires managers to rethink managerial and governance structures that facilitate the flow of knowledge across firm boundaries, motivate participants, and appropriate rents from the practice. Managers must also align their own organizational governance practices to those of outside actors, also depending on whether crowdsourcing takes place directly or through an intermediary or whether it is tournament based or collaboration based (Jeppesen and Lakhani 2010; Afuah and Tucci 2012; Colombo et al. 2013). Since there may be the strong preference for outsiders’ knowledge sourcing and necessity to entice external contributors (Menon and Pfeffer 2003; Piezunka and Dahlander 2015), it is very important to develop certain mechanisms that will allow a smooth decision-making process, which will consist of examination, selection and adoption of appropriate OI ideas, activities and projects (Alexy, Criscuolo, and Salter 2012).

In this context, the relationship between OI and crowdsourcing can help to better understand the relationship between openness and firm performance. Crowdsourcing, together with related developments, such as big data and crowdfunding, highlight the growing importance of OI in general and the need for support of data providers and organized involvement of distributed contributors in particular. In crowdfunding, for example, proponents of innovative projects and entrepreneurial ideas ask for financial support to the crowd of the Internet users (i.e., the backers) by posting these projects and ideas on dedicated websites (i.e., the crowdfunding platforms). In so doing, proponents not only receive money, but they also collect suggestions and perform an early market test (Colombo, Franzoni, and Rossi-Lamastra 2015). While there are several determinants of the effectiveness of crowdfunding, it also offers potential for creating new measures of success in the context of an OI project (cf. Mollick 2014). The availability of projects' descriptions on crowdfunding platforms and the new methodologies for content analysis make crowdfunding a source of data for studying the effects of *soft* aspects on the success of OI initiatives, such as cues to ethical values (Allison et al. 2015; De Fazio, Franzoni, and Rossi-Lamastra 2015). Moreover, crowdfunding can be a good setting to study failure in the context of OI, based on the data on unsuccessful projects. Recent work suggests that crowdsourcing may be more appropriate at later stages of the technological lifecycle (Seidel, Langner, and Sims 2016), and is subject to other contingencies including the context of networks, industry and geography (Agrawal, Catalini, and Goldfarb 2011; Mollick 2014; Dushnitsky et al. 2016).

Extra-Organizational Level of Analysis

A key element related to the effectiveness of OI is the active involvement of external stakeholders (individuals or communities) in the innovation process, as either contributors to the creation of new knowledge and innovations or receivers of knowledge that is used to generate innovations. Literature streams addressing these external stakeholders' role in

knowledge creation and innovation cover a variety of topics including individual contributors (e.g., user innovation), relationships with extra-organizational groups (e.g., communities, consortia, crowdsourcing), and working with a wider network or ecosystem (West 2014). All of these can be regarded as specific cases of OI with external stakeholders, but attention needs to be given to the possible differences between stakeholders, as they may bring about heterogeneous factors contributing to the effectiveness of OI. One important difference is the kind of input that is provided by the external parties, ranging from needs, demands, and ideas to solutions to problems, designs, and patents. It appears fruitful to address both the nature of external stakeholders' contributions, as well as the innovation process steps in which they are involved. Another potentially important difference between single individuals and members of communities is what motivates contributors to actually engage in OI processes, as they arguably can perceive different motivational factors. The role played by external stakeholders in the innovation process is largely conditioned by the type of knowledge creation process, its outcomes, and its further absorption. External stakeholders are highly relevant when the needed knowledge refers to preferences and needs of customers and users, as well as in contexts where experts have a fundamental role in defining problems and/or providing knowledge input to solutions. External stakeholders' importance for innovation reduces in situations where knowledge is tacit and where its development is closely knit to contextual aspects of an organization, such as culture, history, and tradition. Another important aspect that is in need of future research is how heterogeneity and cognitive distance (Nooteboom et al. 2007) between internal and external contributors influence the knowledge creation dynamics as well as innovation output. Whereas some OI processes appear to favor interaction between heterogeneous, and to a large extent complementary competences, it is also possible to identify other OI processes in which internal- and external stakeholders have very similar knowledge, which based on the theory of absorptive capacity (Cohen and

Levinthal 1990) ought to allow for fruitful exchange of highly specialized information. Following this reasoning, it is clear that the relationships between various types of extra-organizational individuals and different types of knowledge creation and innovation processes stand out as an interesting area of future research, especially in the context of explaining the effectiveness of OI.

One stakeholder group that has received significant attention is that of individual users. Indeed, one of the largest sources of OI that firms can draw upon is the activities and knowledge of individual users, consumers, clients or customers (Laursen and Salter 2006; von Hippel, de Jong, and Flowers 2012; Piller and West 2014). Individual users may directly contribute to the OI process of firms by communicating their needs and preferences, based on their use experience, while they may also use and innovate their goods in contexts outside of the firm's domain (von Hippel 1988, 2005; Bogers, Afuah, and Bastian 2010). Such users are motivated to produce innovations because they enjoy the process of doing so (West and Gallagher 2006), can benefit from using the solution (von Hippel 1982), or gain symbolic capital in the form of thanks and peer recognition (Berthon et al. 2007). Examples of these users include people (or communities) who use sporting goods (Franke and Shah 2003), music equipment (Langlois and Robertson 1992) and automobiles (Franz 2005).

