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A Research Agenda on Open Innovation and Entrepreneurship: A Co-Word Analysis

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Abstract: This paper aims to contribute to a better understanding of the literature on open innovation and entrepreneurship. Several studies have applied bibliometric methods to innovation and entrepreneurship separately. However, no study has considered these fields in combination while using a bibliometric approach. The main aim of this paper is to understand the relationship between open innovation and entrepreneurship. We develop a descriptive analysis, focusing on temporal evolution, journals, authors, universities, countries, and keywords, and a co-word analysis. Our research identifies the main topics investigated in the open innovation and entrepreneurship literature and describes their relationships. Based on our results, the topics are grouped in three clusters. We present observations on how this literature is influenced by the resources and how this literature affects the management of innovation and knowledge. Future research could focus on questions such as the advantages of open innovation in the creation of new companies, whether open innovation processes facilitate access to funding sources by entrepreneurs or the analysis of business models based on open innovation for the creation of new companies.

Keywords: open innovation; entrepreneurship; bibliometrics; co-word analysis

1. Introduction

Open innovation (OI) is an emerging area that has followed several different strands due to the multidimensional nature of the concept of openness (Spender et al. 2017). It has been researched from different perspectives and levels of analysis but such research predominantly addresses the firm as the unit of analysis (Bogers et al. 2017). At the organizational level of analysis, OI is associated with entrepreneurial opportunities, processes, and outcomes. OI holds important implications for entrepreneurial activities in both new ventures and corporate ventures. And, OI approaches enable and create entrepreneurial opportunities for diverse types of organizations and in diverse types of contexts (Bogers et al. 2017).

Despite the interest for studying the relationship between entrepreneurship and OI, we found few studies that analyze both OI and entrepreneurship. For example, Spender et al. (2017) study the start-ups and OI but do not consider others types of entrepreneurship. The main aim of this paper is to understand the relationship between entrepreneurship and OI using bibliometric techniques. Therefore, two research questions have been defined: What are the main topics studied in the literature that combines both lines of research? What does the OI paradigm contribute to research on entrepreneurship?

We apply one bibliometric technique, the co-word analysis method, following Cobo et al. (2011), in a longitudinal framework to identify different themes treated by OI and entrepreneurship across the

studied period. Bibliometric analyses enable us to perceive how a specific field of research has evolved over time. Similarly, they enable the synthesis and analysis of high volumes of scientific publications through the identification of the authors and main topics (Martens et al. 2016). This has allowed us to make an aggrupation proposal of the main terms obtained in the co-word analysis. The analysis results show a grouping around three clusters.

After accomplishing this objective, we will be better able to (a) facilitate a more realistic view of both fields, (b) enable us to describe the temporal evolution of publication activity and identify the most representative journals, authors, universities, and countries, (c) synthesize and organize existing knowledge through the identification of research clusters, and (d) identify potential areas for future research.

2. Theoretical Background

OI has become one of the most studied topics in innovation management literature. OI has been a topic of increasing interest in practice and academia (Bogers et al. 2017). From the practical perspective, a small group of innovation practitioners (Gassmann et al. 2010) developed the OI phenomenon. From a theoretical perspective, Chesbrough (2003a, 2003b) defined the OI concept and initiated a debate. In the following years, theory and practice evolved significantly (Bogers et al. 2017).

The basic premise of OI is an opening up of the innovation process. One of the most often used definitions of OI is "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and to expand the markets for external use of innovation, respectively" (Chesbrough 2006). Later, Chesbrough and Bogers (2014) define it as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, in which OI is essentially a concept that resides at the level of the organization" (Bogers et al. 2017).

The OI paradigm emphasizes the importance of a wide range of external actors and sources for achieving and sustaining innovation (West and Bogers 2014). Rather than relying on internal R&D, organizations are increasingly engaging in OI applied in others areas (Bogers et al. 2017) and the locus is changing from closed innovation to open innovation (Frishammar et al. 2018). This means that they have exchanged the do-it-yourself option in the innovation process for a rich dialogue of different partners working together (Montoro-Sánchez and Mora-Valentín 2012; Greco et al. 2016).

Therefore, previous studies, such as Gassmann et al. (2010), state the importance of developing OI theory more fully. Huizingh et al. (2011) affirm that there is a need for and benefit to expanding this field with new perspectives. Bogers et al. (2017) analyze the main perspectives and themes emerging in research on OI. They summarize the levels of analysis for OI: intra-organizational, organizational, extra-organizational, inter-organizational, industry, regional innovation systems and society. The relationship between OI and entrepreneurship is included at the organizational level of analysis and OI can help to identify opportunities for entrepreneurs, for different types of organizations and contexts. Bogers et al. (2017) state that "research would involve theories and constructs drawn from both fields (OI and entrepreneurship) and contribute to a deeper understanding of how varied OI approaches lead to varied types of entrepreneurial opportunities, processes and outcomes."

Bibliometric techniques allow a joint analysis of OI and entrepreneurship topics. There are several studies about OI using bibliometric analysis. Kovacs et al. (2015) conducted a literature review on OI using two bibliometric techniques: bibliographic coupling and co-citation analysis. Randhawa et al. (2016) offers a bibliometric review that combines the co-citation and text mining techniques to examine 321 articles on OI. Similarly, other studies conduct bibliometric analysis to investigate the development of the OI literature (Hossain and Anees-ur-Rehman 2016; Hossain et al. 2016). Seguí-Mas et al. (2016) present a bibliometric analysis of OI and absorptive capacity, while Medeiros et al. (2016) present a systematic review of the literature on OI in the food industry through a bibliometric analysis. De Paulo and Porto (2017) analyze OI in the solar energy sector using bibliometric techniques and social network analysis. De Paulo et al. (2017) provide a bibliometric analysis of OI in developed and emerging countries.

