

10-17-2018

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Recommended Citation

Pustovrh, A., & Jaklič, M. (2018). Intellectual Structure of the Open Innovation Field: State of the Art and a Critical Literature Review. *Economic and Business Review*, 20(3). <https://doi.org/10.15458/85451.68>

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INTELLECTUAL STRUCTURE OF THE OPEN INNOVATION FIELD: STATE OF THE ART AND A CRITICAL LITERATURE REVIEW

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Received: October 3, 2016
Accepted: April 25, 2018

ABSTRACT: *This paper presents an overview of open innovation. It positions the concept into a wider framework of scholarly research of innovation, discusses its historical development and its positioning within the wider area of innovation research. Using different types of bibliometric analysis, we estimate the impact of open innovation and continue with their contributions to the theory of innovation. While not a true paradigm shift as it used to claim, open innovation is a clearly defined innovation concept that brings important contributions to the theory of innovation, helps answering some of the key questions that were recognized by innovation scholars.*

Keywords: *open innovation, innovation concepts, open innovation practices, open innovation policies, user innovation, bibliometric analysis*

JEL: O31, I24

DOI: 10.15458/85451.68

1. INTRODUCTION

The nature of innovation has changed recently. Innovation activities have become globalized and open in a way that was unimaginable even 20 years ago (Wooldridge, 2010). Companies now innovate in an environment in which competition is global, knowledge is spread more widely, R&D investments are increasing and in which product life cycles are shortening (Koen De Backer, Cervantes, Van De Velde, & Martinez, 2008). Companies can no longer succeed by developing the next innovative product in their internal laboratories or by outsourcing manufacturing activities to low-cost countries (Herrigel, 2010). Countries implement competing innovation policies in order to become more attractive as potential innovation hubs.

These changes have brought new insight into innovation research. Several theoretical concepts have emerged, but the most interest has recently been devoted to a new innovation concept of open innovation, introduced by Henry Chesbrough's 2003 book (Chesbrough, 2003). The open innovation concept presumes that companies use external ideas besides

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those generated inside the boundaries of the company. They also seek internal and external ways to the market for them. Research and development represent an open system (H W Chesbrough & Crowther, 2006)³.

The underlying reason for the development of open innovation and other theoretical innovation concepts was the changing nature of innovation practices. During the first decades of the 20th century, industrial enterprises in the US cooperated and sourced R&D services from dedicated external R&D labs in a way that is very familiar to the current practitioners of open innovation (E. K. R. E. Huizingh, 2011), (Mowery, 1983). The best known example is Edison's The Invention Factory at Menlo Park. Cooperation between companies was common at the time and critical to the survival of an industrial structure dominated by small firms (Hollingsworth, Campbell, & Lindberg, 1991). Still, there was a large gap in theoretical understanding of innovation that was being observed in innovation practices.

Open innovation concept has been targeting this lack of understanding observed in existing innovation practices. Chesbrough claims that open innovation represents a paradigm shift. It emphasises cooperation and sharing of ideas between companies regardless of the boundaries between companies or states. Companies buy or license processes and innovations from other companies and at the same time push their innovations to the market through licensing, joint ventures or spin-offs (Chesbrough, 2003). This challenges the 'closed' innovation model that sees innovation as the result of work of the large internal laboratories that only large, usually multinational companies can afford.

While no one disputes that the open innovation concept has attracted a lot of attention both in practice and academia (E. K. R. E. Huizingh, 2011), there are authors that claim it is not a clear concept and that it comes in many forms, which makes the concept rich but hinders generalization. Others dispute the paradigm shift that open innovation claims to present. They predict that the term will fade away in a decade (E. Huizingh, Conn, & Torkkeli, 2011), merging into the 'standard' definition of innovation. Others have suggested that the term itself could be acting as a communication barrier - hindering growth in research and understanding, thus representing constraint to future research (Groen & Linton, 2010).

Based on these insights, our analysis on the literature review aims to contribute to filling the gaps in understanding innovation recognized by scholars (Fagerberger, 2005) and to answering three research questions in particular:

1. Is it really a new paradigm in understanding innovation (Chesbrough, 2003)?
2. Is open innovation a new innovation concept or just the continuation of the innovation research and not distinct from other existing innovation concepts (E. Huizingh et al., 2011)?

3 In the paper, we continue to use Chesbrough's definition of open innovation which he defines as: "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively" (Henry William Chesbrough, Vanhaverbeke, & West, 2006, p. 1).

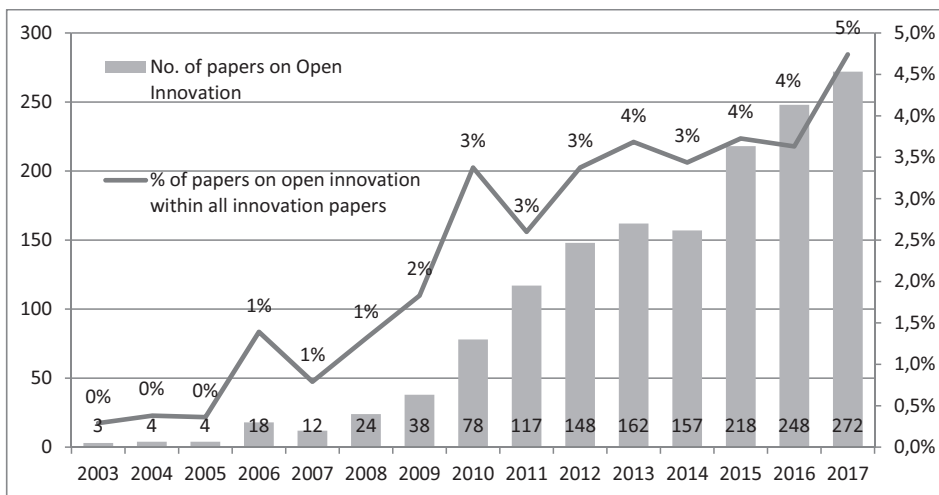
3. Is open innovation even important for theory and practice of innovation – or is the term a communication barrier hindering growth in innovation research and understanding of innovation (Groen & Linton, 2010)?

We will try to provide answers to these three research questions using the bibliometric methods and critical literature review.

2. DEVELOPMENT OF THE OPEN INNOVATION CONCEPT IN INNOVATION RESEARCH

The beginning of the open innovation concept is clear – , it was introduced in Henry Chesbrough's book in 2003 (Chesbrough, 2003). It received significant interest from scholars who soon followed with a growing number of publications.

Figure 1: Number of papers on open innovation and its share among innovation papers



Source: Thompson Reuters Web of knowledge 2018

The initial studies of open innovation focused on early adopters and good practice examples, which tend to be successful. They were usually case studies and descriptive in nature e.g. (Huston & Sakkab, 2006), (Chiaroni, Chiesa, & Frattini, 2009) or (Christensen, Olesen, & Kjar, 2005). Most case studies also focused on particular industries, most often high-tech (Chesbrough, 2003).

These initial studies were followed by expanding the scope to other industries (H W Chesbrough & Crowther, 2006). Some authors soon discovered that 'few corporations have institutionalised open innovation practices in ways that have enabled substantial growth or industry leadership' (Rufat-Latre, Muller, & Jones, 2010). More case studies

followed that attempted to compare different open innovation practices to determine their context dependency e.g.(Sarkar & Costa, 2008), (Vanhaverbeke, Ine, & De Zutter, 2012). They expanded the scope of activities connected to the concept (Grøtnes, 2009).