The individual user is an important aspect of OI for at least two reasons. First, it is a prevalent and growing source of external knowledge for innovation. For example, a national survey found that the potential time and money spent by individual consumers in the UK on innovation was greater than all UK consumer product firms combined (von Hippel, de Jong, and Flowers 2012). Second, there are interesting research opportunities presented by the different types of individual user innovators that exist, which include lead users (von Hippel 1986), creative consumers (Berthon et al. 2007), hackers (Lakhani and Wolf 2005) and online pirates (Choi and Perez 2007). Consumers have different abilities, motivations and outcomes

that are linked to important contingencies in the context of OI, such as user characteristics and interfaces, the nature of their innovation, the IP attributes and implications, as well as different levels of “emotional property” (Berthon et al. 2015)—all relating to the effectiveness of OI.

A second relevant stakeholder group in the context of OI is the community. While communities can be fully independent, there may also be a relationship between organizations and communities—thus highlighting the link to the inter-organizational level of analysis. Communities increasingly represent an important external source of knowledge, practical experience and innovation. Considerable attention has been devoted to understanding how to best interact with these organizational forms to foster innovation and entrepreneurship (Dahlander and Frederiksen 2012; Autio, Dahlander, and Frederiksen 2013). Indeed, firms and communities face multiple challenges in developing mutually beneficial relationships, requiring both to invest the time and effort, and to demonstrate patience in working with the other (Dahlander and Magnusson 2005). Some of the most important obstacles in developing these relationships involve communities’ typical lack of the formal structure and hierarchy, which create difficulties in steering the work both on the collective and individual level (Dahlander and Wallin 2006). To date, much of the research highlights the role of users in online communities (Dahlander, Frederiksen, and Rullani 2008; West and Lakhani 2008). Scholars have examined the governance, coordination and architecture of communities, primarily focusing on open-source software as an empirical context (den Besten and Dalle 2008; Langlois and Garzarelli 2008; West and O’Mahony 2008). Further research on communities could explore relational aspects between communities and organizations (Alexy, Henkel, and Wallin 2013), or how status and identity of individuals affect these relations. Few studies explore how firms address the non-pecuniary nature of community involvement (Piller and West 2014). A potential empirical context is industry study groups that are essentially

communities involved in the corporate innovation processes. Originating from Oxford in 1968, study groups consist of people from a particular field of study who solve industrial problems under professional supervision and without any pecuniary benefits. Another interesting research direction would be to examine how both virtual and traditional communities of practice (Lave and Wenger 1991), provide firms a unique opportunity to tap into a very specialized and often tacit topic knowledge. As a final example, (industrial) hackathons as a natural continuation of online communities transformation could constitute an interesting empirical ground, which consists not only of software and hardware developers, but also graphic and interface designers as well as project managers, collaborating intensively on software projects development.

Industrial, Regional and Societal Level of Analysis

Given the uncertain and complex nature of innovation and in particular OI, a number of industry-level contingencies seem relevant in the context of OI and may be relevant for explaining the effectiveness of OI across different settings. First, industries characterized by higher levels of both R&D intensity and uncertainty (Dyer, Furr, and Lefrandt 2014) are interesting environments for firms to experiment with OI and to share not only knowledge but also share the costs and risks of uncertain innovative projects. Second, industry modularity, the degree to which production systems and product designs in industries can be decomposed into separate components, creates environments in which innovation of components is quasi-independent (Baldwin and Clark 2000; Rosenkopf and Schilling 2007). Industry modularity creates flexibility and multiple inputs through a division of labor that enables firms to use multiple inputs from different sources for their innovation process (Schilling 2000). Third, industries differ in the degree to which, historically, knowledge resides within a particular industry or is more widely distributed (Scherer 1982; Pavitt 1984). Firms in industries

characterized by broader flows of knowledge across industry boundaries can be expected to be more receptive to a wider range of knowledge inputs from partners that do not belong to a given set of industry participants (Laursen and Salter 2006; Lakhani, Lifshitz-Assaf, and Tushman 2013). Future research on such industry-specific contingencies could attempt to gain a better understanding of the multi-dimensional intricacies of industry-specific conditions for OI and firm-specific conditions. This then begs the question whether it will pay off to go with or against the tide and to what degree.

Within or even beyond industrial boundaries, firms organizing for OI face spatial challenges of access and separation of co-creators or the richness and reach of their communication activities. These challenges, however, can no longer be dealt with by traditional location theories. Spatial decisions have long been seen as constitutive decisions in organizations (Weber 1909) that are made when an organization is first set up or adapts to labor or consumer markets over time. However, what we see in e-business, digital transformation and OI settings differs from this traditional picture: “sticky knowledge” determines spatial decisions for innovation and problem solving (von Hippel 1994, 1998), virtual spaces and real places take the role of platforms where innovators and co-creators meet (Reichwald, Moeslein, and Piller 2001) and the design of these platforms turns out to be crucial for OI strategies (Bullinger 2012). For more than a decade, OI initiatives have experimented with the options these virtual and real platforms provide and the design parameters that specific OI strategies can build on. Still, research on the spatial aspects of organizing for OI is scarce and better design knowledge is needed: How to design virtual and real spaces as OI platforms? How to bridge between the virtual and the real in these spaces? How to integrate spaces for OI in larger innovation ecosystems? How to institutionalize such spaces in global innovation networks?