We found several studies that analyze entrepreneurship using bibliometric analysis. A study by Schildt Henri A. (2004) uses bibliometric techniques to determine trends in entrepreneurship research. Cabeza-Ramírez et al. (2017) perform a systematic review of the literature using bibliometric techniques on the state of scientific production in the field of entrepreneurship. Shim et al. (2017) use co-word analysis to design agent-based models (ABMs) in entrepreneurship research. Volery and Mazzarol (2015) studied the evolution of the small business management and entrepreneurship fields through a bibliometric examination of all 660 articles published in the International Small Business Journal from 1982–2012. López-Fernández et al. (2016) perform a systematic review centered on the terms "entrepreneurship" and "family business" using a bibliometric analysis that combines co-citation and co-word analysis. Servantie et al. (2016) offer a bibliometric analysis of 567 articles on international entrepreneurship from 1989–2015. Albort-Morant and Ribeiro-Soriano (2016) conducted a bibliometric analysis of 445 articles to examine the international impact of business incubators. Rey-Martí et al. (2016) analyzed the phenomenon of social entrepreneurship using bibliometric techniques.

However, we found few studies that analyze OI and entrepreneurship using bibliometric analysis. For example, Spender et al. (2017) conducted a systematic literature review and constructed a state-of-the-art map of the start-ups in an OI context. Thus, our study conduct a widely analysis of entrepreneurship in an OI context though the co-word analysis.

3. Research Protocol and Descriptive Analysis

The objective of our search was to identify articles that contain an analysis of both topics: OI and entrepreneurship. The Web of Science (WoS) database was used for this task. Specifically, a search was executed for all documents published up to December 2017 that contained at least two of the keywords related to OI and entrepreneurship. The keyword identification was performed based on an initial literature review and through a brainstorming activity. Table 1 presents our search protocol.

Table 1. Search protocol.

WoS Database	Time Period	Document Type	Search Criteria	Keywords
Social Science Citation Index (SSCI) Science Citation Index (SCI) Emerging Sources Citation Index (ESCI)	Up to December 2017	Article or Review	Title, Keywords and Abstract	"open innovat*" and ("entrepreneur*" or "incubat*" or "new firm*" or "new venture*" or "start-up*")

A total of 190 publications met these criteria. When each topic was queried individually (using the search protocol in Table 1), publications on OI numbered 1557, while publications on entrepreneurship numbered 291,403. Studies that combined both topics were significantly fewer. Next, we provide comments on the principal results of the descriptive analysis.

3.1. Evolution over Time

Figure 1 shows that most of the documents were published in recent years. Before 2010, articles on these topics appeared sporadically. In 2005, only three articles were published, two of which appeared in Research Policy and provided an industry perspective. In 2006, again, only three articles were published, two of which appeared in the International Journal of Technology Management and were exploratory in nature. In 2007, no publications met the search criteria. In 2008 and 2009, articles were more scattered and appeared in various non-specialized publications. In 2010 and 2011, the number of published studies exceeded 10, decreasing to 6 publications in 2012 and then returning to the prior level in 2013. In 2013, two special issues on entrepreneurship were published in the Service Industries Journal and the International Entrepreneurship and Management Journal. The number of published articles continued to increase in 2014 and 2015 (considering there were no special issues these years). However, in 2016 and 2017, the number of publications increased to 35 and 61 articles, respectively.

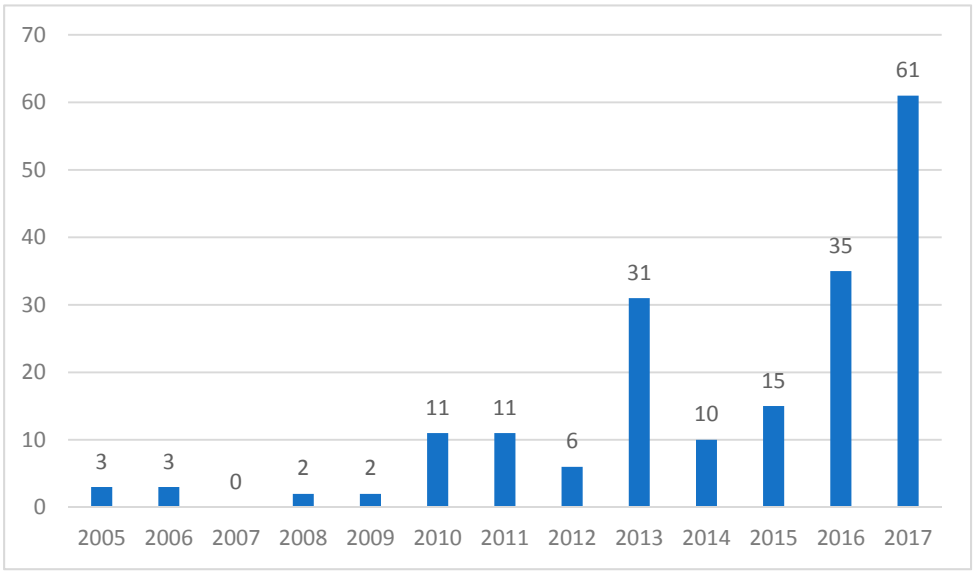

Figure 1. Evolution over time.