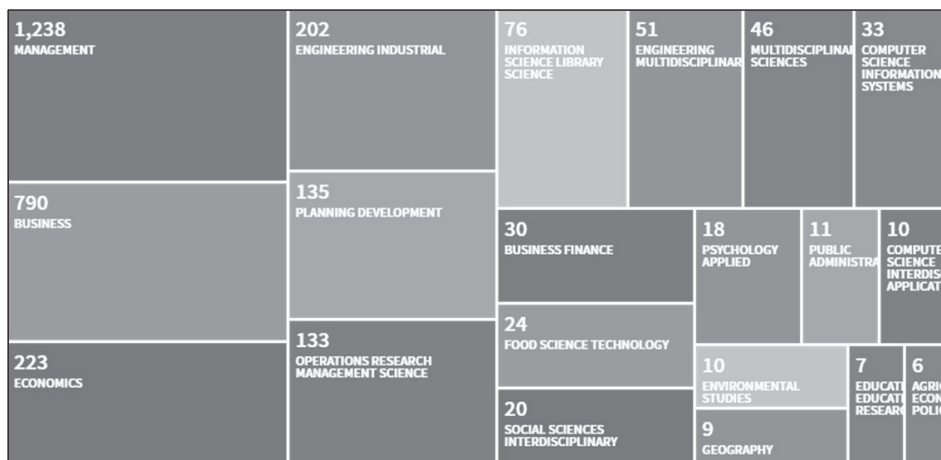
At the same time, the first empirical studies were implemented. They initially used existing data sources like the European CIS survey (Ebersberger, Herstad, Iversen, Kirner, & Som, 2011), (Mention, 2011) or global indicators that were not designed to measure open innovation (K. De Backer, López-Bassols, & Martinez, 2008). They later included specific quantitative studies, but often focused on certain industries (Harison & Koski, 2010), countries (Lazzarotti, Manzini, & Pellegrini, 2010) or institutions (Spithoven, Clarysse, & Knockaert, 2010).

Some quantitative studies focused on small and medium sized companies and discovered that open innovation is a logical step for them. Consequently, they are collaborating with external partners more frequently than large companies (van de Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009)

Others discovered that open innovation is not always the best option (Praest Knudsen & Bøtker Mortensen, 2011). A ‘closed’ innovation system can also be more suitable for some companies or even industries, as there are clear differences in open innovation among companies and industries. Some authors even believe that ‘closed’ innovation systems could return and see evidence of that emerging with the development of the Internet (Anderson & Wolff, 2010).

In recent years, open innovation research has seen systematic appraisals of the contributions of the open innovation in the form of several literature reviews and summaries, as well as identifications of areas for future research (West & Bogers, 2017). As the table X shows, the body of research on open innovation is still increasing and that means that it is spreading to new areas and targets new research questions. Interestingly, one of the opportunities identified by scholars is also a better connection to prior theoretical research, including topics such as absorptive capacity, user innovation, resources, dynamic capabilities, business models, and the definition of the firm (West & Bogers, 2017). They clearly recognized the opportunities of expanding the scope of open innovation beyond organisational-level research to multiple levels of analysis (Bogers et al., 2017).

There is some evidence that open innovation is limited to certain research areas – for example R&D management. Analysing the interest in open innovation, the search of Thomson Reuters Web of knowledge for “open+innovation” after 2003 (when the concept was established) and limiting the results to management, business and economics categories resulted in 1.554 documents in our document set. We have limited our research to the business, management and economics categories because they are by far the most numerous ones. Other categories are numerous but very limited, as the graph shows.

Figure 3: *Open innovation topic among the Web of knowledge categories*

Source: Thompson Reuters Web of knowledge 2018

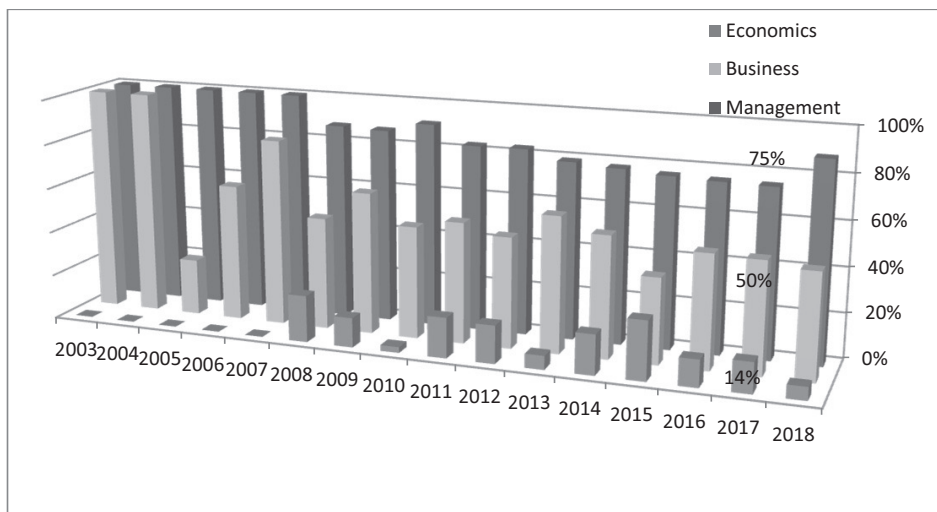
Our analysis also shows that open innovation remains most widely used in the management of R&D. This is clearly seen from the top journals publishing open innovation research with four out of five top journals that publish open innovation research focusing on R&D management.

Table 1: *Top journals that publish open innovation research*

Source Titles	Published articles
R D MANAGEMENT	67
RESEARCH TECHNOLOGY MANAGEMENT	59
TECHNOVATION	53
RESEARCH POLICY	51
INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	50
TECHNOLOGY ANALYSIS STRATEGIC MANAGEMENT	46
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	42
JOURNAL OF PRODUCT INNOVATION MANAGEMENT	37
CREATIVITY AND INNOVATION MANAGEMENT	32
INTERNATIONAL JOURNAL OF INNOVATION MANAGEMENT	32

Source: Thompson Reuters Web of knowledge 2018

The focus on business and management aspects of open innovation is a constant and not changing much, emphasizing the focus on the business research topics. Even the category of economics is not well researched - and the interest of open innovation scholars in economics seems even to be waning in recent years.

Figure 4: *Categories chosen by the open innovation articles*

Source: Thompson Reuters Web of knowledge 2018

While our analysis focuses on the articles published after 2003, some articles also results from our search that originated before 2003. Interestingly, in the most cited literature review of open innovation (Dahlander & Gann, 2010), the authors also include papers on open innovation that were published even before the concept was introduced in 2003. They also present some additional findings. First, open innovation is not a completely new concept as the organisation of innovation activities that breached firm boundaries was already present before the introduction of the open innovation concept. This includes distributive innovation (Lakhani & Panetta, 2007) and network innovation (Steinle & Schiele, 2002) that remain closely connected to open innovation. The main difference between these concepts is the ratio between internal and external sources of innovation. Due to these similar concepts, the open innovation paradigm was much less sudden and more gradual. As confirmed also by our analysis, the open innovation concept that was introduced in 2003 was new, but open innovation activities were not.

This can be clearly seen in the table below, where open innovation references are presented. We have prepared a shared unit (bibliometric coupling) analysis on the dataset of 500 most cited open innovation papers in the categories of economics, management and business. Using the method most often used (Persson, Danell, & Schneider, 2009) and the BibExcel software (Persson, 2017), the analysis shows the most often used sources used in the open innovation core document set. A sizable percentage of open innovation research is clearly founded on previous innovation research.