At levels of analysis higher than the firm, OI is considered in a wide variety of contexts that go beyond the innovativeness and profitability of firms. Openness is increasingly recognized on the level of cities, particularly in the context of smart cities, regions and even nations or governments (Neshkova and Guo 2012; Almirall, Lee, and Majchrzak 2014; Mergel 2015). On one side, OI in the public sector comprises similar processes than the ones that we encounter in the private sector. But on the other, we find novel ones such as the free revealing of public data in the form of open data as well as new platform-based forms of citizen participation and collaboration (Hilgers and Ihl 2010; Mergel and Desouza 2013). It is notable that not only in for-profit organizations but also in non-profit ones a mix of actors is involved comprising developers, civic activists, political organizations, civil society representatives and, of course, citizens. The mix of actors and motivations reflects the kinds of tools and mechanisms used to carry out the OI process, often linked with the co-creation of policies or the development of citizens' projects (Linders 2012). This mix of tools and mechanisms has its reflection on the types of OI intermediaries that we encounter that engage in providing structure and governance to the different forms of citizen participation and knowledge collection. Some contingencies make the use of OI in the public sector more relevant in certain occasions. First, it requires the design of effective policies for wicked problems that need the contribution of different types of knowledge and, in many times, their validation in real-life environments. Second, we need to create and deliver new types of services where a mix of public and private, for-profit and non-profit organizations is essential in order to maximize their effectiveness. This is, for example, the case of supporting with novel solutions and approaches, the increasing number of elderly people living in cities.

DISCUSSION

The Emerging Open Innovation Research Landscape

In the following, we synthesize and highlight a number of distinct OI themes that emerge from the collected contributions described above. Together, these contributions offer a complex, multi-level view of OI including elements ranging from the identity of R&D employees to new forms of democracy in the context of open public management. Table 2 provides an overview of the proposed perspectives, research themes, relevant contingencies, as well as potential empirical settings at different levels of analysis.

INSERT TABLE 2 ABOUT HERE

At the *intra-organizational* level of analysis, we propose a variety of perspectives that help to explain how individual-level attributes and behaviors as well as design elements of the organization need to adapt as the organization transitions to OI. The relevance of such intra-organizational elements is likely to vary with contextual factors, such as OI challenges and costs, the degree of organizational paradoxes that the firm faces as it transitions to OI, as well as the firm's development stage in this transition. At the *organizational* level of analysis, an entrepreneurship perspective suggests investigating the nature and outcomes of diverse entrepreneurial opportunities that OI can enable and help to enact, particularly in environments characterized by modularity and digitization. In contexts that emphasize customer integration and rapid technological change, a business model perspective becomes particularly relevant, whereby future research needs to address how firms can combine open business models with closed innovation strategies and all possible combinations thereof (Vanhaverbeke and Chesbrough 2014). At the *inter-organizational* level of analysis, we propose various perspectives that shed light on how new network forms combine value creation and value capture, such as innovation ecosystems, innovation platforms, and crowd-based search and financing. Digitization and different forms of complexity (especially

technological complexity) drive these new network forms and require new frameworks for governing interactions between heterogeneous actors. At the *extra-organizational* level of analysis, a broader stakeholder approach suggests that it is important to differentiate between different stakeholder groups—individuals, communities or organizations—as they deliver different kinds of knowledge at different stages of the OI process. Several factors emerge as important drivers or contextual factors for various external stakeholders, such as knowledge, abilities and motivations, structural and relational alignments, and distinct IP frameworks. Finally, OI is embedded into higher levels of analyses, such as *industries or societies*, with relevant contingencies, such as the R&D intensity, modularity and the breadth of knowledge distribution in the industry, spatial challenges (including virtual and real platforms), and new forms of democracy and managerial skills for collaborative public management in the context of cities, regions, and governments. New types of policies and services are required for OI to function at this highest level of analysis.

Collectively, the contributions depict a multi-level research landscape that connects the phenomenon of OI to diverse perspectives. Across those levels and perspectives, a number of common contingencies are highlighted. First, digitization is as an important enabling and reinforcing factor for different OI perspectives (i.e., entrepreneurship, business models, crowdsourcing, and spatial organization). Second, innovation architecture elements, such as modularity, complexity, and technological interdependencies, are emphasized across various OI perspectives. A final recurring element is institutional- and firm-level frameworks for IP and governance. As these contextual factors are discussed across various levels and perspective, they represent a good starting point for researching contingencies of OI.

An Emerging Framework with New Research Categories

While Chesbrough and Bogers (2014) presented an overview of existing OI research and organized this research into a multi-level framework, we suggest that the boundaries

between different levels of analysis are becoming more permeable. Considering the more complex interaction of different levels at which OI develops, future research needs to adopt a cross-level approach in which this interaction sets out on a course of a more complex nested analytical and theoretical lens. Such a perspective goes beyond additive effects of multiple levels of analysis to focus on more complex interplays of multiple OI mechanisms across different levels (see also Hagedoorn 2006). A framework for designing future OI research should therefore acknowledge that OI does not only take place at a single level of analysis but involves research categories that are nested in between or span different levels of analysis. Based on the collected contributions, we propose some research categories and suggest them as an alternative representation for mapping out a future research agenda for OI (see Table 3).