3.2. Journals

When analyzing the primary journals that published articles on the topics (Table 2), International Entrepreneurship and Management Journal stands out with 11 articles, followed by Service Industries Journal with 8. Both journals published special issues in 2013. The other journals exhibit a wider distribution of articles published over time except for the European Journal of Innovation Management, which published all of its relevant articles in 2017, and Technological Forecasting and Social Change, which published three of six articles in 2017 (Figure 2). When analyzing how SSCI classifies these journals using the WoS Journal Citation Reports (JCR) categories, we find that three are in the first quartile and that two are in in the ECSI category and had not yet been placed in a quartile. Most are in the "Business" and "Management" categories.

Table 2. Top journals.

Journals	SSCI-JCR Categories	JCR 2016 Quartile	# Articles
International Entrepreneurship and Management Journal	Business	Q3	11
	Management	Q3	
Service Industries Journal	Management	Q3	8
European Journal of Innovation Management	ESCI	—	7
Research Policy	Management	Q1	6
	Planning & Development	Q1	
Technological Forecasting and Social Change	Business	Q2	6
	Planning & Development	Q1	
International Journal of Technology Management	Management	Q4	6
Technovation	Management	Q1	5
International Journal of Innovation Management	ESCI	—	5

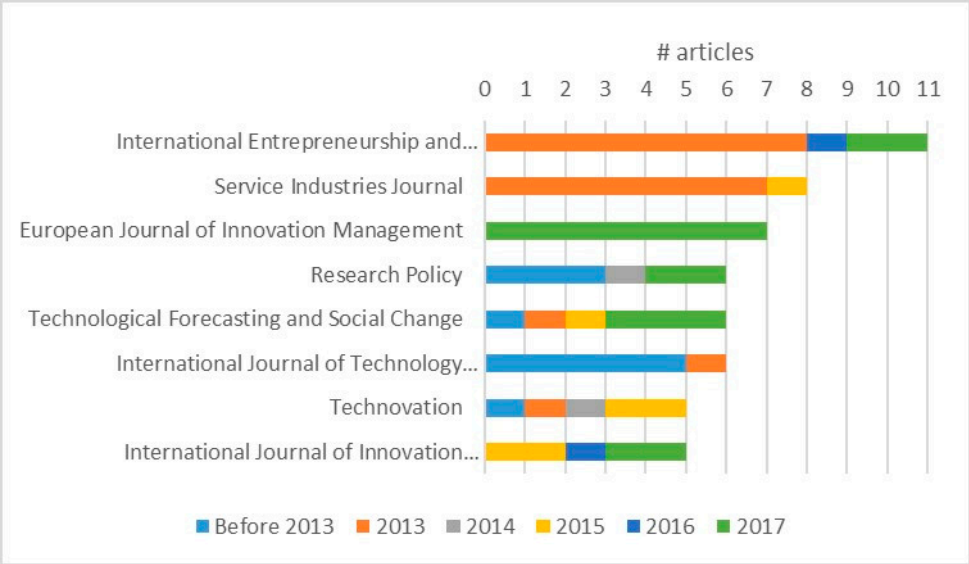

Figure 2. Evolution over time of articles by journal.

3.3. Authors

The author with the most publications is Chaston[1], with 2.5 articles. His research analyses the relationship of OI with knowledge management and company performance. Cooke has published two papers, while Urbano, Yun, and Vanhaverbeke have an average equal to or greater than 1.4 because they have collaborated with other authors on several studies in this subject area (Table 3).

Table 3. Top authors.

Author	# Articles
Chaston, I.	2.5
Cooke, P.	2.0
Urbano, D.	1.7
Yun, J.J.	1.5
Vanhaverbeke, W.	1.4
Saguy, I.S.	1.3
Brown, T.E.	1.3
Park, K.	1.3
Shin, C.	1.2
Mortara, L.	1.2
Chesbrough, H.W.	1.2
Minshall, T.	1.1

Table 4 presents the authors with the greatest number of co-authors for their articles. Yun, Park, Mortara, Vanhaverbeke, and Urbano have collaborated the most (between four and five articles). Figure 3 shows the number of authors per publication for each year. Before 2013, most publications only had one or two authors. From 2013 to 2016, most articles had three authors. In 2017, the articles typically had two authors.

[1] The statistics account for fractions of articles. That is, when a document has more than one author, each article is attributed proportionally to the number of co-authors. This criterion was also applied to the filiation analysis, considering both institutions and countries of origin.

Table 4. Authors with the most co-authors.

Author	# Articles
Yun, J.J.	5
Park, K.	4
Mortara, L.	4
Vanhaverbeke, W.	4
Urbano, D.	4
Saguy, I.S.	3
Chesbrough, H.W.	3
Chaston, I.	3
Minshall, T.	3

