ACADEMICS AS ORCHESTRATORS OF CONTINUOUS INNOVATION ECOSYSTEMS: TOWARDS A FOURTH GENERATION OF CI INITIATIVES

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ABSTRACT

In this paper we shed light on why academics are in one of the best positions to orchestrate inter-organizational initiatives of Continuous Innovation (CI) within an innovation context that is shifting towards an Open Collaborative Ecosystem mode. Two rationales seem to explain the potential key role of aca-demics within a CI ecosystem: (i) their independence; (ii) their compliance to CI ecosystem's purposes—independently by its type. The implications of the four papers invited to be part of the special issue, and formerly presented at the 14th International CINet Conference in Nijmegen (The Netherlands), are also discussed.

Keywords: Continuous Innovation; Open Collaborative Ecosystem; Academics Orchestration

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1. THE MULTI-FACETED NATURE OF CONTINUOUS INNOVATION

Since its inception (Boer and Gertsen, 2003), the field of *Continuous Innovation* (CI) has evolved dramatically, yet it has maintained its conceptual core, which involves a synergistic balance between exploitative and exploratory activities (Martini et al., 2013). These activities compete for the same resources (Holmqvist, 2004) in an inertial context (Sørensen and Stuart, 2000) that emphasises the tensions produced by a set of antecedents of exploratory rather than exploitatory behaviours (Lavie et al., 2010). The combined effect of these forces tends to open up the gap between exploration and exploitation, which act as two opposing attractors between which an effective balance arises only if persistent, on-going efforts are put in place (Martini et al., 2013). While CI researchers focus on how it is possible to unceasingly maintain this instable balance over time, empirical evidence shows not only that there is a plethora of complementary ways of accomplishing this task (Boumgarden et al., 2012), but also that some balancing efforts fail to deliver on their promises (e.g., Van Looy et al., 2005).

However, how to reach those configurations has been the subject of over 15 years of research (O'Reilly and Tushman, 2013). Duncan (1976) suggested that to accommodate the conflicting alignments required for innovation and efficiency, organizations needed to shift their structures sequentially over time to align them with the firm's strategy (e.g., Burgelman and Grove, 2007; Boumgarden et al., 2012). Alternatively, some researchers have recently begun to characterize exploration and exploitation as independent activities, such that firms can choose to engage in high levels of both activities at the same time

(e.g., Gupta et al., 2006; Simsek, 2009). Two ways of carrying them out together have been identified: structural and contextual (O'Reilly and Tushman, 2013). The former occurs through the joint pursuit of both exploitation and exploration by using separate subunits (e.g., Jansen et al., 2006; Lavie and Rosenkopf, 2006). In 2004, Gibson and Birkinshaw defined the contextual approach as "the behavioural capacity to simultaneously demonstrate alignment and adaptability across an entire business unit" (p. 209). Recent research has found that in reality a combination of different solutions may be most practical (e.g., Andriopoulos and Lewis, 2010; Raisch et al., 2009).

The need to find a solution to the tensions between exploration and exploitation cannot be properly addressed if organizations and individuals do not keep track of changes occurring in the surrounding environment. Taken from an historical perspective, three decades have shaped the innovation landscape and environmental conditions within which CI initiatives took place.

First era (1990s): the competitive landscape was characterized by centralized inward-looking innovation systems (*closed innovation*), in which collaboration activities were mainly focused on signing agreements with supply chain partners. In that decade, in which the Internet was still in its infancy, the debate about the role of information technology in future manufacturing systems was on-going, and innovators were trying to shift to a more extended enterprise mode of doing things (Browne et al., 1995). To put it simply, extended enterprise meant placing the manufacturing systems in the context of the value chain (Porter, 1985).

Second era (2000s): A progressive opening of the boundaries of the companies started taking place, embracing what has been defined by Chesbrough (2003) as the *open innovation* paradigm, in which externally focused, collaborative innovation practices were adopted. Companies started applying this philosophy by looking at the enormous potential outside their boundaries, even those of their supply chains. In the meanwhile, ICT advancements enabled them to engage in more effective collaborative partnerships modes, by extending their innovative scope beyond their value chain and towards new actors in the network (*open networked innovation*) (Chesbrough et al., 2006).