INSERT TABLE 3 ABOUT HERE

The first research category is what we refer to as ‘OI behavior and cognition’ and focuses mainly on individuals that operate in an OI environment. While this category is traditionally located at the individual or intra-organizational level of analysis, it spans across different levels in the context of OI. For example, employees are inherently linked to the firm they are part of, not the least in terms of their activities and output (Tushman and Katz 1980; Ettlie and Elsenbach 2007; Whelan et al. 2010; Dahlander, O'Mahony, and Gann 2016)—with linkages to organization design, business models, governance, etc. Also, employees may participate in communities together with external partners, thus not only facilitating internal and/or external knowledge development but also inherently linking innovation within, between and outside the focal organization (Dahlander and Magnusson 2005; Fleming and Waguespack 2007; O'Mahony and Ferraro 2007; West and Lakhani 2008; Autio, Dahlander, and Frederiksen 2013).

The second category is ‘OI strategy and design’, which includes entrepreneurship and business models as related concepts. While traditionally positioned at the organizational level,

this category ties into various perspectives at other levels of analysis. For example, a certain strategic decision may directly influence the firm's innovation activities that cross its organizational boundary (Chesbrough and Appleyard 2007; Whittington, Caillaet, and Yakis-Douglas 2011; Matzler et al. 2014). Or the organizational design will create the structure that can facilitate (or hamper) OI processes at the level of the firm (Garriga, von Krogh, and Spaeth 2013). At the same time, an organization's strategy and design in the face of OI directly links to the strategy and design of external partners, which is particularly important in the context of innovation ecosystems where there is a cooptation process involving multiple stakeholders (Afuah 2000; Bouncken et al. 2015). In contrast with established organizations, it is important to recognize that OI strategy and design have yet to be defined and developed in emerging firms; and we know from entrepreneurship research (e.g., Fauchart and Gruber 2011) that the extent and the nature of the involvement of external partners depends in important ways on the founder's prior knowledge, experience and identity, given that these pre-entry endowments shape the founder's outlook and ideas about the new firm. Hence, the first two categories (OI behavior and cognitions and OI strategy and design) have a particularly strong linkage in entrepreneurship, which means that interesting and meaningful research opportunities arise at the intersection of these categories.

The third category is 'OI stakeholders', which includes users, communities, and solution providers as special cases. This category focuses on OI actors per se by emphasizing their personal or organizational attributes, and the motives and incentives driving their contribution to the OI initiative of an organization. For example, it is well known that lead users, in contrast to average users, have particular characteristics that give them a particular potential as sources of innovation (von Hippel 1988, 2005). Along these lines, one could explore the respective roles of different stakeholders and their heterogeneous contributions to corporate innovation processes (Laursen and Salter 2006; Knudsen 2007; Leiponen and

Helfat 2010). The interface between the respective stakeholders becomes an important study object as it relates to behavioral and strategic considerations as well as the institutional logic that the boundary-crossing innovation activity is part of (Geels 2004; Hargrave and van De Ven 2006). At the same time, more emphasis has to be placed on the motives and incentives for individuals to contribute to firm-level OI activities. Too often, users or external solution providers are still seen as an unlimited, free resource of input, exploitable by the innovative activities of a firm. Better understanding the motives of users to contribute, the interactions between these motives and how they are incentivized over the different levels of analysis, is an important area of research in this category.

The fourth category is ‘OI ecosystems’, describes the constellations and relations of different OI actors. Such ecosystems can have different forms, such as digitized platforms or crowdsourcing platforms. This category supersedes the single organization while it still involves the organizational attributes through the multi-organizational connections and interdependencies (Adner and Kapoor 2010; Chesbrough, Kim, and Agogino 2014; Gawer and Cusumano 2014). Therefore, the ecosystem, as a research category, intrinsically links to other concepts, such as individual behavior and entrepreneurship, while it also involves a coevolution between the ecosystem and organizational business models (van der Borgh, Cloudt, and Romme 2012; Nambisan and Baron 2013; Ritala et al. 2013; Radziwon, Bogers, and Bilberg 2016).

The final research category is ‘open governance’, which emphasizes higher-level practices that enable organizations to lead and control OI processes, which transcend the single organization’s level (Tihanyi, Graffin, and George 2014; McGahan 2015). This leads to an interest in higher-level organizations, such as cities or governments, where open governance in itself becomes the primary activities unit (Almirall, Lee, and Majchrzak 2014; Kube et al. 2015; Mergel 2015). This research category implies linkages with individual or

organizational level attributes as well as with platform-based processes (Hilgers and Ihl 2010; Mergel and Desouza 2013).

Mapping New Research Directions Across Research Categories

Based on the research categories framework presented in Table 3, we identify exemplary research questions that we believe have the potential to help mapping interrelationships between these research categories. While the proposed research categories are already inherently multi-level in nature, we specify research questions that inherently cut across these categories. On the one hand, a question may refer to how concepts at higher levels of analysis *emerge* from lower-level entities and interactions (e.g., through interactions and exchanges among individuals). On the other hand, a question may refer to contextual influences, whereby factors at higher levels of analysis either directly influence outcomes at a lower level or moderate relationships at a lower level. Such research questions will generate opportunities to bridge the micro- and macro-level views (cf. Rothaermel and Hess 2007; Markard and Truffer 2008; Felin, Foss, and Ployhart 2015; Geels et al. 2016) as well as address possible paradoxes within OI, such as in the context of ambidexterity or appropriability (cf. Gupta, Smith, and Shalley 2006; Bogers 2011; Laursen and Salter 2014). Moreover, we suggest several theoretical perspectives that we believe can be meaningfully explored in future research to further develop these and other questions within the respective research categories.