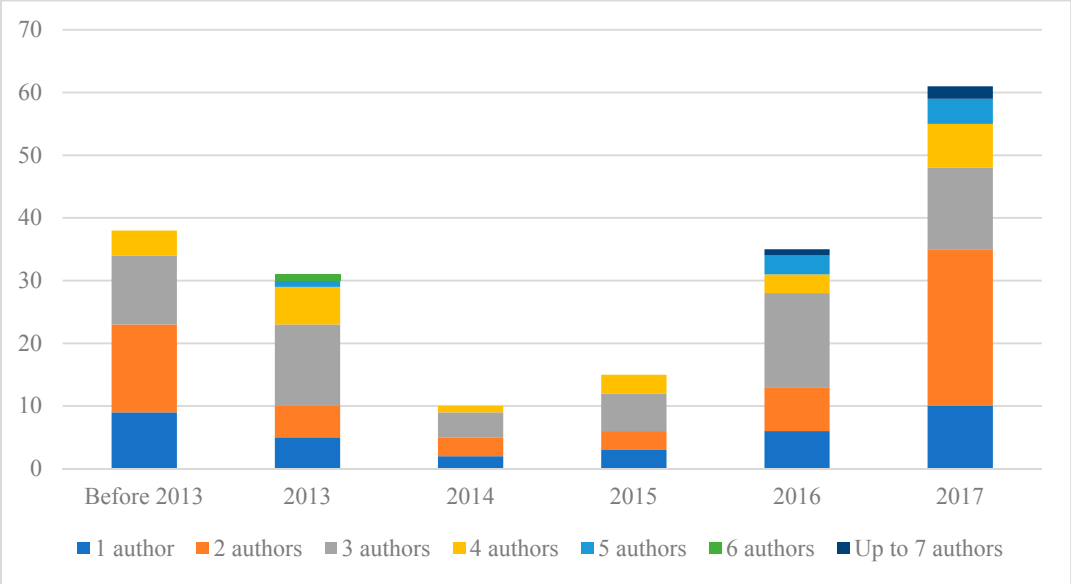

Figure 3. Number of authors per publication.

Regarding the authors' countries of origin (i.e., filiation, Table 5), Spain stands out with its significant scientific contribution (23 articles), ahead of research powers such as England (19 articles) and the United States (19 articles). It also highlights the scientific contributions of Italy and South Korea (over 11 articles).

Table 5. Top countries (author filiation).

Countries	# Articles
Spain	23.17
England	18.94
USA	18.61
Italy	11.70
South Korea	11.33

In addition to the analysis of the authors' origins, it is interesting to study the collaboration between countries (Figure 4). In this network that includes only those countries whose authors have published at least five papers, three clearly distinct groups emerge. On one hand is the red group, in which the United States and Canada stand out, along with a group of European countries. On the other hand, is the much less centralized blue group of four European countries plus Taiwan. In the green group, Spain and England join China and South Korea, two of the largest contributors. This group is much more centralized, at least regarding the first two countries.

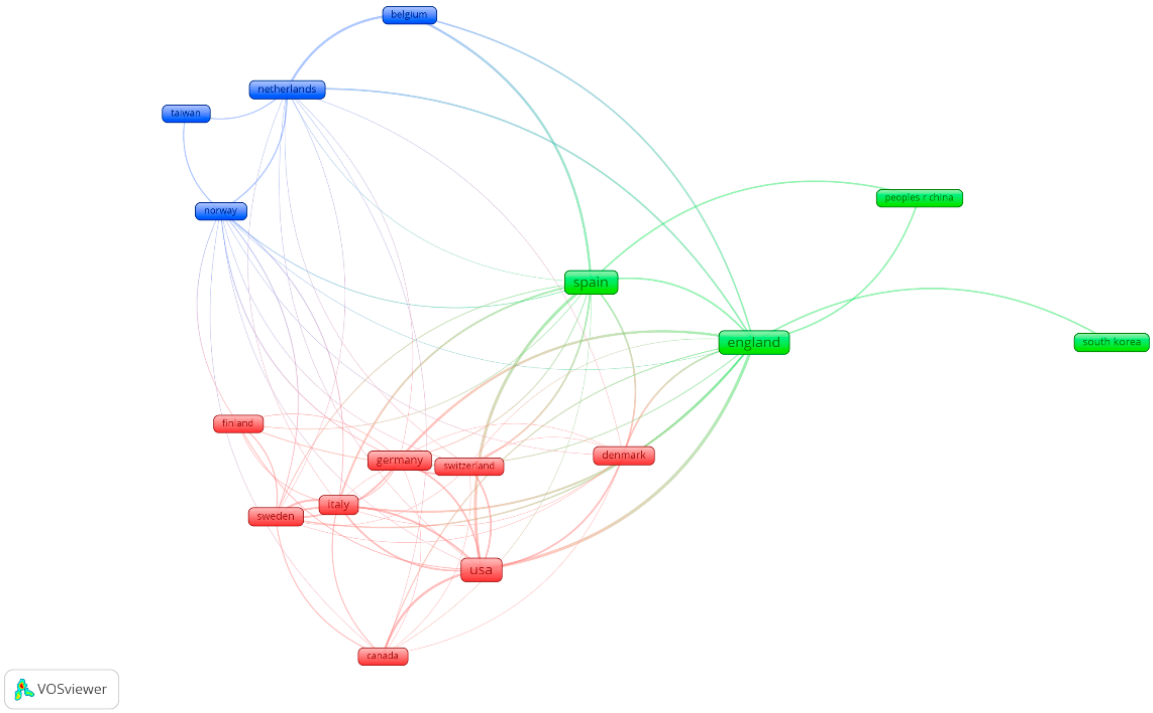

Figure 4. Collaboration between countries.

Considering the institutions to which the authors belong, the universities with the most published articles are the University of Cambridge, Lund University, and the Autonomous University of Barcelona (Table 6).

Table 6. Top universities.