Third era (2010s): A deep mutation in the competitive landscape occurred with the birth of the Open Collaborative Ecosystems (OCEs) (Baldwin and Von Hippel, 2011; Curley and Formica, 2013). OCEs are based on principles of integrated collaboration, co-created shared value, cultivated innovation ecosystems, unleashed exponential technologies, and extraordinarily rapid adoption. They also capture the elemental characteristics of the con-stant transformation of network ecosystems: the continual realignment of synergistic re-lationships of people, knowledge and resources for both incremental and transformational value co-creation (Ramaswamy and Gouillart, 2010). The need for responsiveness to changing internal and external forces make co-creation an essential force in a dynamic innovation ecosystem (Russell et al., 2011). In the third era, borders are constantly blurring, formal and informal networks interplay, organizations and individuals have multiple memberships to dynamic and evolving structures.

Moving through the three eras requires a profound understanding of the challenges the new contingencies poses to organizations when coping with innovation dynamics. The

rising complexity increases the chances to embarking in collaborative innovation practices in OCEs whilst actually not being well equipped to do that. What is becoming a general trend today is that most CI initiatives fail, and more than often this is due to organizations and individuals lacking a coherent ecosystem in order for them to be able on the one side, to keep the pace of changes occurring in the innovation context, while on the other side, support and complement CI efforts (Stadler et al., 2013). It is therefore important to understand how to orchestrate ecosystems made up of multiple organizations, institutions and other intermediaries (Afuah, 2009; Dougherty and Dunne, 2011; Stadler et al., 2013) to produce streams of CI. We define a *CI ecosystem as a community of actors interacting as a unique system to produce inter-organizational streams of CI*. Drawing on Kapoor and Lee (2013), we recognise that firms are increasingly embedded in networks of interdependent activities carried out by external agents. On the one hand, these interdependencies underlie the ability of firms to appropriate returns from investments in CI (Adner and Kapoor, 2010). On the other hand, firms can exploit these interdependencies to sustain efforts of inter-organizational CI (Stadler et al., 2013). Thus, CI ecosystems require processes characterised by simultaneous cooperation and competition (Afuah, 2009), and an orchestration of the actors involved in the inter-organizational efforts of CI (Dhanaraj and Parkhe, 2006).

Leveraging on Seo et al. (2004), and following the description of the three aforementioned innovation eras, all these initiatives can be grouped into generations of CI initiatives, as summarized in Table 1:

Innovation Era		**Closed**	**Open**	**Open Networked**	**Open Collaborative Ecosystem**
		→	→	→	
CI Initiatives		**First generation**	**Second generation**	**Third generation**	**Fourth generation**
CI target	*Level of analysis*	Organization	Individuals and groups	Individuals, groups and organizations	Inter-organizational ecosystems
	Drivers	Internal	Internal	Alternate internal and external drivers	Combination of internal and external drivers
	Enablers	Low ITR*, ITC**, ITI***	Moderate ITR, ITC, ITI	Moderate ITR, ITC, ITI and OSS/ISS#	High ITR, ITC, ITI and OSS/ISS
	Depth	First order (actions)	Second order (underlying framework)	First/second order (paradoxical balance)	Third order (inter-org. boundary conditions)
CI process	*Approach*	Top-down (structural)	Bottom-up (contextual)	Bottom-up and top-down	Transversal
	Tempo	Episodic, time invariant	Episodic, time invariant	Continuous, time variant	Episodic, continuous, time variant
	Role of academics	Facilitating and directing CI	Planning and channelling CI	Leveraging on the CI tensions	Orchestrating the CI ecosystem

*ITR=IT Resources, **ITC=IT Capabilities, ***ITI=IT Investments, #OSS= Operations Support Systems, #ISS= Interpretation Support Systems.

Table 1. Four generations of CI initiatives in four innovation contexts

A potential fourth generation of CI initiatives may be envisaged in OCEs contexts (Baldwin and Von Hippel, 2011), which can be described along some of the dimensions proposed by Seo et al. (2004), namely:

- *The CI target*: what to change and develop in order to produce CI, and when;
- *The CI process*: how to paradoxically balance exploration and exploitation.

1.1 CI TARGET

Table 1 summarizes the differences between the four generations of CI initiatives in terms of the following sub-dimensions:

- *Level of analysis*: level at which the CI intervention is applied;
- *Drivers*: forces on which to focus in order to balance exploration and exploitation;
- *Enablers*: technology advancement to rely on in order to reach the proper configuration of exploration and exploitation;
- *Depth*: radicalism of the CI initiatives (how fundamental they are).