For example, regarding *OI behavior and cognition*, it is not only the individual cognition and behavior that add up to some organizational-level actions or outcomes. In the context of OI, it is particularly the characteristics of external stakeholders, such as communities, that may affect individual behavior and cognition. Engagement in external communities may give individuals such strong professional/external identities that it could be questioned how external identity and loyalty may affect the extent to which individuals keep

organizational goals of innovation in mind. Hence, engagement in external communities emerges as an important contextual factor for the behavior and cognition of individuals engaged in OI processes, which in turn may have important implications for organizational-level outcomes.

An example of a question concerning *OI strategy and design* refers to how a focal firm's business model intersects with business models of external stakeholders. As firms open up their business models to those of external stakeholders, important research questions emerge about the dynamics and co-evolution of multiple stakeholders' business models. Moreover, it will be important to consider how stakeholders with intersecting business models share risks and rewards, and how the relative power and authority of these stakeholders influence the distribution of such risks and rewards.

Another example, regarding *OI stakeholders*, relates to how the involvement of heterogeneous external stakeholders (e.g., users or communities) may lead to the development of new types of business models. For instance, given different motivations of various stakeholders (which may not always be monetary), firms need to develop new strategies for combining pecuniary and non-pecuniary innovation processes.

In the context of *OI ecosystems*, an example is the mutual dependence between the ecosystem and the industry in which it is implemented. While the industry in itself provides an important contingency factor for how relevant stakeholders can provide input to the underlying problem solving or innovation process, the ecosystem can enable new forms of industrialization and cross-industry collaborations and even shape policies and regulations. An example is the smart building ecosystem, which connects mechanical devices, control systems, and a number of services such as lighting and heating. The smart building ecosystem does not only connect players from diverse industries but it is also heavily dependent on city representatives, economic planners, and policy makers. In this context, an interesting research

question refers to how innovation ecosystems shape policymaking and contribute to new, open forms of governance.

Finally, a question regarding *open governance* refers to how innovations in the public sector enable new forms of crowdsourcing. In this context, it will be particularly interesting to investigate if and how the availability and organization of open data enable the participation of new types of stakeholders (e.g., citizen participation). These strong interdependencies between levels necessitate a multi-level perspective in which different concepts at different levels need to be jointly considered.

Overall, linking concepts, theories, levels, and contingencies—as we attempt to propose with the research categories in Table 3—provides an opportunity to develop research questions and research designs that address the fundamental underlying causal mechanisms and inherent interdependencies in OI.

CONCLUSION

This paper presents the results of an “open” and innovative way to collect a large number of perspectives from scholars who have studied various aspects of more open models of innovation. In particular, we present an overview of the main perspectives and in OI research, grounded in a series of PDWs held at the Annual Meeting of the Academy of Management and further developed in a subsequent collaborative paper writing process. Taking Chesbrough and Bogers’ (2014) classification of existing OI research at different levels of analysis as point of departure, our presentation of opportunities for future research demonstrate that OI is a multi-faceted phenomenon that requires an understanding that cuts across various perspectives and levels of analysis. Indeed, as firm boundaries become more permeable in the context of OI, so do the boundaries between the different levels of analysis. We have addressed this complexity by proposing a framework for future OI research that

highlights OI behavior and cognition, OI strategy and design, OI stakeholders, OI ecosystem, and open governance as research categories that inherently cut across different levels of analysis and may therefore help in creating connections between the various levels.

We propose a broad framework that combines the insights from earlier research with the prevailing relationships between the most important variables. Our integrative framework allows comparing, contrasting, and integrating the different perspectives at different levels of analysis, while offering a basis for further elaborating on and validating the categories within the framework as well as the boundaries in between. To achieve this, we advocate more emphasis on theorizing at the various levels under scrutiny by OI research. In other words, we should always be asking the “why” questions, while drawing on pertinent theoretical perspectives (Sutton and Staw 1995), when developing research within the field of OI. Finally, we identified some research gaps within and across different research streams, thereby identifying avenues for future research—in particular, we propose new research questions that span across research domains that have so far by and large developed in isolation. While the frameworks and ideas proposed in this paper are by no means exhaustive, we hope that the paper will be helpful in the development of this very exciting agenda.

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Table 1: Level of analysis and research objects for open innovation research