University	# Articles
University of Cambridge	3.9
Lund University	3
Autonomous University of Barcelona	2.8
Daegu Gyeongbuk Institute of Science and Technology	2.5
Aarhus University	2.2
Valencia Polytechnic University	2
University of New Mexico	2
University of Seville	2
Complutense University of Madrid	2
Pontifical Catholic University of Peru	2
University of California - Berkeley	2
Valencia University	2

3.4. Keywords

In the analyzed articles, a total of 631 keywords suggested by the authors and 538 suggested by WoS were identified. In general, both keyword types provide information on the subject matter of the articles. Thus, it was determined to include both types in the analysis. Choi et al. (2011) suggest a normalization process with various elements, such as the merging of singular and plural forms, the normalization of abbreviations, the correction of alternative spellings (for example, derived from the use of scripts or uncorrected transcriptions), the merging of synonymous terms and the exclusion of terms with no specific meaning and that do not clearly indicate a topic. As a result of this normalization process, 330 keywords were excluded, leaving 507 keywords to be analyzed. Table 7 summarizes the statistics regarding the most repeated keywords.

Table 7. Most frequent keywords.

Keyword	Frequency
Open innovation	145
Entrepreneurship	87
Performance	64
Cooperation	48
Knowledge	47
Research and development (R&D)	47
Innovation	46
Firm	41
Industry	34
Small and medium-sized enterprise (SME)	28
Network	28
Strategy	27
Absorptive capacity	24
Start-up	23
Technology	20

To clarify the identification of the knowledge structure of this research field, the following pages present the results of our co-word analysis. Zupic and Čater (2015) note that co-word analysis is the only bibliometric technique that deals directly with concepts extracted from documents and therefore focuses its attention on the knowledge structure of the area studied rather than its intellectual base, thus enabling the identification of the main topics of a research field and their relationships (Cobo et al. 2011).

4. Co-Word Analysis

Callon et al. (1983) indicate that the co-word analysis enables the representation of the intensity of associations between information items in textual data. He (1999) states that this method is used to study the co-occurrence of item pairs (for example, keywords) that are representative of a document (e.g., a research paper, patent or any other type of written document) to identify relationships between the ideas presented in those texts.

In terms of inputs and outputs, the co-word analysis is performed using a set of documents to which representative terms of the information they contain are associated. These terms are often referred to as keywords. When analyzing two terms in the same document, it is understood that there is a relationship between them, that is, that the subjects represented by those terms are linked. The more often that this coincidence is repeated, also termed co-occurrence, the greater the connection is. That is, the more documents there are that address both subjects simultaneously, the greater the intensity of the relationship.

The study of co-occurrences in a group of documents that represents a research field enables the identification of topic sets, that is, groups of terms that demonstrate a relationship between one another and with the rest of the terms that comprise the knowledge area. Thus, the result of a co-word analysis is a series of topic sets and their relationships that can be represented and analyzed with tools provided by social network theory.

Several approaches to conducting this analysis are described in the literature. The methodological proposal of Cobo et al. (2011) consists of four phases and uses the SCIMat tool. Van Eck and Waltman (2010) use the VOSViewer tool, which enables the use of VOS mapping and grouping algorithms (Van Eck and Waltman 2007, 2014; Van Eck et al. 2010; Waltman et al. 2010; Waltman and van Eck 2013) and has demonstrated performance that is superior to other techniques, such as multidimensional scaling (Van Eck et al. 2008). For this study, we have chosen to employ both techniques because they provide excellent alternatives for representing a knowledge structure by analyzing co-occurrences of keywords in a research area.

To execute this analysis, it was necessary to select a data source and then calculate the occurrences and co-occurrences of the keywords considered representative of each document. These data must be

submitted to a normalization process, in which one typically must choose between different alternatives to construct the so-called similarity indexes. In our study, we chose the "Association Strength" index, which has advantages over other direct measures of similarity (such as those that adopt the number of co-occurrences between objects and adjust that number according to the number of occurrences and co-occurrences of each of the objects being measured), as demonstrated by Van Eck and Waltman (2009).

For our study, the analysis was performed by first configuring the co-word analysis as recommended by the VOSViewer software developers and then setting the minimum number of keyword occurrences to 10 to limit the analysis to those terms that are truly relevant in the literature analyzed.

5. Results

The constraint that at least 10 keyword occurrences must exist before the term can enter the network reduced the number of analyzed topics to 37. The analysis results show a grouping around three clusters (Figure 5). The terms included in each cluster are presented in Tables 6–8. Based on these results, another grouping of terms within each cluster was performed. These blocks of terms within the clusters facilitated the interpretation and discussion of the results.

