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Evolution of the open innovation paradigm: Towards a contingent conceptual model

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ABSTRACT

Openness has increasingly become a trend in innovation management. This study aims to propose a contingent conceptual framework for open innovation that reflects the evolution of this concept based on the academic literature. Besides, it aims to analyze how open innovation can affect firm and innovation performance. Additionally, it identifies the key contingent variables that affect the relationship between open innovation and performance. To accomplish these objectives, the research design is a systematic literature review, merging bibliometrics, content analysis and mind maps. The bibliometrics was applied to investigate the key references and topics. For the content analysis, a detail-coding schema was developed. Then, a mind map approach was applied towards a contingent conceptual model. Finally, a methodological triangulation was applied for understanding in-depth the insights of these research methods applied. As a result, a contingent conceptual model of open innovation has been developed. In this model, the open innovation construct is an independent variable classified as inbound or outbound, and the dependent variables are firm performance and innovation performance. Moreover, contingent variables (control and moderator) were identified, highlighting the moderate effect of knowledge flow. Finally, open innovation antecedents and enablers were identified.

1. Introduction

In an increasingly competitive and innovative-driven environment, the collaborative view of innovation has stood out. Particularly, the open innovation phenomenon has increasingly attracted attention in innovation management (Popa et al., 2017). It is a field of research under rapid development (Bogers et al., 2017), which can be proved by the rising number of academic publications and special issues in journals (Cheng and Huizingh, 2014); however OI research has only just begun (Gambardella and Panico, 2014; West and Bogers, 2014).

Besides, researching on open innovation is complex. OI has multiple facets (Randhawa et al., 2016) and it is a multi-level phenomenon (Bogers et al., 2017), leaving major gaps on how such innovation is integrated (West and Bogers, 2014). It brings distinctive contexts and different levels of analysis to the research design, demanding more theory development efforts (Bogers et al., 2017). Moreover, OI is an inherently dynamic process, and so the research needs to incorporate dynamic elements (Appleyard and Chesbrough, 2017).

On the one hand, identifying the key variables and factors affecting open innovation is still a research challenge. Innovation openness can involve several features, such as risk, belief, exchange and share, governance, partner and feature training (Kratzer et al., 2017). Besides, it is important to understand the structures and processes that facilitate open innovation at the organizational level (Bogers et al., 2017), knowledge management strategies (Cammarano et al., 2017), as well as the human side of openness (Ahn et al., 2017).

On the other hand, understanding the key aspects is not enough. It is also important to understand the implications of open innovation on performance on distinctive levels of analysis, such as organizational performance (Caputo et al., 2016; Cheng and Huizingh, 2014), innovation performance (Chen et al., 2011, Greco et al., 2017) and OI efficiency (Greco et al., 2017). The impact of open innovation on innovation performance and organizational performance is still a controversial issue, and the concept of its efficiency is novel in the literature (Greco et al., 2017). It is difficult to measure the impact of an internal innovation openness on innovation and on economic measures, and results demonstrate the limited impact (Kratzer et al., 2017), eventually diminishing marginal returns of open innovation in the innovation performance (Greco et al., 2017).

Moreover, due to the complex nature of interdependencies between open innovation and performance, the choice of the contingent variables represented a particularly important part of the research design.