<i>Level of analysis</i>	<i>Possible research object</i>	<i>Exemplary topics researched in extant studies</i>	<i>Exemplary references</i>	<i>Contributors</i>
Intra-organizational	Individual Group/Team Project Functional area Business unit	Individual level challenges and coping strategies for OI OI at the functional and project level	(Salter, Criscuolo, and ter Wal 2014; Antons and Piller 2015; Salter et al. 2015; Dahlander, O'Mahony, and Gann 2016) (Bogers and Lhuillery 2011; Salge et al. 2013; Du, Leten, and Vanhaverbeke 2014; Lopez-Vega, Tell, and Vanhaverbeke 2016)	Linus Dahlander Lars Frederiksen Ann Majchrzak Anne ter Wal
Organizational	Firm Other (non-firm) organization Strategy Business model	Organizational design, practices, and processes for integrating external sources of innovation OI in the context of new entrants, SMEs, and entrepreneurs	(Foss and Foss 2005; Chiaroni, Chiesa, and Frattini 2011; Foss, Laursen, and Pedersen 2011; Robertson, Casali, and Jacobson 2012; Foss, Lyngsie, and Zahra 2013) (Gruber, MacMillan, and Thompson 2013; Brunswicker and van de Vrande 2014; Zobel, Balsmeier, and Chesbrough 2016).	Marc Gruber Stefan Haefliger Satish Nambisan
Extra-organizational	External stakeholders Individual Community Organization	The role of users and communities for OI	(Bogers, Afuah, and Bastian 2010; Autio, Dahlander, and Frederiksen 2013)	Mats Magnusson Ian McCarthy Agnieszka Radziwon Jonathan Sims
Inter-organizational	Alliances Network Ecosystem	How organizations practice OI in ecosystems and industry platforms	(Rohrbeck, Hölzle, and Gemünden 2009; Adner and Kapoor 2010; van der Borgh, Cloudt, and Romme 2012)	Allan Afuah Sabine Brunswicker Annabelle Gawer Cristina Rossi-Lamastra
Industry, regional innovation systems, and society	Industry development Inter-industry differences Local region Nation Supra-national institution Citizens Public policy	Applications of OI outside of R&D in areas such as manufacturing, marketing, strategy, services, tourism and education	(Bogers and Lhuillery 2011; Chesbrough 2011; Huff, Mösllein, and Reichwald 2013; Matzler et al. 2014; Egger, Gula, and Walcher 2016)	Esteve Almirall John Hagedoorn Dennis Hilgers Kathrin Moeslein

Notes:

- *Levels of analysis and research objects adapted from Chesbrough and Bogers (2014).*
- *All contributors acted as facilitators on the respective topics during the PDWs with the exception of Agnieszka Radziwon and Jonathan Sims who assisted as organizations.*
- *Marcel Bogers and Ann-Kristin Zobel are the lead authors who developed the overall paper, also integrating and synthesizing the other author's contributions, while Keld Laursen and Frank Piller contributed to the development of the introduction and discussion. These authors are therefore not listed in the table.*

Table 2: Emerging OI research themes at multiple levels of analysis

<i>Level of analysis</i>	<i>Perspectives</i>	<i>Emerging themes</i>	<i>Examples of relevant contingencies</i>	<i>Examples of possible empirical settings and data</i>
Intra-organizational	Organizational behavior	Commitment, resistance to change, identity, motivation, communication and learning of employees involved in OI	Degree of OI challenges and costs, degree of organizational paradoxes	<ul style="list-style-type: none"> • Formal inbound OI initiatives with intra-firm data on employee participation • Individual engagement in informal OI activities in relation to identity and career trajectories of individuals • Workshop interventions with R&D staff to overcome resistance and shift identity
	Organizational design	Formal and informal organizational structures and managerial tools that support different forms of openness	Strategic objectives, human resource management, growth stages	<ul style="list-style-type: none"> • Use of surveys, qualitative configurational analysis, and sequence analysis • Organizational routines or structure-openness fit to determine when different structures are needed • Intra-firm differences in OI structures, practices, and policies as ‘quasi-natural’ experiment on incentives to engage in OI
Organizational	Entrepreneurship	Quantity and quality (nature) of entrepreneurial opportunities identified, formed and enacted via OI	Modularity, digitization, IP frameworks, institutions, infrastructure, founder knowledge, experience, and identity	<ul style="list-style-type: none"> • Public open data initiatives or data from crowdsourcing, social media and 3D printing platforms on entrepreneurs interactions with other participants in forming and enacting opportunities • Founder networks and knowledge domains in high tech setting • Role of scientific, cultural, military experience of founding team members
	Business models	Link between open knowledge flows and economic activities	Customer interfaces, capabilities for orchestrating information technologies	<ul style="list-style-type: none"> • Multisided business models that engage with innovative customers • Customization and servitization with data on externalities across customer groups • Comparative case studies
Inter-organizational	Innovation ecosystems	Interactions between various development and commercialization actors, as well as the governance of such interactions	Technological complexity, business model complexity, IP frameworks	<ul style="list-style-type: none"> • Action research focusing on inter-organizational attributes (e.g., governance, IP frameworks, co-creation) • Direct observations of relations and interactions • LexisNexis data
	Innovation platforms	Governance of digital platforms to align individual success with collective welfare	Digitization, technological interdependencies	<ul style="list-style-type: none"> • Quasi-experiments comparing different platform configurations for different OI challenges • Platform-based ecosystems with data on participating new ventures, offerings, sales, etc (could be combined with e.g., surveys of entrepreneurs/founders)
	Crowdsourcing	‘Hard’ (e.g., governance) and ‘soft’ (e.g., values) aspects of crowd-based search	Digitization, governance structures, industrial and spatial characteristics	<ul style="list-style-type: none"> • Attributes of contributors and posts in external and internal crowdsourcing challenges • Field studies and ethnographies focusing on individual actions and