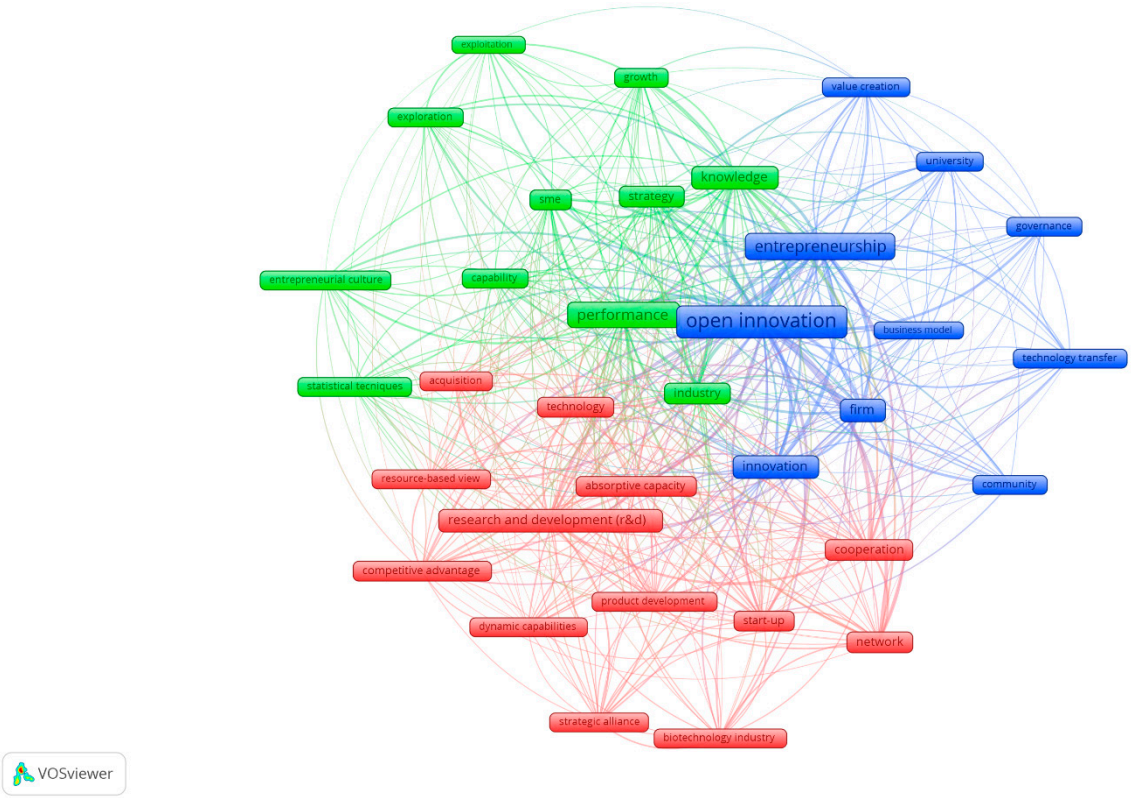

Figure 5. Clusters.

Table 8. Red cluster.

Terms	Blocks
Product development Research and development (R&D) Technology	Innovation management
Start-up	Entrepreneurship
Cooperation Network Strategic alliance	Business cooperation
Absorptive capacity Dynamic capabilities Resource-based view	Resources and capabilities
Acquisition Biotechnology industry Competitive advantage	General

The first cluster (red) is the most numerous, with 13 terms that have been grouped into five blocks (Table 8). The first block is linked to innovation management: PRODUCT DEVELOPMENT, RESEARCH AND DEVELOPMENT (R&D), and TECHNOLOGY (e.g., Du et al. 2014; Sakhdari 2016). The second block is related to entrepreneurship and includes the term START-UP (e.g., Homfeldt et al. 2017; Spender et al. 2017). The third block incorporates aspects related to business cooperation: COOPERATION, NETWORK and STRATEGIC ALLIANCE (e.g., Alberti and Pizzurno 2017; Huggins and Thompson 2017). The fourth block contains several terms related to resources and capabilities: ABSORPTIVE CAPACITY, DYNAMIC CAPABILITIES, and RESOURCE-BASED VIEW (e.g., Patton 2014; Venturini and Verbano 2017). Last, the fifth block includes other general terms, such as ACQUISITION, BIOTECHNOLOGY INDUSTRY, and COMPETITIVE ADVANTAGE (e.g., Mawson and Brown 2016; Patterson and Ambrosini 2015).

In the second cluster (green), 11 terms have been grouped into four blocks (Table 9). Noticeable are terms related to knowledge management: CAPABILITY, EXPLORATION, EXPLOITATION and KNOWLEDGE (e.g., Clausen et al. 2013; Noguera et al. 2013) and entrepreneurship: ENTREPRENEURIAL CULTURE (e.g., Knošková 2015). In addition, other terms appear that are related to results: GROWTH and PERFORMANCE (e.g., Lassala et al. 2013; Zhao et al. 2016). These terms demonstrate the need to use statistical techniques to understand the impact of OI and entrepreneurship on business results. In addition, more general terms appear here, such as INDUSTRY, SME, STATISTICAL TECNIQUES and STRATEGY (e.g., Chesbrough et al. 2014; Hossain and Kauranen 2016; Munir et al. 2016).

Table 9. Green cluster.

Terms	Blocks
Capability Exploitation Exploration Knowledge	Knowledge management
Entrepreneurial culture	Entrepreneurship
Growth Performance	Results
Industry SME Statistical techniques Strategy	General

Last, in the third cluster (blue), 10 terms have been grouped into three blocks (Table 10). This cluster incorporates the two main topics of interest to our search: OPEN INNOVATION and ENTREPRENEURSHIP (e.g., Bengtsson 2017; Yun et al. 2016a). One can note terms related to OI, such as INNOVATION, with OI ecosystem agents, such as UNIVERSITY, FIRM, and COMMUNITY (e.g., Alexander et al. 2015; Miller et al. 2016) as well as the role of the state: GOVERNANCE (e.g., George et al. 2015). Regarding entrepreneurship, the term BUSINESS MODEL appears (e.g., Colombo et al. 2016; Yun et al. 2016b). Finally, a new term for measuring results emerges: VALUE CREATION (e.g., Herskovits et al. 2013).

Table 10. Blue cluster.

Terms	Blocks
Open innovation Innovation University Firm Community Governance Technology transfer	Open innovation
Entrepreneurship Business model	Entrepreneurship
Value creation	Results

To complete this analysis, Figure 6 presents the evolution of the various topics over time. As explained by the legend, the different colors represent topics according to frequency of appearance, which facilitates perceiving the topics that stand out currently and those that have become neglected. This time-based analysis is limited due to the small number of years it covers.