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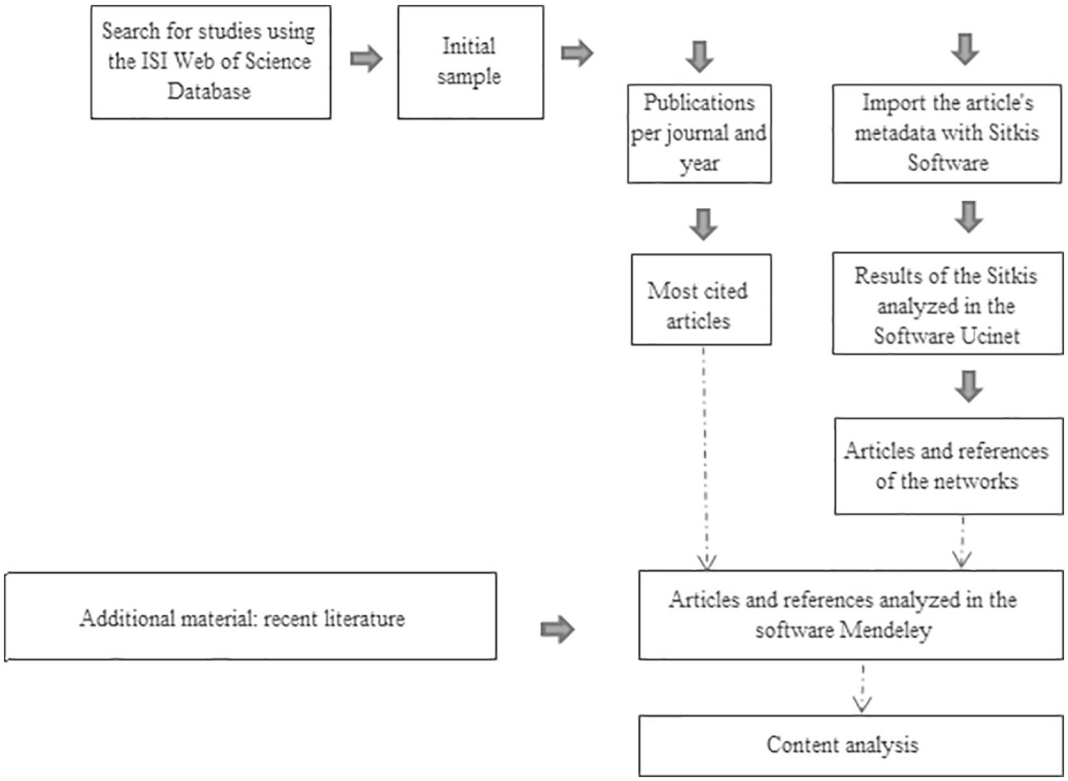

Fig. 1. Workflow of systematic literature review.

The literature pointed out some contingent variables that can affect the relationship between OI and performance, at higher or lower levels of analysis (Bogers et al., 2017). It can be influenced by both internal and external environment (Greco et al., 2017), such as firm size (Greco et al., 2017), interdependencies between organizations and various stakeholders in an innovation ecosystem setting (Bogers et al., 2017).

In this context, in which the existing literature on open innovation is not sufficiently theorized (Bogers et al., 2017; Gambardella and Panico, 2014), researchers do not sufficiently draw on theoretical perspectives (Randhawa et al., 2016) and it is mainly descriptive by nature (Martinez-Conesa et al., 2017). This paper helps to narrow this gap by performing a mapping study, analyzing the emergent literature on open innovation and its impact on performance towards a contingent conceptual model. To accomplish this objective, this paper seeks to answer the following research questions: (RQ1) Which are the key constructs and variables to investigate open innovation?, (RQ2) How open innovation can affect organizational and innovation performance? and (RQ3) Which are the contingent variables that influence the relation between open innovation and performance?

To address these questions, the research design is a systematic literature review, merging bibliometrics, content analysis and mind maps. The bibliometrics was applied to investigate the key references and topics. For the content analysis, a detail-coding schema was developed. Then, a mind map approach was applied towards a contingent conceptual model. Finally, a methodological triangulation was applied for understanding in-depth the insights of these research methods applied.

This paper proceeds by presenting the methodological approach of a systematic literature review in Section 2. After that, Section 3 presents the research results, followed by the theoretical framework in Section 4. Finally, Section 5 brings the conclusions, highlighting the main findings, theoretical and practical implications, and future research paths.

2. Research design

As mentioned in Section 1, the aim of this study is to propose a conceptual framework on open innovation that reflects the evolution of this concept based on a literature review. The systematic literature review on open innovation in this study aimed to identify and synthesize a research on open innovation in a comprehensible way by applying structured, transparent and replicable procedures for each phase of the process (Littell et al., 2008).