				interactions
Extra-organizational	Stakeholders	Different types of knowledge provided by stakeholders at different stages of the innovation process	Nature and type of knowledge (e.g., tacitness, heterogeneity, distance)	<ul style="list-style-type: none"> Stakeholder-specific context and roles For-profit and non-profit stakeholders, including NGOs, governments, educational institutions, legal institutions, consumer groups, and professional bodies Surveys, observations, mixed methods
	Users as innovators	Identification and leveraging knowledge produced by individual users with different abilities and motivations	User characteristics, intellectual and emotional property frameworks	<ul style="list-style-type: none"> User characteristics in terms of demographics (e.g., gender, age, nationality) product/service sector (e.g., sporting goods, healthcare, consumer electronics), expertise (e.g., professionals versus amateurs), and the legality of the innovation act (e.g., hackers, pirates) Industry groups and value chain studies CIS data, surveys, mixed methods
	Communities	Structural and relational alignment, and interfaces between organizations and communities	Digitization, pecuniary versus non-pecuniary settings	<ul style="list-style-type: none"> Traditional and virtual communities of practice, industry study groups, and firms and organizations Comparing different forms of organizations such as online communities and living labs Qualitative exploratory research, mixed methods, early quantitative research
Industrial, regional, and societal	Industry dynamics	Industrial characteristics that enable OI	R&D intensity, modularity, knowledge distribution	<ul style="list-style-type: none"> Standard industries (SICs), emerging industries, new combinations of industries (e.g., pharma and biotechnology, new innovation-driven design and service sectors, cross-sectoral 'industries' such as new materials) Data with relation to standard SIC data, CIS data, USPTO and EPO patent data Tailor-made surveys on industry, regional or societal level
	Spatial organization	Management of spatial challenges at the intersection of virtual and real platforms	Digital transformation	<ul style="list-style-type: none"> User data and usage patterns from OI platforms (online, offline, mixed) Case studies on corporate projects on these platforms Field experiments with companies, users and intermediaries in different spatial settings
	Public management	New forms of democracy and managerial skills for collaborative public management in the context of cities, regions, governments	Policies and services	<ul style="list-style-type: none"> Surveys, case studies and experiments with citizens and public officials (e.g., new forms administrative openness and innovative smart cities) Content analysis of platform dialogues and social network analysis of contributors Cross-country comparative analysis of openness and transparency (large data surveys, e.g., secondary datasets by OECD)

Table 3: OI research categories, concepts, research questions, and theoretical approaches

<i>OI research categories</i>	<i>OI related concepts</i>	<i>Examples of multi-level research question</i>	<i>Examples of possible related theoretical perspectives</i>
OI behavior and cognition	<ul style="list-style-type: none"> • Identity • Commitment 	<ul style="list-style-type: none"> • How do individual-level attributes (e.g., motivation) influence inter-organizational knowledge flows with OI stakeholders? • How does individual-level openness affect organizational identity development and conflict? 	<ul style="list-style-type: none"> • Organizational behavior • Human capital and resource management • Social and role identity theory • Self-regulation (e.g., self-control) • Role conflict theory
OI strategy and design	<ul style="list-style-type: none"> • Open business models • New types of entrepreneurial opportunities 	<ul style="list-style-type: none"> • As a focal firm opens up its business model how does it co-evolve with the business models of relevant stakeholders? • How does the involvement with external stakeholders shape employees' organization identity and commitment? 	<ul style="list-style-type: none"> • Modeling and rational choice theory • Economic sociology • Service logic and value co-creation • Effectuation theory • Resource dependency theory
OI stakeholders	<ul style="list-style-type: none"> • Communities • Users 	<ul style="list-style-type: none"> • How do users as innovators collaborate with organizations in digitized platforms? • How does the involvement of external stakeholders shape new types of business models (e.g., combining pecuniary and non-pecuniary processes)? 	<ul style="list-style-type: none"> • Technology affordance and constraints theory • Economic and network sociology • Motivation theories • Behavioral economics • Dynamic capabilities and resource-based theory • Social network theory
OI ecosystem	<ul style="list-style-type: none"> • Digitized platforms • Crowd-based platforms 	<ul style="list-style-type: none"> • How do innovation ecosystems in specific sectors (e.g., food or renewable energy) shape policy and regulations? • How does ecosystem governance (e.g., open forms of governance) enable the participation of heterogeneous stakeholders in the innovation process? 	<ul style="list-style-type: none"> • Technology generativity • Information systems design • Practice theory and practice-based approaches to information systems • Actor network theory • Transaction cost theory • Agency
Open governance	<ul style="list-style-type: none"> • Smart cities • Open government 	<ul style="list-style-type: none"> • How can citizens influence the public sector, especially regarding performance, quality, innovativeness, compliance and integrity? • How do innovations in the public sector (e.g., smart cities) enable new forms of crowdsourcing (e.g., citizen participation)? 	<ul style="list-style-type: none"> • Public service motivation • Theory of planned behavior • Principal agent and stewardship theory • Organizational and institutional trust • Technology acceptance model • Institutional theory

APPENDIX: RESEARCH ON OPEN INNOVATION AT DIFFERENT LEVELS OF ANALYSIS

At the intra-organizational level, recent studies highlight the role of individuals in the implementation of OI, including individual-level challenges and coping strategies for external engagement in innovation (Salter, Criscuolo, and ter Wal 2014; Antons and Piller 2015; Salter et al. 2015; Dahlander, O'Mahony, and Gann 2016), the changing role of the technology gatekeeper in managing search and knowledge flows across the organization (Ettlie and Elsenbach 2007; Whelan et al. 2010; Monteiro and Birkinshaw 2016), or the increasing usage of digital technology and social media by employees (Kietzmann et al. 2011). Additional research topics emerging at the intra-organizational level of analysis include applications of OI at the functional (Bogers and Lhuillery 2011) and the project level (Salge et al. 2013; Du, Leten, and Vanhaverbeke 2014; Lopez-Vega, Tell, and Vanhaverbeke 2016).