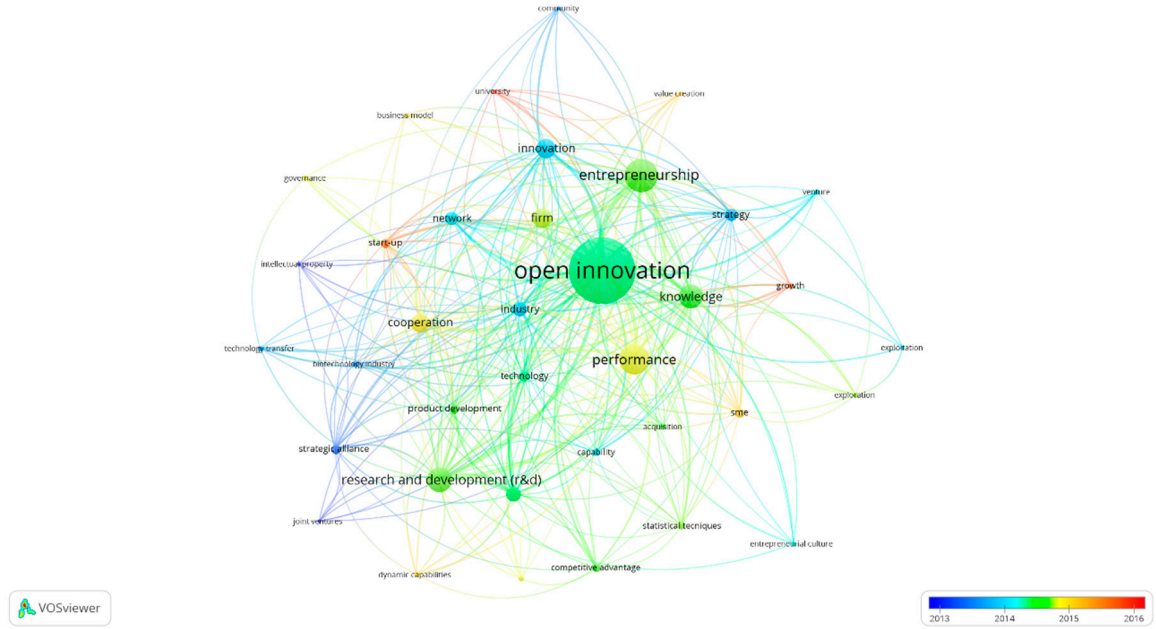

Figure 6. Evolution over time of topics.

In 2013, the most common terms are INTELLECTUAL PROPERTY, TECHNOLOGY TRANSFER, STRATEGIC ALLIANCES, and JOINT VENTURES. In 2014, the topics with the highest relative frequency are NETWORK, INNOVATION, INDUSTRY, and STRATEGY. Approaching 2015, OPEN

INNOVATION, ENTREPREURSHIP, and KNOWLEDGE begin to stand out, while in 2015, the most common terms are PERFORMANCE and COOPERATION. Finally, the most frequent topics in 2016 and 2017 are START-UP, UNIVERSITY, and GROWTH.

6. Discussion

Based on the results, Table 11 presents our aggrupation of main topics by area in three clusters. In that sense, Frishammar et al. (2018) present the key dimensions of prior innovation audit frameworks (culture, resources & capabilities, innovation process, business model) and their effect on innovation performance and competitive advantage. Our results show that the literature that focuses their attention in studying entrepreneurship in an OI context is considering those dimensions.

Table 11. Clusters and topic.

Cluster	Open Innovation	Entrepreneurship
1. Red	Innovation management Cooperation Resources theory	Start-up
2. Green	Knowledge management Results	Entrepreneurial culture
3. Blue	Open innovation Value creation	Entrepreneurship Business models

The first cluster consists of a series of studies that constitute the theoretical bases for the studies that analyze both subjects of interest to this research. Specifically, the first cluster includes studies inspired by the resources theory and based on the innovation management literature. In that sense, West and Bogers (2014) found that one gap in the OI literature "is a tendency in OI to use 'innovation' in a way inconsistent with earlier definitions in innovation management." In addition, the study of cooperation acquires special relevance. In that sense, collaboration has increasingly interest in OI literature. West and Bogers (2014) present a four-phase model to classify the previous research on how firms leverage external sources of innovation (outbound OI): (1) obtaining, (2) integrating, (3) commercializing external innovations, and (4) interaction between the firm and its collaborators. The last phase the interaction phase considers concepts such as co-creation, network collaboration and community innovation. Greco et al. (2016) explain that OI can follow one or more strategies: inbound OI (internal use of external knowledge); outbound OI (external use of internal knowledge); and coupled OI (active collaboration with partners to innovate). Furthermore, the term "start-up" implies a link between OI and entrepreneurship. In that case, Spender et al. (2017) present a state-of-the-art of the start-ups in an OI context.

The second cluster consists of studies that apply a knowledge management perspective and reveal the application of knowledge flows (exploitation and exploration) that relate to OI types (inbound, outbound and coupled). Some authors have analyzed the effect of knowledge exploitation to learn in using external sources of innovation (Hughes and Wareham 2010). Enkel et al. (2009) develop the "coupled" practice concept as a way of interaction between firms and innovative actors outside the firm including the flows of knowledge between them. There is greater interest in measuring the results of OI through statistical techniques. This cluster represents a consolidation of the literature on the culture of entrepreneurship.