Level of Analysis. The first real difference between the fourth generation initiative of CI and the previous ones regards the level of analysis. Historically the field of CI registered a swing from the organizational level to the individual or group levels (Martini et al., 2013). Whereas the latest initiatives (third-generation) combine these levels of analysis (Martini et al., 2012), the current methodological sophistication opens up the possibility of orchestrating CI in complex interrelated settings. From this viewpoint, more research is needed to understand how to manage the interplay between organizational and inter-organizational efforts of CI in a comprehensive overarching framework.

Drivers. A distinction addresses whether CI focuses on: (i) responding to externally driven forces that demand organizational alterations and/or (ii) addressing issues and factors arising from inside organizations. The duality between these drivers has been progressively recognized and tackled in CI (Martini et al., 2013). In fact, while first- and second-generation initiatives focused respectively on external and internal drivers, third-generation initiatives alternate their emphasis between these two poles accordingly to the specific domain under analysis. It is becoming increasingly possible is to paradoxically apply the drivers at the same time, by leveraging on the concurrent presence of several stakeholders as well as on the synergies between organizational and inter-organizational efforts. Again, further research is necessary to study how to achieve and maintain these synergies over time.

Enablers. Advancements in Information Technology and Information Systems (IT/IS) are increasingly making it possible for organizations to come up with new ways of working that were not previously possible (Birkinshaw and Gupta, 2013). IT/IS leverage on knowledge assets, nurtures innovation, helps coordinate processes, and offers opportunities to conciliate the capability to exploit the current knowledge base with the capability to shift away from it in order to explore new and better ways of delivering value (e.g., Im and Rai, 2014; Drnevich and Croson, 2013; Joshi et al., 2010). Thus, moving towards fourth generation initiatives, IT/IS has the potential to contribute to the strategies adopted within and among individuals and organizations to increase their performances by operating efficiently (exploit) and, at the same time, adapting continuously (explore).

Depth. Over time, CI initiatives increased their depth, and switched from first-order methods – which aim at increasing skills or solving problems in an already agreed-upon arena – to second-order methods – which aim at changing organizational members' frames of reference and the ways that they understand key components and functions of organizing (Martini et

al., 2013). Third-generation initiatives focused on the interplay between the two orders—exploring the mechanisms that make both possible (Martini et al., 2012). Worthy of further investigation is the possibility of leveraging on third-order methods, which aim at changing the inter-organizational boundary conditions influencing the reference frameworks adopted by the different stakeholders of a CI ecosystem.

1.2 CI Process

Table 1 summarizes the differences between the four generations of CI initiatives in terms of the following sub-dimensions:

- *Approach*: level of participation and openness indicative of the process through which exploration and exploitation are balanced;
- *Timing*: pace of the process through which exploration and exploitation are balanced;
- *Role of academics*: main role played by academics in the CI initiative;

Approach. All three generations of CI initiatives have leaned toward open and participatory approaches (Boer and Gertsen, 2003). If first-generation initiatives focused on top-down approaches based primarily on a structural balance between exploration and exploitation, second-generation initiatives privileged basing CI on bottom-up approaches that leveraged on contextual balancing processes. Only in third generation initiatives of CI did researchers and practitioners start to combine the two approaches (Martini et al., 2013). A complementary approach may be advanced, which is based on a transversal form of collaboration among organizations, and which contributes to both bottom-up and top-down approaches. Further research should establish how to make the interchange between 'vertical' (bottom-up and top-down) and 'transversal' approaches to CI effective.

Timing. Despite their names, most first- and second-generation initiatives of CI emphasized episodic balances between exploration and exploitation, implemented as an occasional interruption or a divergent - time invariant - from a state of equilibrium (Boer and Gertsen, 2003; Piao, 2010). Only third-generation initiatives started to adopt a real 'continuous' - time variant - approach to CI (Martini et al., 2012; Piao, 2010), assuming that this last one is a pattern of on-going modification in work processes and social practice to be purposefully and dynamically maintained. In order to do this, it is necessary to further investigate how to effectively achieve these results while taking into account more refined perspectives on time (e.g., Hautala and Jauhiainen, 2014).

Role of Academics. The role of academics in effectively contributing to CI has switched from facilitating and directing the relative processes (first-generation), to planning and channelling them (second-generation). Recently, academics have concentrated on leveraging on the tensions present between exploration and exploitation (Martini et al., 2013) in order to effectively balance them (third-generation). Research has shown that all these roles are no longer sufficient in the current competitive scenario. Academics, in the inherent diverse roles they may cover along their career path (Lowe and Gonzalez-Brambila, 2007; Peñuela et al., 2014), have to consider practitioners as a set of engaged change agents who can collaborate in an interdependent set of CI ecosystems, in which activities can be orchestrated. Thus, it is necessary to understand which research configurations that incentivize this orchestrating role in academics.