At the traditional firm-level unit of analysis, a number of studies shed some light on how organizational design, practices, and processes can facilitate interaction with and integration of external sources of innovation (Foss and Foss 2005; Chiaroni, Chiesa, and Frattini 2011; Foss, Laursen, and Pedersen 2011; Robertson, Casali, and Jacobson 2012; Foss, Lyngsie, and Zahra 2013). Yet, the issue of how to organize for OI is not yet fully understood (West and Bogers 2014), which calls for additional research on structures, mechanisms and tools of OI that can be institutionalized at the level of the organization (e.g., Sieg, Wallin, and Von Krogh 2010; Lüttgens et al. 2014). Furthermore, there has been a limited focus on failures, costs, and downsides of OI (Faems et al. 2010; Laursen and Salter 2014; Monteiro, Mol, and Birkinshaw 2016). In general, future research needs to add to a better understanding of how firms can profit from OI by aligning OI strategies to the business model (Baden-Fuller and Haefliger 2013) and governing inter-organizational relationships (Hagedoorn and Zobel 2015). Research at the organizational level of analysis also expands beyond the initial focus

on large firms (e.g., Chesbrough 2003) by exploring the role of external knowledge sources for small and medium sized enterprises (SMEs) (Brunswick and van de Vrande 2014), new entrants (Zobel, Balsmeier, and Chesbrough 2016), and entrepreneurs (Gruber, MacMillan, and Thompson 2013).

Going beyond the organizational level of analysis, a variety of themes have emerged, such as the role of users and communities (Bogers, Afuah, and Bastian 2010; Autio, Dahlander, and Frederiksen 2013), and how such external sources can be leveraged through internal organizational attributes (Nambisan, Agarwal, and Tanniru 1999; Dahlander and Magnusson 2005; Colombo et al. 2011) as well as how could the OI outbound project selection process bias be overcome by balancing involvement of both insiders and outsiders (Menon and Pfeffer 2003; Piezunka and Dahlander 2015). External sources such as communities and users can either be considered as a distinct level of analysis (i.e., as an extra-organizational set of actors) or in relation to the organization in the context of inter-organizational networks and knowledge flows. At the inter-organizational level of analysis, an important emerging theme relates to how organizations practice OI in ecosystems in which all participants are depending on each other in co-evolving their capabilities and innovation outcomes (Rohrbeck, Hölzle, and Gemünden 2009; Adner and Kapoor 2010; van der Borgh, Cloudt, and Romme 2012). In the last years, research on crowdsourcing explores how firms can identify novel and distant sources for innovative inflows by broadcasting specific tasks to a larger undefined network of potential external problem solvers (the “crowd”) (Jeppesen and Lakhani 2010; Afuah and Tucci 2012). Focusing on how technological design impacts inter-organizational innovation, recent research investigates the role of industry platforms, which are often associated with innovation ecosystems (Gawer 2014; Gawer and Cusumano 2014). Additionally, OI has recently been supplemented by the notion of open business models, describing a firm’s use of the assets of external partners to develop its business model

(Vanhaverbeke and Chesbrough 2014). Especially the recent digital transformation of many industries puts open business models into the focus of many discussions (Porter and Heppelmann 2014; Kortmann and Piller 2016).

Presenting another perspective, OI research increasingly considers a wider variety of contexts that go beyond the innovativeness and profitability of firms. For instance, OI is becoming more recognized on the level of entire industries and regions (Cantner, Meder, and ter Wal 2010) and even nations or governments, to thereby address the potential of OI for citizens and the public sector more generally (Kube et al. 2015). Furthermore, the concept of OI is increasingly applied outside of its traditional domain of technology and R&D to acknowledge applications in areas such as manufacturing, marketing, strategy, services, tourism and education (Bogers and Lhuillery 2011; Chesbrough 2011; Huff, Möslein, and Reichwald 2013; Matzler et al. 2014; Egger, Gula, and Walcher 2016).

NOTES

¹ **Acknowledgement:** We would like to thank the *Industry and Innovation* Editor-in-Chief Christoph Grimpe and Associate Editor Marion Poetz for their guidance and support during this innovative paper-writing journey, and we also greatly appreciate the constructive feedback we received from two anonymous reviewers. We are also extremely grateful for the intellectual contributions that we received in relation to the “Researching Open Innovation” PDWs at the Academy of Management Meetings in Philadelphia (2014) and Vancouver (2015)—specifically noting the involvement of John Ettlie, Dries Faems, and Joel West. Moreover, we greatly appreciate the input provided by the many participants who joined our PDWs—serving as a basis for useful discussions around open innovation and as such also feeding into the development of this paper. Finally, we appreciate the constructive comments that we received from the participants of the Open Innovation and Business Model Workshop, held at Cass Business School on June 7-8, 2016.

² **Notes on authorship:** We follow the so-called “Vancouver Protocol” in that authorship is based on the following criteria:

- “Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- Drafting the work or revising it critically for important intellectual content; AND
- Final approval of the version to be published; AND
- Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.” (<http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html>; Accessed February 11, 2016)

The two lead authors are listed as first and second authors to indicate their leading and coordinating role in this collaborative paper. The remaining authors are listed in alphabetical order. While all authors agreed to be accountable for all aspects of the work (following the Vancouver Protocol), their specific contributions are listed in Table 1.