Table 2: *Top 20 most cited references by open innovation research core document set*

Authors	Title	Year	Source Title
Chesbrough, HW	Beyond high-tech: early adopters of open innovation in other industries	2006	R&D Management
Crowther, AK			
Chesbrough, HW	Open innovation: the new imperative for creating and profiting from technology	2003	Harvard Business Press
Chesbrough, HW	Open Innovation: Researching the New Paradigm	2006	Oxford University Press
Vanhaverbeke, W			
West, J			
Chesbrough, HW	Open business models	2006	Harvard Business PRes
Chesbrough, HW	The era of open innovation	2003	MIT Sloan Management Review
Cohen, W;	Absorptive-capacity – a new perspective on learning and innovation	1990	Administrative Science Quarterly
Levinthal, D			
Dahlander, L	How open is innovation ?	2010	Research Policy
Gann, DM			
Eisenhardt, K M	Building theories from case study research	1989	Academy of Management Review
Enkel, E	Open R&D and open innovation: exploring the phenomenon	2009	R&D Management
Gassman, O			
Chesbrough, H			
Grant, RM	Toward a knowledge-based theory of the firm	1996	Strategic Management Journal
Huizingh, E.K:R.R	Open innovation: state of the art and future perspectives	2008	Technovation
Laursen, K; Salter, A	Open for innovation: the role of openness in explaining innovation performance among uk manufacturing firms	2004	Strategic Management Journal
Laursen	The paradox of openness: appropriability, external search and collaboration	2014	Research Policy
Lee, S, Park, G	Open innovation in SMEs – an intermediated network model	2010	Research Policy
Yoon, B, Et al.			
March, JG	Exploring and exploiting in organizational learning	1991	Organization Science
Parida, V	Inbound open innovation activities in high-tech SME's: the impact on innovation performance	2012	Research Policy
Westerberg, M			
Frishammar, J			
Teece, D	Profiting from technological innovation – implications for integration, collaboration, llicensing and public-policy	1986	Research Policy
Van de Vrande, V	Open innovation in SME's: trends, motives and management challenges	2009	Technovation
De Jong, JPJ			
Vanhaverbeke, W,			
Et al.			
von Hippel, E	Democratizing innovation	2005	MIT Press

Source: Own shared unit (bibliometric coupling) analysis on the dataset of 500 most cited open innovation papers in the categories of economics, management and business.

Papers marked with grey were published prior to the definition of the open innovation concept.

Based on this analysis and the findings of other bibliometric studies of open innovation, is it safe to answer our first research question:

1. Is it really a new paradigm in understanding innovation (Chesbrough, 2003)?

While the concept is often presented as a revolutionary shift in understanding innovation activities, the change has been much less abrupt (Altmann & Li, 2011). In fact, open innovation is building on work developed by several innovation concepts introduced in the 1980's and 1990's. In order to represent a paradigm shift in the whole innovation research, open innovation would have to completely replace the old way of thinking, replacing the coherent tradition of investigation on innovation (Kuhn, 1962). However, our literature review as well as other reviews (E. K. R. E. Huizingh, 2011) clearly show that previous literature on innovation has also regarded network connections between actors (including connections across company boundaries) as being important. In particular, innovation systems concept has emphasised the collaborative aspect of innovation (B. Å. Lundvall, 1992; Richard R. Nelson, 1993).

Other authors have also recognized that the origins of open innovation were influenced by several areas of economics and management, developed over the last decades (e.g. dos Santos, Zambalde, Veroneze, Botelho, & de Souza Bermejo, 2015).

However, while open innovation is not a paradigm shift as it sometimes claims to be, does that mean that it has been redundant, yielding no contributions to scholarly research of innovation? Is it perhaps just limited to being a useful tool for companies that they can use to profit from innovation of others? Or has it made contributions to the theoretical understanding of innovation that other theoretical concepts haven't been able to? Does it represent a distinct innovation concept which brings valuable contributions to the body of knowledge on innovation?

3. RELATION OF OPEN INNOVATION CONCEPT WITH OTHER NEW CONCEPTS OF INNOVATION RESEARCH

- Is open innovation a new innovation concept or just the continuation of the innovation research and not distinct from other existing innovation concepts (E. Huizingh et al., 2011)?

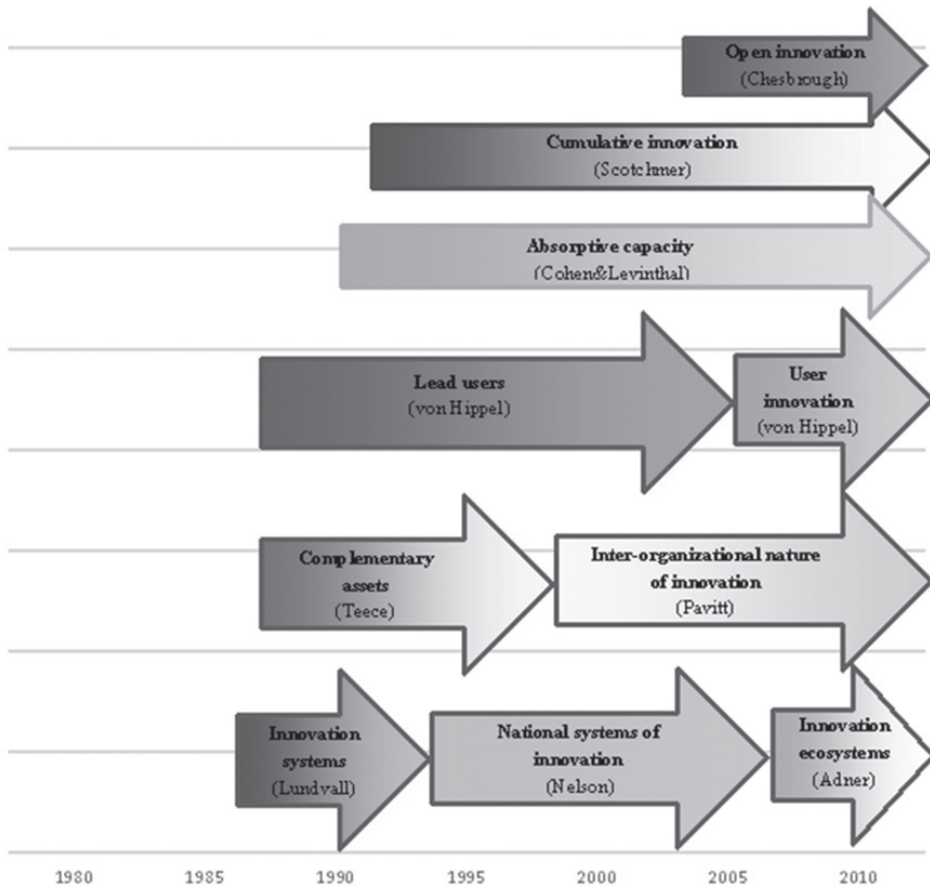
To answer this research question, it is important to recognize if open innovation has brought some theoretical contributions to the study of innovation that was lacking before. Essentially, our research question ask if open innovation, while not a paradigm shift in understanding on the innovation in general, is a new theoretical concept that is contributing knowledge and understanding to the innovation phenomena that was previously lacking. To answer this, we first need to establish the current state-of-the-art of scholarly understanding of innovation. A good overview of our current understanding of innovation was provided by the Oxford Handbook of Innovation ((Fagerberger, 2005).

Based on this overview, we have identified several concepts of innovation that have added to the understanding of innovation.

The concept of absorptive capacity supported the idea that companies should access and absorb external ideas, science and other kinds of knowledge inputs to innovation (Cohen & Levinthal, 1990). Complementary assets were discussed in regard to market failures in the innovation activities (Teece, 1986). The inter-organizational nature of innovation learning has been discussed by many authors (for example Pavitt, 1998). User-led innovation (von Hippel, 1986) introduced involvement of users in the innovation process. The concept of an 'innovation system' that includes customers, suppliers, competitors, universities, government organisations etc. was first used by Lundvall (B.-åke Lundvall, 1985). The analysis of innovation systems was upgraded with the work of Nelson (Richard R. Nelson, 1993) and others and is sometimes developed into innovation ecosystems (Adner, 2006). Exploration and exploitation of organisational learning were also discussed before (March, 1991).