Understanding how to orchestrate a CI ecosystem in a constantly changing innovation context, and which actors are best positioned to do that in an effective way, is the twofold aim of this introductory paper. The implications of the four invited papers to the special issue, formerly presented at the 14th International CINet Conference in Nijmegen (The Netherlands), are also discussed. They refer to two research themes: the multi-faceted nature of discontinuous innovation; indicators for innovation. Discussion and future developments will be outlined at the end of the description of their contributions.

2. ACADEMICS AS ORCHESTRATORS OF CI ECOSYSTEMS

In order to understand the role of academics as orchestrators in the face of ever changing innovation contexts, we will focus on the different CI initiatives emerged since the definition of the CI Network (CINet) (Boer and Gertsen, 2003; Boer et al., 2006)

Entering the fourth innovation era, CI initiatives are no longer limited to solitary exercises, but extended to a collective achievement involving permanent negotiations and innovative forms of collaboration/competition among different stakeholders (Afuah, 2009). Inter-organizational initiatives of CI entails complex phenomena, which exceed the capacity of individuals and organizations to accomplish them (Porter and Powell, 2006). Only through a continuous interaction among many diverse actors—over long periods of time and with a considerable amount of uncertainty—it is possible to benefit from the use of ecosystems as a means to foster CI (Dhanaraj and Parkhe, 2006; Dougherty and Dunne, 2011).

In such a scenario, academics can play an important role as 'orchestrators of CI ecosystems', whereby—paraphrasing Dhanaraj and Parkhe (2006)—*orchestration is defined as the set of deliberate actions to create and extract value from a CI ecosystem*. What makes the role of academics worthy of further investigation is not only its inherent independence within the CI ecosystem, but also its compliance and exaptation towards the multi-faceted nature of CI ecosystem's purposes.

Academics hold a valuable role in orchestrating CI ecosystems because of their inherently neutral position. Indeed, they find their natural habitat in that instable and ever-changing ground surrounding the diverse population ecology of organizations (Hannan and Freeman, 1977), which have to make sense of the complexity and instability of the external envi-ronment (Chesbrough and Schwartz, 2007) by learning how to leverage upon collabora-tive efforts in order to survive and profit in the long run. However, according to the soci-ologist Richard Sennett (2012), cooperation cannot be stable either, as the environment is never fixed. As a consequence, the independence and freedom of academics to ma-noeuvrer, put them in the condition to always exaptate their knowledge being their back-ground, initially evolved for usages in specific knowledge domains, later 'coopted' for their current role when dealing with multiple agents (Gould and Vrba, 1982), regardless the field in which they operate. At the very basis of such independence through exaptation is their reliance upon social interactions to coordinate the activities of an ecosystem in-stead of their formal counterparts (e.g., contracts) (Dhanaraj and Parkhe, 2006).

In the attempt to better characterize this ecology of organizations, and leveraging on the works of Docherty et al. (2003) on inter-organizational networks, it may be useful to disentangle the multiple ways in which academics may interact with them.

Academics, when confronting with practitioners to gain some benefit from exchanges with like-minded peers (Docherty et al., 2003), can be helpful in offering opportunities to share knowledge and expertise, moderating and initiating effective collaborative discussions about individual experiences, wrapping up and formalizing the knowledge generated through peer interactions in models and systematic framework, guiding and bringing value to discussions on the basis of their diverse knowledge bases, helping to enact lateral think-ing practices. Normative isomorphism is the most relevant coordination mechanism rul-ing the way practitioners interact (Docherty et al., 2003), whereby participants leverage the notion of 'community of practice' in which they share understandings concerning what they are doing and what that means in their contexts; thus, they are united in the action and in the meaning of that action, both for themselves, and for the larger collective (Lave and Wenger, 1991). Such an arrangement can be thought of as a *professional CI ecosystem*.