In the third cluster, the term "open innovation" appears independently, and an interest in studying value creation is observed, as is the participation of agents such as universities, government, industry, and companies. The concept of entrepreneurship also emerges autonomously, and there is special interest in analyzing business models. West and Bogers (2014) find that a gap in prior research on OI is "a tendency to ignore the importance of business models," but Chesbrough (2003a) states that "OI

combines internal and external ideas into architectures and systems whose requirements are defined by a business model" and one of the key goals of a business model is value creation.

These results complement and expand those found by Spender et al. (2017), who conducted a review of the literature on OI and start-ups. These authors analyzed 41 studies published before 2015 and organized the topics found in the OI and start-up literature into seven groups: (1) the role of start-up networks, (2) the actors who interact with start-ups in OI processes, (3) start-up ecosystems and their impact on OI processes, (4) the entrepreneurial dimension in the OI processes of start-ups, (5) the role of funding and funding institutions, (6) start-up performance in an OI context, and (7) knowledge stocks and flows in start-up OI processes. This article complements and extends the results obtained by Spender et al. (2017) in several aspects:

- Our study was not limited to start-ups but included any form of entrepreneurship, for which other keywords were included (e.g.: "entrepreneur*"; "incubat*"; "new firm*"; and "new venture*").
- A literature review was conducted using a bibliometric technique, which provides rigor to the review and enables the analysis of larger volumes of information. Specifically, 190 articles were considered compared to the 41 studied by Spender et al. (2017).
- The time horizon was extended so that all the studies published up to December 2017 were considered, whereas Spender et al. (2017) only included works published up to 2015.
- The grouping of topics (clusters) studied in the literature was achieved by applying co-words analysis, which yields more objective and rigorous results.

If we compare the results of Spender et al. (2017) with ours, the following similarities emerge. The first topic commented on by Spender et al. (2017), "the role of start-up networks," is included in Cluster 1. Topic (2) ("actors who interact with the OI processes of start-ups"), Topic (6) ("performance of start-ups in an OI context"), and Topic (7) ("knowledge stocks and flows in the OI processes of start-ups") are among the Cluster 2 keywords. Last, Topic (3) ("start-up ecosystems and their impact on OI processes") and Topic (4) ("the entrepreneurial dimension in the OI processes of start-ups") are related to Cluster 3. However, in this study, clusters of more complete subjects were found that advance the state of the art of this literature and suggest new areas of research.

7. Conclusions

In this paper, we have developed a previous literature review on OI and entrepreneurship. We attempt to answer two research questions. The first question was: What are the main topics studied in the literature that combine both research areas? The co-word analysis enabled us to identify the topics under study and group them into three clusters (Tables 8–10). This analysis was presented in the results section. The second research question was: What does the OI paradigm contribute to research on entrepreneurship? The discussion summarizes the answer to that question (Table 11).

This study has some contributions to the literature. It describes the temporal evolution of publication activity and the most representative journals, authors, universities, and countries. In addition, our results complement and expand those found by Spender et al. (2017) presenting state-of-the-art literature on entrepreneurship and OI through the identification of research clusters that allow us to propose some potential areas for future research.

This study also has implications for business practices. It helps entrepreneurs better understand OI and find examples of good practices for applying OI processes in their activities. In addition, this study sheds light on the effect of funding, on value creation, on cooperation, and on the advantages of networks for increasing the likelihood of success in entrepreneurial activity.

Finally, we suggest a direction for future research. Many newly created companies start small, which determines their first steps. In this regard, authors such as Bogers (2011) consider that OI practices can help start-ups "overcome both the liability of newness and the liability of smallness" (Spender et al. 2017). Future studies could more thoroughly analyze OI's advantages for small start-ups.

Another issue relevant to entrepreneurship is funding. Spender et al. (2017) found funding to be one of the primary topics of studies on OI. However, this study did not find that funding is a focus in the literature on OI and entrepreneurship. Future research could consider an analysis of the main funding sources, its advantages and disadvantages as well as ways in which OI can facilitate access to funding sources for entrepreneurs.

Yet another aspect to pursue is the entrepreneurial dimension. Spender et al. (2017) define the entrepreneurial process in OI through activities such as "opportunity identification, resource mobilization, and the creation of an organization." They organized their results regarding the OI and start-up literature into three categories: "prior entrepreneurial experience," "entrepreneurial social capital" and "entrepreneurial policy." Future research could focus on defining the activities that comprise the entrepreneurial process in OI and on the analysis of the three categories proposed in this article through qualitative and quantitative studies.

Knowledge management is also addressed in previous studies. However, Spender et al. (2017) note an unresolved question: "How do start-ups manage knowledge flows among different partners?" The results of our research also indicate the significance of re-addressing this issue to analyze the management of knowledge flows in the ecosystem of entrepreneurial companies that follow OI processes.

Another relevant topic in the literature is the study of business results. Spender et al. (2017) highlighted the interest of several authors in analyzing the performance of start-ups in an OI context by identifying studies that analyzed innovation performance and organization performance. Our results add another: value creation. Future research could focus on conducting quantitative studies on the value creation generated by applying OI processes in entrepreneurial ventures.

Future research could also investigate the advantages of adopting an OI approach and the business models that can be developed. In this regard, several research questions could be addressed: How can one take advantage of OI when creating a new company? Which OI-based business models for creating new companies generate greater value? How to manage the complexity of business models based on new trends of innovation: openness, servitization, and digitalization? In that sense, Frishammar et al. (2018) present three major trends that are transformed the innovation landscape: (1) openness: from closed to more open models of innovation; (2) servitization: from providing physical products to industrial product-services; and (3) digitalization: from an analog to a highly digitalized world.

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