Open innovation (as well as other authors before, for example Kline and Rosenberg (1986) also challenges the linear model of innovation (research → invention → innovation → diffusion) from the 1960's with the central role for research and development (Gibbons et al., 1994, Smith, 1994, (Clark & Guy, 1998). These models never corresponded to the complexities of the innovation processes (Chesbrough, 2003, 2006) as they could not explain innovation activities of small and medium enterprises or clusters. Open and networked innovation systems are much better able to explain the competitive advantage of these organizations. New models look at innovations as a non-linear technical and social process based on complex relations between companies and their environment (Asheim & Isaksen, 1997). These models explain the innovation process from the viewpoint of innovation flows in the organisations and between them (Saxenian, 1994) as the companies cooperate with suppliers, customers, research institutes or even competitors.

Figure 5: A historical overview of development of innovation concepts



Source: own conceptualization loosely based on Fagerberg (2005)

Dramatic developments of innovation activities and innovation research have not only influenced the emergence of the open innovation concept. Building on similar academic foundations, other innovation concepts have developed at the same time as open innovation.

Open innovation is often compared to open source innovation. Open-source innovation is a more specific concept, most often associated with software (Euchner, 2010). In open-source software, platforms like Linux represent platforms that enable users to develop and share the code that they need. There is no owned intellectual property since anyone can access, use and modify the code. That does not mean that there are no governance structures though and business models have developed based on the open-source. In fact, business model development based on open-source innovation has many similarities with open innovation and open business model generation. However, the concept of open –

source differs from open innovation in three main characteristics: intellectual property rights are open, open governance of R&D and open direction of development (Euchner, 2010).

The usage of open-source innovation is spreading from the IT industry to industries such as medical engineering and sports equipment. Some authors believe that there is a clear technological trend and that open-source community innovation will be the future of open innovation (Bughin, Chui, Johnson, & Internet, 2008). The new technological revolution of digital manufacturing could represent a great boost to open source (Pearce et al., 2010). Its recent applications include development of open-source communities for scientific publishing and design.

Nevertheless, there are signs that open-source innovation has reached its potential in software development (The Economist, 2012), an industry where it has become the most prevalent. Other open source usages have remained limited to a few cases and have failed to gain wider usage. As the open source concept is already well over a decade old, it has developed beyond expectations. However, it has not become the dominant or only innovation concept even in software development. Some argue that it will remain an interesting but niche practice of innovating (Economist, 2006).

Open source innovation is based on networks of individuals that form a community. This community both contributes to the development and uses the product or service. Sometimes, these networks have enabled users to radically redefine the role of the firms that supply them. Von Hippel sees this as a more general trend where users (both individuals and firms) are increasingly able to innovate for themselves (von Hippel, 2005). Similarly, the concept of user innovation builds on the insight of van Hippel that in many industries, users were the originators of the most novel innovation. The user's dominant role in originating innovations reflects the fact that knowledge is distributed and sticky, an insight originating from Hayek's work in 1945 (Hayek, 1945). The distributed nature of knowledge results in the acknowledgement that traditionally closed models of proprietary innovation will have difficulty completing knowledge intensive tasks when most of the needed knowledge resides outside of the organisation (Lakhani & Panetta, 2007). The user innovation concept represents several distributed innovation systems, including open source innovation. In practice, the limitations of such innovation are notable. They include a high failure rate for several projects, organisational issues in regards to delivering innovations on demand and difficulties in embracing distributed innovation into organisations. The last limitation is closely connected with the issues of trade secrecy and intellectual property protection (Lakhani & Panetta, 2007).

Even though open innovation and user innovation are closely connected concepts with a number of similarities and based on the same socio-economic and technological changes of the last decades, they are completely distinct and even competitive. Their main difference is in the business model. User innovation focuses on value creation through lead users and innovation communities. Open innovation does not only focus on value capture. This is the distinction that has made it very popular with companies when they finally

realize how they can profit from user innovation. Open innovation is primarily focused around the organization and the process of open innovation is within the firm and on ways of how to profit from them. Therefore, it clearly supports Intellectual Property Rights (IPR), while user innovation (especially open source innovation) does not support private ownership IPR. There are other differences between the user innovation concept and the open innovation concept, but it is clear that the main difference is the profit motive as the driver of innovation in the open innovation concept (West, 2012). Open and user innovation remain two separate, but similar theories of innovation.

In reality, both research streams are separate with only a handful of scholars active in both communities. Few authors have tried to combine and consolidate the two research streams. One example is Joel West (2010), who coined the overarching term of distributed innovation. However, the term has not yet been widely accepted.

There is a third body of scholarly research on innovation – cumulative innovation. This concept is most recently associated with the work of Scotchmer (1991). Her contribution from the 1990's and 2000's emphasises the cumulative nature of research since most new discoveries are the result of previous technological progress. They are based on the foundations provided by earlier researchers and innovators (Scotchmer, 1991). The cumulative nature of research poses challenges to the patent system. It does not provide proper incentives for research since it rewards only individual, often breakthrough innovations. By contrast, most improvements are incremental. The cumulative innovation literature considers the role of interdependencies of producers within the industry (West, 2009). Companies often share the leadership of technological progress, which does not depend on any one individual or firm. Companies also build upon a common, ever increasing pool of enabling science, even if their specific products are unique point products. The best example is the biopharmaceutical drug discovery (Scotchmer, 2004).

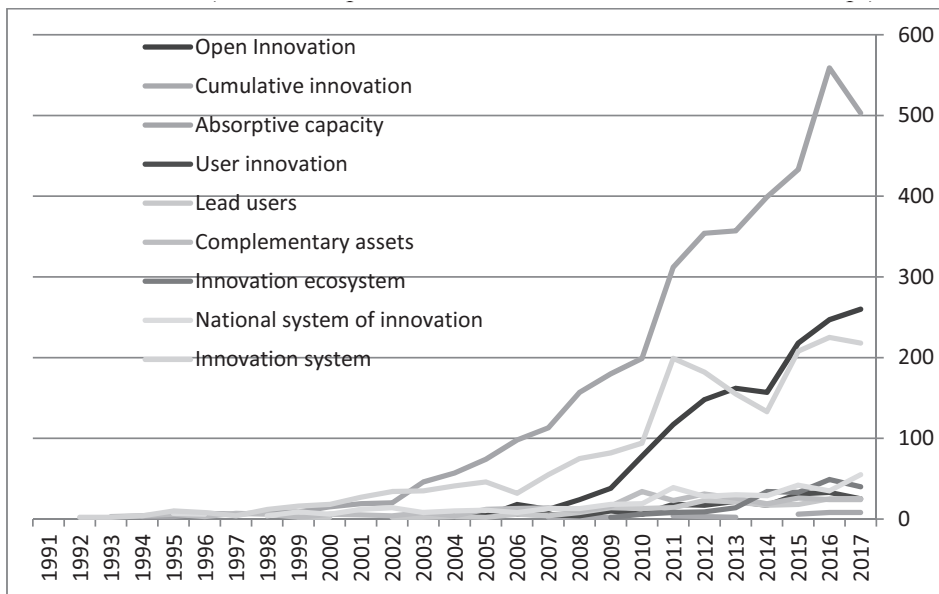
In some cases, cumulative innovation is fuelled by explicit cooperation between firms, while in other cases an industry's joint innovation is advanced through unintended spill-overs and information flows among the firms in the industry. In the latter case, cumulative innovation happens to the degree to which it is permitted by IP policies, as firms use whatever information is available to develop their innovations — and thus, IP monopolies tend to slow the rate of innovation and progress (Scotchmer, 1991). In contrast to the open innovation concept, cumulative innovation sees intellectual property protection as a possible hindrance to innovation.