Organizations, in the attempt to learn by finding out the right exploration/exploitation configuration (O'Reilly and Tushman, 2013), start looking for new and diverse sources of inspiration outside their boundaries (West and Bogers, 2013). The different degrees of diversity of their knowledge bases (Stirling, 2007) stimulate organizations to interact through private/public meetings, purposefully reflecting on theirs and others' experiences to identify learning opportunities related to organizational and inter-organizational CI issues. The range of formal and informal consortia emerging from such interactions, strongly influences the existing learning systems by creating a safe psychological climate in which resistance towards CI initiatives can be loosed (Schein, 2002). Academics can be seen as natural enablers of the learning processes underlying these groups. According to the chance combination theory (Simonton, 2004), creativity in such a context may result from the ability of the academics to associate and combine pieces of knowledge and infor-mation in ways that are both original (never tried before) and useful. The probability of a successful combination is tiny and cannot be foreseen, but it increases with the number of attempts at novel combinations. This is why the more radical the CI initiatives, the higher the number of heterogeneous academics to involve as they will be of help in mak-ing sense out of it (Hagstrom, 1965). As such, they moderate multiple streams of unbiased reflections around key topics of CI, being able to understand the idiosyncrasies of the specific reality being addressed, in embracing a broad perspective and producing more effective outcomes in terms of learning experience (Werr and Greiner, 2008). Academics are effective in leveraging upon the three main features characterizing group learning (Wilson et al., 2007): (i) *the breadth and depth of sharing*, defined as the process by which new knowledge, routines or behaviour becomes distributed among group members and members understand that others in the group possesses that learning; (ii) *storage*, meaning that the changes in the group's repertoire need to be stored in memory in order for learning to persist over time; (iii) *retrieval*, or rather the ability of group members to find and access knowledge for subsequent inspection or use. This structure can be defined as *learning CI ecosystem*.

When academics induce changes in ecosystems which by themselves orient and transform their participants, we are confronted with *transformational CI ecosystems*. The evolution and transformation of such ecosystems is intimately related to the evolution and transformation of their participants. Thus, ecosystems act as a tightly-coupled peer system, in which

participants collaborate on directing, developing and deploying CI at both the organizational and inter-organizational levels (Coughlan and Coghlan, 2011). Academics are particularly effective in leading an inter-organizational transformation in this setting for two reasons. First, academics have historically manifested the highest level of independence, and are able to size and pursue opportunities creating an environment in which a delicate equilibrium among different interests is accomplished. A critical prerequisite to this equilibrium is the presence of a safe psychological climate avoiding any perceived risk of free riding. Second, academics, because of the very nature of their daily work, characterized by in depth literature analyses and exposure to the practices of other sectors, have strong competences in systematically identifying potential directions along which to guide the joint transforma-tional paths of the CI ecosystem.

Finally, academics can play a major role in a context which can be defined as *strategic CI ecosystem.* In this setting, organizations form liaisons to add value to business processes through mutual dependence on exchange relationships. Their interactions are focused on goal-oriented activities around shared problems, with the aim of constantly and dynamically achieving CI objectives—both through the reduction of transactional problems and the improvement of overall ecosystem effectiveness (Coughlan and Coghlan, 2011). The inherent complexity behind such an ecosystem can be managed by academics who, acting as an integration mechanism of inter-organizational knowledge streams generated into the ecosystem, are able to decode the choices made by each actor and assess the efficiency and effectiveness of their actions. ICT-base integration solutions play a fundamental role in that they guarantee consistency of interests and practices within shared innovation pathways, but they have to be homogenized with other existing solutions and simplified in order to reduce their costs. To this end, academics realize systematic literature reviews, maintaining a continuous relationship with different actors and avoiding any potential perception of free-riding, and supporting the whole strategic CI ecosystem in knowledge creation, extension, conversion and integration.

Table synthesises the different orchestration roles played by CI academics. From this viewpoint, the CI community shows also an increasing interrelationship among the different types of CI ecosystems. This interrelationship underscores how CI arise from the com-bination of top-down and bottom-up forces (Martini et al., 2013) stemming from semi-autonomous entities (Adner, 2011) that have to interact through complex and uncertain processes of collaboration-competition (Afuah, 2009), and consistent with the main dy-namic emphasis adopted by the CI ecosystem to which they belong (Allen et al., 2011).

CI ecosystem type	**Main orchestration roles**
Professional	Providing meeting opportunities for the demand/ supply side of the industry
	Helping practitioners think outside the box
	Maintaining the focus on mutual inter-organizational interests
Learning	Semiotic broker to reduce learning anxiety
	Activating multiple streams of collaborative reflections
	Fostering ecosystem and organizational reflexivity
Transformational	Seizing the transformation opportunities
	Enabling the transformation
	Sustaining the transformation
Strategic	Producing ecosystem knowledge and objectives
	Extending and converting organizational knowledge
	Integrating organizational knowledge

Table 2. Orchestrating roles within the different CI ecosystems

3. OVERVIEW OF ARTICLES IN THE SPECIAL ISSUE

The four papers included in this special issue are a mix of invited and competitive papers that explore and articulate various aspects of CI practices. Collectively, these papers offer insights that further understanding of CI processes, practices, and indicators, and deline-ate important consequences both at scientific and managerial levels. The papers are grouped into two themes based on their primary focus: (i) the multi-faceted nature of discontinuous innovation; (ii) indicators for innovation. There are also important connec-tions to be made across these papers, which we highlight within the next section and then draw together to offer insights/provocations for further research.

3.1 THE MULTI-FACETED NATURE OF DISCONTINUOUS INNOVATION

The two papers in this theme focus on discontinuity in terms of business models and innovation processes. The first contribution shows how an exogenous discontinuous in-novation may act, in a quite complex way, on the relationships between innovation and business model on one side and resources, competencies and capabilities on the other side. The second contribution sheds new light on the different ways of applying the Lean pro-cess management method in R&D and its effects on R&D performance and employee creativity.

Ghezzi, Cavallaro, Balocco and Rangone's invited paper, "On resources, discontinuity and (dis)continuous innovation: the effects of a distribution paradigm innovation on core resources", highlights how – and to what extent - dealing with a paradigm shift challenges traditional ways of doing business and managing technological change, in particular for dominant incumbents. By relying on empirical evidence drawn from a distribution paradigmatic case in the Mobile Content industry, authors advance a conceptual model suggesting useful guidelines to incumbent firms' managers in order to react to an exogenous discontinuous innovation. By looking at the dynamics of dominant incumbents within the Mobile value network (with their Mobile Portals) and the newcomer Apple Inc. (advanc-ing the Apple Store model), the authors try to shed some light on the "mediating role" of the business model in transferring a discontinuous innovation to an innovation-taker's pool of resources, competences and capabilities (R&C&C). In doing so, they disentangle how – and to what extent - an exogenous discontinuous innovation in the distribution system affects an incumbent firm's business model in the attempt to catch the wave of a Mobile-Internet convergence. The possible relationship existing between the change induced by innovation in the business model variables (notably, value proposition, customer segments, revenue streams, etc.) and in the R&C&C (notably, network infrastruc-ture, open innovation, brand reputation, customer ownership, etc.) is comprehensively explored.

Helander, Bergqvist, Lund, and Magnusson's invited paper, "Applying lean ap-proaches within product development: Enabler or disabler for creativity" illustrates that it is one thing to talk about the paradoxical management of exploration and exploitation activities, an entirely another thing to closely investigate how such a paradox emerges from companies' way of operating and dealing with the plethora of process management

approaches. The latter can be characterized under several respects, but here the focus is on the implementation of the Lean approach. How Lean in product development has been interpreted and implemented in practice, and to what extent different ways of applying Lean in product development influence creativity and efficiency are the two research questions to which authors want to find an answer. By means of multiple case studies, and data collected through interviews, authors provide important implications both for theory and practice: the importance of management support and employee training when implementing the Lean approach, rather than the role of disturbances, slack time and skunk work, deserve attention.

3.2 INDICATORS FOR INNOVATION

The two papers in this theme focus on indicators for both search and open innovation practices. The first contribution shows how the fuzzy front end of the innovation process can be made less fuzzy by advancing a radical idea search construct and taking a step towards effectively measuring a firm's capability to search for ideas for radical innovation. The second contribution aims at defining Open Innovation (OI) adoption models based on an accounting framework which analyses all the economic and financial transactions in both inbound and outbound processes. The work is based on the analysis of annual reports, defining all the pecuniary flows related to OI transactions.

Nicholas, Ledwith, Martini, Nosella and Aloini in their article, "Searching for radical new product ideas", provide the reader with an attempt to make sense of the wide array of practices companies can use in order to innovate in the early stages of the innovation process, increasing the chances to be radical, is a quite compelling task. However, a chronic lack of objective indicators discourages companies from embarking on such an endeavour. The authors of this paper want to give a significant contribution by validating a construct called 'Search Capability'. In order to test this construct, authors go through a three stage cycle methodology (exploratory factor analysis, confirmatory factor analysis, construct validity), making sense of all the informative content of the survey submitted to an international network called DILab. Authors find support, by means of both the measurement and the structural model, for the importance of the 'Search Capability' con-struct, defining it in terms of market awareness, idea management, customer involvement, open environment, and internal networking.