There are other innovation concepts connected to similar innovation activities that form the foundation of the open innovation concept. Doing, using and interfacing mode of learning and innovation emphasises the role of informal processes of learning and experience-based know how (M. B. Jensen, Johnson, Lorenz, & Lundvall, 2007).

These concepts had different contributions to the understanding of innovation. Figure below shows that the highest number of articles have been discussing three main concepts of innovation: absorptive capacity, innovation systems and open innovation. Of these,

open innovation is the most recent concept but has seen the most rapid increase in the number of articles recently.

Figure 6: A historical overview of development of innovation concepts
(Number of published articles for each innovation concept)

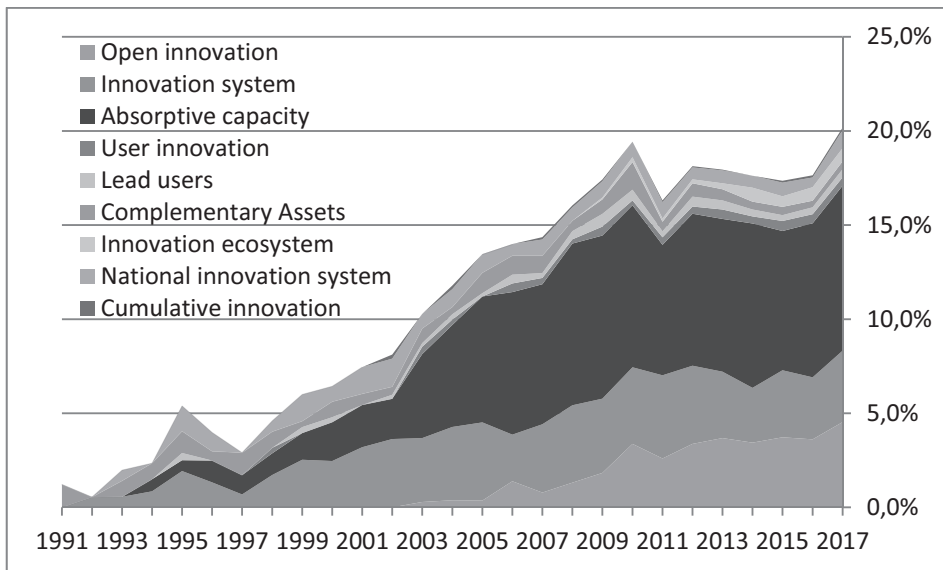


Source: Thompson Reuters Web of knowledge 2018

Each innovation concept was defined by keywords in the fields of economics, management and business in the research topic in the Web of knowledge

As a share of the total number of articles discussing innovation, open innovation has been representing some 4,5 % of the total research field in 2017. It trails only the concept of absorptive capacity that was discussed by almost 9 % of all innovation articles. Open innovation has contributed more papers than a much older concept of innovation systems while no other concept has yielded more than 1 % of all innovation articles.

Figure 7: A historical overview of development of innovation concepts (Share of published articles in the total publications on innovation)



Source: Thompson Reuters Web of knowledge 2018

Each innovation concept was defined by keywords in the fields of economics, management and business in the research topic in the Web of knowledge

This analysis shows that our understanding of innovation is comprised of several concepts and is discussed from different viewpoints, so it is unrealistic to expect one concept (such as open innovation) to become the only 'true' innovation concept. A body of knowledge on innovation is comprised of numerous theories (or research programs according to Lakatos (1976)) and each of them sheds new light on a subject – especially one as complex as innovation. Open innovation will never be the only innovation concept as other views on innovation already exist and will continue to exist in the future. However, open innovation does contribute new insights and is clearly different from other concepts, even very similar ones (like user innovation). It has a clear definition of the concept and fit the usual criteria for concept adequacy (Gerring, 1999).

It is actually one of the most prolific innovation concepts. Its impact on the understanding of innovation is also growing: it represents a growing proportion of additional published academic research articles. On the contrary, some other concepts (like cumulative innovation) have contributed almost no additional scientific articles in recent years and have thus all but stopped contributing to the body of knowledge about innovation. Based on this analysis and our findings, we can thus answer our second research question:

- Is open innovation a new innovation concept or just the continuation of the innovation research and not distinct from other existing innovation concepts (E. Huizingh et al., 2011)?

Clearly, the answer is positive. Open innovation is a new innovation concept, distinct from other innovation concepts. As other concepts, it is contributing new insights into our understanding of innovation.

4. CONTRIBUTIONS OF OPEN INNOVATION

Open innovation is thus not a paradigm but a new innovation concept that is growing and adding to our understanding of innovation. But what kind of contributions has it made to the theoretical understanding of innovation that other theoretical concepts haven't been able to?

Our analysis of literature shows that scholars have recognized at least three sets of contributions.

4.1. Contributions of Open Innovation to the theory of the firm

The result of the decline of the Fordist regime of innovation organisation and of the organisational expansion of innovation activities is that the locus of innovation is shifting away from the individual firm and national innovation system towards globally distributed knowledge networks. This development was not as new and surprising as it might seem. Alfred Marshall's concept of 'external economies' in 'industrial districts' were inspired by the modes of industrial organization found prior to the growth and consolidation of Fordism (Marshall, 1920). The major advantages of Marshallian industrial districts arise from the simple propinquity of firms, which allows easier recruitment of skilled labour and rapid exchanges of commercial and technical information through informal channels. They illustrate competitive capitalism at its most efficient, with transaction costs reduced to a practical minimum; but they are feasible only when economies of scale are limited.

However, the consequent theoretical work on the theory of the firm developed in another direction that implied that open innovation systems were opposing the existing economic theories of the firm. The debate on the nature of the firm followed Coase's insight that transaction costs in the market are not minimal but rather large. They represent a market failure that allows company's administrative control over transactions to be more efficient than market transactions (Coase, 1937). According to the transaction cost theory that evolved, companies exist since it is preferable not to leave some complex functions to the market as transaction costs would be too high (Williamson, O., 1975). Innovation services are an example of such a complex transaction, Therefore, according to this theory, open innovation systems would be less competitive than internal research.

Evolution theories (R.R. Nelson & Winter, 1982; Penrose, 1952, 1995, Veblen, 1898, 1899) describe development of companies from lower to higher levels of operations and success as a result of manager's actions, who transfer new routines to operational levels of the

company. They are connected to the general theory of evolution, which can be understood as any process whereby small variations can accumulate and predominate over time into large-scale changes. Companies improve their efficiency with relentless repetitions. By transferring complex routines and functions beyond the boundaries of the firm it would lose crucial benefits and control that it derives from its ownership. We find them especially useful as the underlying foundation for the research of business ecosystems. In connection to open innovation, they support government intervention as necessary due to the systemic failure argument. We will present this in more detail below.

Agent theories (Milgrom & Roberts, 1992) describe firms as a quest for control between principals and agents. Principals use contractual relations to allocate agents according to their needs. However, this is much more difficult for relations with outside partners as principals lose their hierarchical advantage.

Innovation economics (Schumpeter, 2013), (Freeman & Soete, 1974) enabled the development of large internal laboratories in corporations that enabled them to monopolize innovation by establishing large entry barriers.

All of these theories share the view that open innovation is not preferable to internal innovation. It was only Porter and his five forces model that recognized that the firm is at the centre of the network and other forces (the five forces he describes) are in the network as well (M. Porter, 1985). Concepts such as barriers to entry have less meaning, and the idea of rivalry, buyers, and suppliers is transformed by an environment of “co-competition”. The distinctions between companies and markets have been blurred. Some of the challenges of the networked world cannot even be considered from a firm-level perspective, any more than a complex ecosystem can be understood by studying one of its actors, or a chemical reaction can be understood by studying a single reagent. Nevertheless, they still looked at the positioning of the competitive advantage of the individual company inside a network of other players. At the core of Porter’s model, the boundaries of the firm remained intact.

The rise of networks has fundamental implications for business strategy and competencies. However, it also complicates and raises the issue of which activities the firms should perform internally and where to set the boundaries of the firm.

It seems that the most useful definition of the firm for researching open innovation is that firms are bundles of activities which simultaneously include different forms of interactions with external actor groups (Ebersberger et al., 2011). This implies that small firms can compete with larger firms through innovation if they collaborate with external partners. As such, open innovation activities can become a tool for small companies to successfully compete with the innovation activities of large companies. The lack of resources does not necessarily hinder their innovation activities as most theories of the firm would imply.

Empirical evidence confirms that. Some recent studies in the EU find that the SMEs engage in many open innovation practices and have increasingly adopted such practices

(van De Vrande, de Jong, Vanhaverbeke, & de Rochemont, 2009). Other studies show that SME's have, on average, a much higher intensity of open innovation practices than large companies (Vanhaverbeke et al., 2012). This finding is further developed (and contradicted) by the most comprehensive study of the effects of the firm size on different open innovation practices reported in the Open Innovation in Europe Report. It shows that firm size increases the implementation of open innovation practices (Ebersberger et al., 2011). This finding is also true for small firms. However, it clearly shows that SMEs are also actively implementing open innovation practices.

These global changes will be resolved through a combination of technology and social policies. Both will be organized differently than the standard theory suggests.

4.2. Contributions of Open Innovation to the innovation policy research

Ever since the theory of open innovation was established, it has influenced innovation policies (e.g. (Chesbrough, 2003). This seems contradictory at first since the open innovation paradigm puts more emphasis on the market transactions in the innovation activities – ‘opening’ innovation activities that previously belonged to closed organisations. However, that does not mean that the markets for innovation function well.

Government intervention in corporate innovation activities was usually based on the market failure argument. In the world of perfect competition, the market's innate coordination mechanisms would allocate goods and services efficiently. They would reach the Pareto optimum (KJ Arrow & Debreu, 1954). However, since the perfect competition requirement is not fulfilled in the real world, the resulting allocation of resources is not optimal (Greenwald & Stiglitz, 1986). Knowledge has characteristics of a public good as it spills over from creator to other actors who are only limited by their own capabilities in utilizing it. This results in an appropriability problem for the creator of the knowledge. Innovating companies cannot fully appropriate the returns of their innovation and will hence under-invest in knowledge and knowledge creating processes (K Arrow, 1962). This reasoning is based on the classical view that goes back to Adam Smith (1845) and neoclassical economics. According to these views, the target for the government is to establish conditions for competition that will channel individual self-interest for the common good.

However, far from creating a perfect world, economic competition often encourages behaviours that not only cause enormous harm to the group but also provides no lasting advantages for individuals, since any gains tend to be relative and mutually offsetting (Frank, 2012). Other theories like evolutionary theory and institutional economic theories, for example the ‘varieties-of-capitalism approach’ (Hall & Soskice, 2001) and national business system (Whitley, 2000), though sometimes regarded as unorthodox, can better explain the reasoning for government intervention in open innovation systems. According to their view, various institutions are present in both contextual and transactional ecosystems (organization of markets). Actors in such ecosystems try to fulfil their interests by seek ways to position themselves in the institutional

environment and by actively trying to use it to their own advantage (Jaklič, 2009, p. 20). In an institutional environment, linkages among actors and institutions are crucial for successful innovation. Lack of linkages presents a systemic failure and can have crippling effects on innovation (Hwang & Horowitz, 2012). According to these views, the standard market failure rationale for government intervention is not sufficient to promote the development and diffusion of new technologies as innovation is based on a complex evolutionary process distributed in a system of multiple socio-economic agents whose behaviour and interactions are governed not only by market forces but to a greater extent by non-market institutions (Bleda & del Río, 2013). Linkages between actors serve as channels for knowledge diffusion and recombination. Lack of linkages and networking across organizational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall 'closure' of learning processes (S. J. Herstad et al., 2010). These failures need to be tackled in a similar way to market failures – with policy intervention (Klein Woolthuis, Lankhuizen, & Gilsing, 2005).

Based on the market and/or system failure argument supporting innovation policies, it seems clear that open innovation needs elaborate innovation policies. Far from becoming redundant, they remain an essential element of industrial policies. However, the new way of thinking about openness and innovation does influence the changes in innovation policies (S. Herstad & Bloch, 2008; S. J. Herstad et al., 2010). Different policy measures are needed to facilitate open innovation activities than were needed to support innovation in the past. But different in what way?

Open innovation theory does not contradict these insights and firmly supports the notion that government intervention in supporting innovation activities is justified. In fact, the open innovation theory suggests another line of reasoning to support government intervention⁴. It argues that linkages between actors serve as channels for knowledge diffusion and recombination. Lack of linkages and networking across organizational boundaries represents a system failure, as do lock-ins to specific collaboration partners, sources of ideas and information or excessive overall 'closure' of learning processes (S. J. Herstad et al., 2010). These failures need to be tackled in a similar way as market failures – with policy intervention (Klein Woolthuis et al., 2005).

There are some concrete examples of market and systemic failures that are inherent in the open innovation concept. It has emphasised the role of innovation and intellectual property agents (such as Innocentive and others), whose role is to promote novel solutions to mitigate market failures. However, these initiatives have not yet widely spread and remain no more than a niche segment of overall innovation activities. Their existence does not solve the market or system failures. Policy intervention is still needed. Researchers and policy makers have taken open innovation into account and tried to suggest policy changes that would support open innovation activities.

⁴ In fact, the systemic approach to innovation policy was developed into a line of research well before the introduction of the open innovation concept, but fits well with the concept.

An OECD study in 2006 specifically tried to provide recommendations on how to connect the new business strategies implementing open innovation with their policy implications (K. De Backer et al., 2008). More recently, several papers and studies have discussed the question of how national innovation policies can be reframed in a context of open innovation (e.g. (S. J. Herstad et al., 2010), (Ebersberger et al., 2011) and others). They suggest that national level tools are still the ones that represent the most immediate form of intervention into innovation behaviour (S. J. Herstad et al., 2010)

4.3. Contributions of Open Innovation to the cluster theory

The answer to the idea that linkages between actors serve as channels for knowledge diffusion and recombination had been limited to a narrow geographic area. The idea became very popular and it is hard to find a country that is not trying to develop a network of complementary and competitive firms. A 2006 study identified 1400 cluster initiatives globally (Ketels, Lindqvist, & Sölvell, 2006). At their core, clusters are simply geographically proximate groups of interconnected companies and associated institutions in a particular field, linked by various commonalities and complementarities (external economies) (Michael Porter, 2008). But the definition of geographic proximity is changing due to the on-going developments of globalisation and information technologies. In 1998, Michael Porter wrote: “Now that companies can source capital, goods, information, and technology from around the world, often with the click of a mouse, much of the conventional wisdom about how companies and nations compete needs to be overhauled. In theory, more open global markets and faster transportation and communication should diminish the role of location in competition. After all, anything that can be efficiently sourced from a distance through global markets and corporate networks is available to any company and therefore is essentially nullified as a source of competitive advantage. But if location matters less, why, then, is it true that the odds of finding a world-class mutual-fund company in Boston are much higher than in most any other place? Why could the same be said of textile-related companies in North Carolina and South Carolina, of high-performance auto companies in southern Germany, or of fashion shoe companies in Northern Italy?” (ME Porter, 1998, p. 76).