Michelino, Lamberti, Cammarano and Caputo in their article, "Open innovation mod-els in science-based industries", show that providing objective lenses through which one can look at OI dynamics is a challenging task. One effective way to face such a complex-ity is going through a gold mine of information: companies annual reports. It is precisely what the authors of this paper try to do, by advancing an accounting-based framework for OI. By evaluating the costs related to the acquisition of external knowledge and the revenues deriving from exploiting the internal technology in external markets, they lay the basis for identifying open costs, open revenues, open additions and disposals of intangibles and knowledge assets. Accordingly, openness indicators are developed. Combinations of these indicators allow authors to aptly describe five adoption models – namely, collaboration, outsourcing, licensing, trading and incorporation – differentiating them for their inherent economic or financial nature, rather than inbound or outbound orientation.

Such indicators and adoptions models set the scene for an empirical application by considering the annual reports (2010-2012) of a sample of 271 of the world's top R&D spend-ing companies in the bio-pharmaceutical and technology hardware & equipment indus-tries. From the comparison of these two industries remarkably different open behaviours emerge.

4. DISCUSSION OF ARTICLES IN THE SPECIAL ISSUE

The undergoing transitions towards a new innovation era, and the emergence of new forms of CI initiatives, call for a deep reflection on how academics can make sense of the characteristics of the four CI ecosystems (professional, learning, transformational, strate-gic). To provide further elements to depict such a complexity, and to better inform the orchestration of academics, this special issue considers four papers dealing with two spe-cific research themes. Discontinuities in business models and innovation processes call for an understanding of how – and to what extent – professionals absorb and react to not only to the challenges of exogenous changes, but also to the endogenous ones impacting learning and creativity practices. On the other hand, objective measurement provides academics with tools that may potentially better inform their orchestration in cases involv-ing changes in transformational and strategic ecosystems.

In detail, the first one deals with a close look at the multi-faceted nature of discontinuous innovation. Although a shared definition looks at this phenomenon as the implementation of new technologies, products or business models that represent a dramatic departure from the current state of the art in the industry (Birkinshaw et al., 2007), few aspects have been investigated concerning its impact on both business models and micro-foundation dynamics.

The first contribution shows how an exogenous discontinuous innovation may act, in a quite complex way, on the relationships between innovation and business model on one side and resources, competencies and capabilities on the other. Despite more than fifteen years of interest and enthusiasm for developing, understanding and applying business model frameworks, rigorous research on business models remains in a nascent stage. The fragmentation of definitions and constructs has precluded integrated and accretive re-search on business models (Mitchell and Coles, 2004; Bock and George, 2011). Based on an inductive study of real case studies, the reconceptualization presented in this paper concretize in a set of interacting dimensions concerning resources, competences and capabilities. This paper is one of the few papers that highlight the shift in studying business models innovation. It well shows the risks of considering business models as static rather than dynamic tools (Demil and Lecocq, 2010), looking particularly at the dynamics created by interactions among the business model components. In particular, a shift from a single firm to a network of firms is discussed and investigated as a combination of multiple and diverse design dimensions and interrelations. Also, authors recall what Gilbert (2005) argued about resource rigidity (failure to change resource investment patterns) and routine rigidity (failure to change organizational processes that use those resources), high-lighting their role when organizations cope with exogenous discontinuous innovation.

The second contribution sheds new light on the different ways of applying the Lean process management method in R&D and its effects on R&D performance and employee creativity. In a similar vein, a recent contribution has advanced an emerging theory on

the relationship between the Agile process management method implementation and a teams' learning and innovation by reporting empirical observations from an extensive cross-case study and advancing an abductive framework (Annosi et al., 2014). Scaling up idea generation and product development processes through the implementation of ap-proaches such as Lean and Agile may induce tensions into the systems which whilst on one hand may contribute to increasing process efficiency, on the other, may hurt creativity and employee empowering practices, resulting in higher time pressure, lower managerial coordination mechanisms, and lower numbers of innovative outcomes (Larman and Vodde, 2010). What these few studies add to the current debate around the introduction of discontinuities in the management of innovation processes is the focus on the fact that the micro-foundations of the dynamics underlying exploration and exploitation practices are addressed, going beyond both theoretical and anecdotal research. Thus, the contribution in this special issue is among the few that pushes the frontier of dealing with process management approaches, investigating their impact on creativity and efficiency of individuals.

The second research theme deals with the refining – and building up – of indicators to measure the radical idea search capability and the open innovation adoption models.