For years, the competitive advantage of industrial districts and clusters has been based on product flexibility and production efficiency. The competitive advantage of firms is now less and less based only on simple products. Competition is more and more shifting to a “service” and to a “business model” level. Innovation now has a prominent importance to firms, and hence have innovation-centred strategies, foster the inter-clusters and the international collaboration of, enhance knowledge transfer and knowledge contamination between different entities (universities, research centres, firms, policy makers, consultants, technology parks, venture capitalists, knowledge brokers, etc.) (Bortoluzzi, 2014). Clusters are focusing on innovation collaboration and activities that can lead to competitive positioning as an innovative node in an innovation network (and consequently, value chain). Economic geographers have argued that interaction with distant partners may be at least as important for innovation as local collaboration (Cotic-Svetina, Jaklic, &

Prodan, 2008). Others have found that international linkages within the value chains are associated with superior innovation performance (S. Herstad & Bloch, 2008). It seems that success of (some) clusters was more based on (innovation) collaboration, not just locating firms in the same place (EIU, 2011). If such collaboration can be established over longer distances, it has at least the same potential to foster innovation as local clusters. Innovation collaboration (and other open innovation activities) is becoming the source of competitive advantage in clusters, just like in companies. Open innovation has contributed to understanding how companies can benefit from such innovation collaboration. It thus also offers the same insights for clusters.

While open innovation has contributed to other research questions about innovation, these contributions are sizeable and clearly aim at closing some gaps in our understanding of innovation as recognized by scholars (for example Fagerberg (2005)). The table below presents the main contributions that open innovation has brought to the research on innovation.

Table 3: *An overview of open innovation's contributions to innovation research*

Research questions	Main insights of innovation literature	Open innovation (OI) contribution
What is innovation?	<p>The function of innovation is to introduce novelty (variety) into the economic sphere. With no innovation, the economy will settle into a state with little or no growth. Innovation is crucial for long-term economic growth.</p> <p>Many different types of innovation exist with distinct features that have an influence on their research and implementation.</p>	<p>Open innovation emphasizes the innovation of new business models – business model innovation (H. W. Chesbrough, 2006). It also expands core concepts to Open Service Innovation (H W Chesbrough, 2011).</p> <p>Its focus on the organization of businesses to conduct and exploit innovation describes novel forms of organization (for example ‘innovation intermediaries’) and networks between companies and partners.</p> <p>It endorses the new ‘combinatorial innovation’ (Economist, 2014) describing the technological and start-up explosion as a system integration of newly emerging (digital) platforms.</p>
How innovation occurs? (with the insight on the systemic nature of innovation)	<p>A firm does not innovate in isolation but based on extensive interaction with its environment. Innovation journey is a collective achievement (Van de Ven, Polley, Garud, & Venkatarman, 1999). System and network perspective are useful for the study of innovation.</p>	<p>The main insight of OI is that companies are no longer able to tackle the entire innovation process on their own. It is crucial to have access to external innovation. The number of sources of innovation is now greater, and its origins are increasingly heterogeneous</p> <p>Internal R&D still plays a role. It is not obsolete. However, it takes on other (additional) tasks: it must pay attention to what is going on outside, identify gaps and holes - and remedy them - and facilitate integration; and it can become an additional source of income.</p> <p>Possibly the main contribution of OI is its focus on implementing OI in companies (innovation management).</p>
Clustering characteristics of innovation (in both time and space)	<p>Innovation tends to cluster in certain industries, which consequently grow more rapidly, implying structural changes in production and demand and, eventually organizational and institutional change.</p> <p>It also clusters in time, influencing business cycles.</p>	<p>OI does not focus on the clustering characteristics. It does support crowdsourcing and innovation communities in general, but both areas are more the focus of user innovation. It does contribute to the understanding that innovation communities can share the benefits of clusters even without geographical proximity.</p>
Effects of innovation on economic performance	<p>Innovation is a powerful explanatory factor of differences in performance between firms, regions and countries. Innovative countries have higher productivity and income than less innovative ones.</p>	<p>There are very few contributions of the effects that OI has on economic growth (although some studies focus on the effects on company growth).</p> <p>Generally lack of broad economic empirical studies on OI.</p>

Source: own conceptualization, loosely based on Fagerberg (2005)

With these insights it is possible to answer our third research question:

- Is open innovation actually hindering growth in research and understanding innovation and representing a constraint to future research (Groen & Linton, 2010)?

Open innovation is contributing towards answering some of the key questions about innovation that were recognized by innovation scholars. As the table above shows, it is adding some significant theoretical understanding to key research questions about innovation. It is clearly adding to our understanding of innovation and is among the most prolific innovation concepts. It is also particularly useful for practitioners as many companies have started intentionally developing their innovation activities in a more open way. Some authors believe that the majority of Fortune 100 companies already use open innovation systems (DeSouza, 2010).

The contributions of open innovation are clearly focused on the question of 'How does innovation occur?' Clearly, open innovation has contributed to the understanding how to implement it in companies. With regards to theoretical gaps in this area, intellectual property issues (especially trading), spatial and network aspects of organization of R&D teams, and management research on the operational and implementation aspects of open innovation in organizations are just some of the key areas where more research is needed to facilitate the consistency of open innovation theory, since there is no holistic model of open innovation which would identify all the determinants of the innovation process, test limits to opening up of organizations following the open innovation paradigm or help us understand the underlying cause-and-effect mechanisms of open innovation practices (Gassmann, Enkel, & Chesbrough, 2010).

5. CONCLUSIONS, LIMITATIONS AND FUTURE WORK OPPORTUNITIES

Research question	Sub-section	Source of the research question	Research method	Answer
Is open innovation (OI) really a new paradigm in understanding innovation?	1.2 Development of OI concept in innovation research	(Chesbrough, 2003)	Shared unit (bibliographic coupling) analysis	In order to represent a paradigm shift in the whole innovation research, open innovation would have to completely replace the old way of thinking, replacing the coherent tradition of investigation on innovation (Kuhn, 1962). However, our literature review as well as other reviews (citiram ?) clearly show that previous literature on innovation has also regarded network connections between actors (including connections across company boundaries) as being important.
Is it a new innovation concept or just the continuation of the innovation research and not distinct from other existing innovation concepts?	1.3 Relation of OI concept with other new concepts of innovation research	(E. Huizingh et al., 2011)	Historical overview of development of innovation concepts and a bibliometric analysis of key terms of the identified innovation concepts	A body of knowledge on innovation is comprised of numerous theories and each of them sheds new light on a subject – especially one as complex as innovation. Open innovation will never be the only innovation concept as other views on innovation already exist and will continue to exist in the future. However, open innovation does contribute new insights and is clearly different from other concepts, even very similar ones. It is actually one of the most prolific innovation concepts. Its impact on the understanding of innovation is still growing.
Is this even important for theory and practice of innovation? Is open innovation actually hindering growth in research and understanding innovation and representing a constraint to future research?	1.4 Contribution of OI	(Groen & Linton, 2010)	Analysis of the gaps in our understanding of innovation as recognized by innovation scholars	Open innovation is contributing towards answering some of the key questions about innovation that were recognized by innovation scholars. It is adding some significant theoretical understanding to key research questions about innovation. It is also particularly useful for practitioners.

As we have seen (and like in many other revolutionary shifts), the development of the open innovation concept was less revolutionary and more evolutionary than initially claimed. It became clear that open innovation activities were present and used a long time ago, were the target of scholarly interest and were not such a clear paradigm shift as sometimes claimed. However, open innovation has developed as a clear innovation concept and is contributing towards answering some of the key questions about innovation – as are some other innovation concepts. It is adding some significant theoretical understanding to key research questions about innovation and is particularly useful for practitioners.

Using bibliographic methods and theoretical insights allowed us to recognize gaps in our understanding of innovation where open innovation has contributed to the body of knowledge. The limitations of these methods are their focus on the existing body of knowledge that is constantly expanding and thus make our analysis immediately obsolete as new research is being published. Theoretical analysis like this is also severely limited in its usefulness for open innovation practitioners or even policy-makers. However, this theoretical approach has allowed us to recognize other gaps where open innovation can continue contributing to the theory of innovation.

These gaps include more focus on other, more economic topics and less business (organisational – level) focus. In particular, the studies of the effects of innovation on economic performance would complement the current open innovation contributions to the innovation research. A crucial drawback of economic research is the lack of specialised data that would allow the studies of open innovation. This was also one of the findings by the OECD studies that focused on open innovation (K. De Backer et al., 2008), (Koen De Backer, Cervantes, Van De Velde, & Martinez, 2008). With more and better data becoming available recently, more research on the effects of open innovation on economic performance could be implemented. This could lead to better understanding of the innovation and technology policies that have caught the attention of economists researching economic growth. They should lead to some theoretical and empirical economic research connected to open innovation.

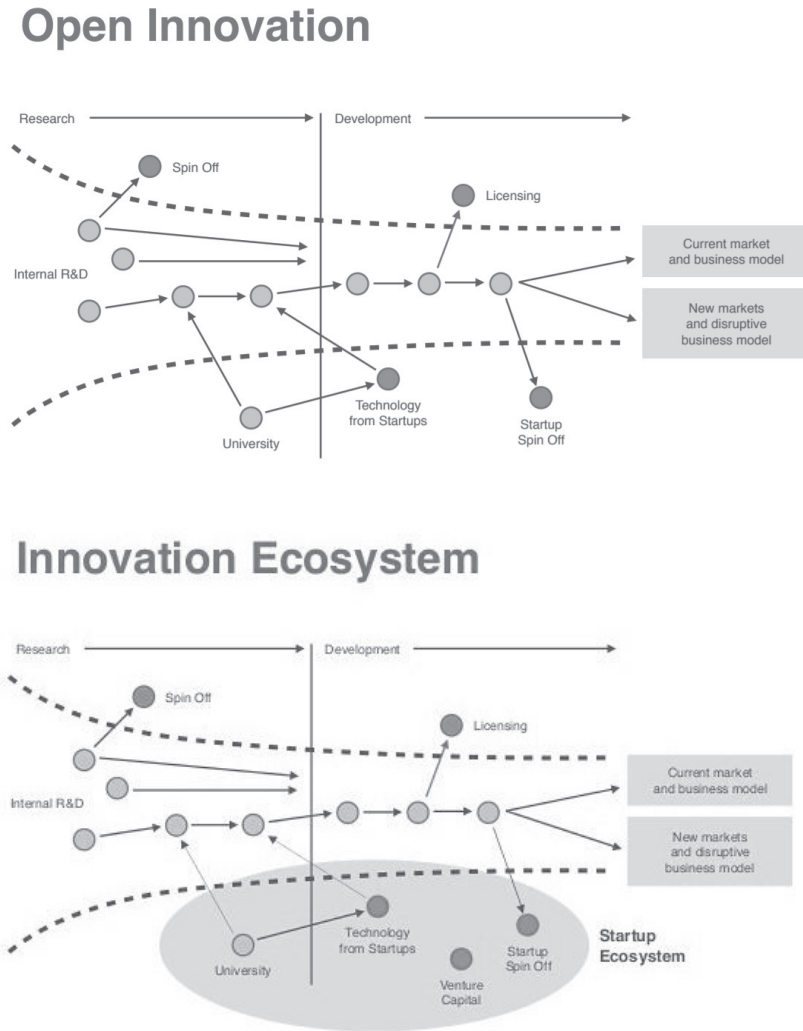
Similarly, the scope of open innovation that has expanded to service and business models can be expanded further, thus contributing to the understanding of what innovation actually is.

A major focus of open innovation has been targeted on how to organize for innovation within companies. Much less has been invested into research on how to organize the environment between businesses and other institutions or entire national, regional and global innovation ecosystems that support (and are influenced by) open innovation. As Chesbrough himself has put it: 'Further research is needed in the field of designing and managing innovation communities' (H. Chesbrough, 2012, p. 26).

A special area for research in open innovation systems is the connection between existing innovation systems and entrepreneurship. Insights on open innovation can be connected to the 'lean' approach to implementing and commercializing innovation. It has become the

organizational model of choice for the new start-up companies, emphasizing the rigorous and rapid testing of new solutions (for example: products) with their users. Firms have to find out what customers want. That involves building something, measuring how users react, learning from the results, then starting all over again until they reach what is known as 'product market fit' (Blank, 2013; Ries, 2011). Companies should start with a 'minimum viable product' to gauge the audience's interest. They should always test their assumptions, aiming for 'validated learning' and if their strategy does not work, they should 'pivot' – start again with the new product (Economist, 2014, p. 4) with the new understanding of the customer's needs. This approach is taught by hundreds of start-up schools, business incubators and venture accelerators and implemented in innovation ecosystems that are highly interconnected with various institutions supporting institutions (large companies, SME's, universities, venture capital companies...). These innovation and entrepreneurial ecosystems are based on innovation collaboration of the kind described by the open innovation research. Organization of these ecosystems that focus on innovation collaboration shows that open innovation systems are theoretically closely related to the 'lean' approach, especially by its contributions in the field of open business models.

The 'lean' approach can be extended from the usual 'lean start-up' (Blank, 2013; Ries, 2011) methodology also to the 'lean' entrepreneurship approach in large companies (Owens & O., 2014) and even to 'lean policy-making'. Similarly, different types of organizations can benefit from open innovation even when they are not developing new products or services (Vanhaverbeke, 2013). Both describe novel forms of organization and networks between companies and their partners. They endorse the new 'combinatorial innovation' (T. Economist, 2014) describing the technological and start-up explosion as a system integration of newly emerging (digital) platforms. While the 'lean start-up' approach is more entrepreneurial oriented with the emphasis on supporting practical implications, open innovation can be regarded as the theoretical framework for such innovation collaboration. As the figure below shows, open innovation concept is very closely connected to startup ecosystems research and can contribute a lot of theoretical contributions to the 'lean start-up' research. Some initial research targeting corporate acceleration has already been conducted (Weiblen & Chesbrough, 2015) but startup ecosystems are much greater than just corporate acceleration and intrapreneurship. But many more theoretical contributions will be needed to wholly connect these concepts.

Figure 8: *Connections between open innovation and startup ecosystem*

Source: Mattina, 2014

Finally, our analysis also points to another observation about open innovation – that it is somewhat insular. A lot of open innovation articles are citing mostly other open innovation research, publishing in a limited number of journals. Most research is focusing on organisational-level innovation and its business and management aspects. This might be limiting the potential of open innovation to influence other innovation concepts – and benefit from the insights discovered by them. As described above, the future open innovation research could focus more on:

- economic (empirical) research,
- systemic view of innovation (eco)systems and its clustering characteristics that influence policy making decisions,
- the connection with the 'lean start-up' approach and the literature on fast-growing companies and the barriers to their growth such as systemic failures.

Recognizing these opportunities to increasing the impact of open innovation further, open innovation could benefit from more opening up, trying to attract scholars that could answer research questions from these areas.

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