The first contribution is ambitious in its research setting and measurement methodology. It basically aims to provide managers and researchers with a multi-dimensional construct for dealing with the search practices in the fuzzy front end of innovation. A wide range of scientific contributions pointed to the variety of tools that can be used to manage this phase of the innovation process (e.g., Achiche et al., 2013); yet what is not addressed is the conceptualization and empirical validation of those dimensions that can help manag-ers in understanding whether, in their searching for innovation, they are confronting with a radical rather than an incremental outcome. Attempts to provide an objective measure-ment basis to one of the key activities of the innovation process are almost absent. Alt-hough some progress has been made in order to grasp the very nature of radicalness on both the antecedents and consequences (Arts et al., 2013), this contribution for the special issue moves a step further as it focuses on specific search practices in a specific phase of the innovation process, namely the fuzzy front end.

The second contribution also focuses on indicator building, this time addressing it by considering the accounting-based framework for defining open innovation adoption mo-dalities through the analysis of annual reports. As pointed out by Chesbrough et al. (2006), a comprehensive measure for the degree of openness is still lacking. This paper aims at filling such a gap, by identifying the openness degree of a company through accounting data. And if one considers that researches relying on accounting data to build up open innovation indicators are substantially absent, this reveals the innovative trait of the paper in question. This work complements what is being done for policy makers at European level (De Backer et al., 2008; Ebersberger et al., 2012): different indicators are presented using existing data on R&D investments, innovation survey data, patent data and data on licensing, thereby illustrating the increasing importance and the different characteristics of open innovation across companies, industries and countries. All in all, this contribution undertakes one of their directions for future research in that it points out the construction of composite indicators allowing for the analysis of more complex issues in open innovation.

5. PROVOCATIONS FOR FUTURE RESEARCH

Together, the contributions of this special issue provide theoretically diverse insights that offer a useful basis for re-thinking the way in which CI is framed, managed and exploited within organizations. They also provide some useful provocations for ensuring that our collective understanding of CI develops in terms of its sophistication, especially in relation to its relationship with other organizational routines, processes and indicators.

Further work is needed to understand whether the framework advanced in the Ghezzi, Cavallaro, Balocco and Rangone's invited paper works in other industries and over time. Investigating other cases, also from an historical standpoint, provide greater insight into the use of mechanisms dealing with resource rigidity and routine rigidity (Gilbert 2005). The dimensions advanced may also be tested with a large-scale analysis to provide the basis for generalization. Another interesting research avenue may be the one that tries to simulate – factually and counterfactually (Malerba et al., 1999) – industrial dynamics, leveraging upon the wide range of dimensions identified. In a similar vein, a multi-agent system can be built up in which interesting biologically oriented algorithms such as stigmergy can allow managers and policy makers to foresee discontinuities (Appio et al., 2014).

From Helander, Bergqvist, Lund, and Magnusson's invited paper, a complementary way of investigating the implementation may be provided by an abductive research method-ology (Peirce, 1931; Dubois and Gadde, 2002), where inferences are used to formulate an explanatory hypothesis in such a way that a consequence can be derived from what went before. A similar effort has been undertaken by Annosi et al. (2014), whereby a multi-national setting has been considered in looking for cross-country cultural traits and other characteristics. Finally, by following Hallgren and Olhager (2009), a large scale investigation of the external and internal drivers and their effect on the innovative perfor-mance can be performed.

Nicholas, Ledwith, Martini, Nosella and Aloini's invited paper calls for an integrative effort with existing constructs and indicators, both patent and non-patent based (Arts et al., 2013). It is possible that different constructs and indicators should be used for differ-ent phases of the innovation process. A large scale, cross-industry investigation may pro-vide sound basis for validation. The indicators may be enriched by historical analysis of some inventions that can inform a better conceptualization of ex-ante and ex-post radicalness (Appio et al., 2014). In a similar vein, Michelino, Lamberti, Cammarano and Caputo's paper paves the way to disentangle how these indicators can measure OI innovation performance share in complex ecosystems, such as those characterized by triple and quadruple helix dynamics (Appio et al., 2014).

This special issue offered a platform for exploring the antecedents, dynamics, and conse-quences of CI. Research has clearly made significant inroads into developing our under-standing of the topic and has offered some insights. However, further work now needs to be done by the research community to begin to address the challenging calls for future research that have surfaced from this special issue—especially those related to the up-coming fourth era of CI initiatives. We hope that the papers presented in this special issue will provoke further research to answers to some of these questions.

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