According to Carvalho et al. (2013) and Takey and Carvalho (2016) a systematic literature review can be developed by applying multimethods to mitigate single method limitation, such as bibliometrics, content analysis and meta-analysis. A combination of bibliometrics and content analysis was applied in this study.

The increasing growth of research and academic publications has stimulated interest in bibliometric studies (Ikpaahindi, 1985; Randhawa et al., 2016). Bibliometrics was chosen to respond if there are patterns in the literature, to identify the journals that published most articles on the subject, and how these publications evolved over time (Prasad and Tata, 2005). On the other hand, bibliometrics also made it possible to analyze the citations, and identify studies that had a significant impact on the field, as well as the relation between these articles and their references, through citation networks (Herther, 2009; Neely, 2005). The examination of the citation networks allows the analysis of the significant relationships between articles and references in common (Kessler, 1963).

In order to complements the quantitative approach of bibliometrics, the content analysis was chosen. Thus, an in-depth analysis of sample studies was made following the content analysis procedures suggested by various authors, such as full reading of the texts, definitions, hypotheses, propositions, models, and other relevant information (Ramos-Rodríguez and Ruíz-Navarro, 2004; White and McCain, 1998).

2.1. Sampling process and research workflow

Fig. 1 presents the workflow of the systematic literature review. The database chosen for obtaining the initial sample was the ISI Web of Science, since articles from other databases, such as Scopus, Proquest

and Wiley, published in indexed journals, and with an impact factor calculated by Journal Citation Report (JCR), are located in the search processes at the ISI Web of Science (Carvalho et al., 2013; Homrich et al., 2017).

A search was performed using the keyword "open innovation", which provided 2367 works, 1228 of which being articles published between 2003 and 2017. Only the articles were considered because they contain the data required for bibliometric, such as abstract, authors, keywords, journal, references and number of citations.

After obtaining the initial sample, a technique was applied, which expands the analysis of the works resulting from the search in the database for references of these works. This technique is known as "snowball", in which books, articles from other databases, conference articles, and theses are recovered, as well as works that were not related to the search keywords but were important in some way for identifing the pillars which built the theory (Fink, 1995a, b). Particularly for this research subject, the "snowball" technique proved necessary, since, despite the term open innovation having been coined in 2003 by Henry Chesbrough, innovation through collaboration has already existed for many years. This expansion allowed the evolutionary process of the concept to be analyzed.

2.2. Data analysis

The sample was analyzed through bibliometrics, analyzing descriptive statistics of the number of publications and citations, then, network analysis, applying the Sitkis 2.0 software (Schildt, 2002) and the Ucinet software for Windows – Version 6.289 (Borgatti et al., 2002).

The first bibliometric indicator was the number of publications per year, then the number of publications stratified by journal and year, which enables the analyzes of the journals that are more related to the research subject, as well as evolution of publications over time.

A list of the most cited works was created, since these articles influenced the study of a large number of authors (Culnan, 1987; Culnan et al., 1990).

All data (abstract, authors, keywords, journal and number of citations) were imported. Such data were exported to a text file (txt) and were used as input to the Sitkis 2.0 software, which allowed the text file to be analyzed. The tabs made in Sitkis served as input data for the development of the networks, which were generated with the Ucinet software for Windows – Version 6.289.

For the network analysis, it was necessary to create a filter criterion for the minimal citation, based on the Sitkis user manual, which recommends that the number of nodes on a network range from 1 to 10% of the total sample actors. Two networks were performed, the keywords and article to reference networks. The article to reference network was used for a snow ball sampling process by identifying the most cited references in the most cited article in the initial sample, thereby articulating the theoretical foundations of the area.

Afterwards, the content analysis was performed in the final screening sample, with the list of the most cited articles and most cited references in the citation networks. The surveyed studies were analyzed individually, applying the coding scheme and using the Mendeley software. In the content analysis, the reading of texts made it possible to identify, for example, definitions, propositions and research hypotheses, variables used, theoretical models, etc.

A code tree has been designed to analyze different aspects of the literature aligned with the research questions, as shown in Table 1. Table 7 summarizes the content analysis according to the coding scheme.

To further develop the theoretical model, a mind map approach was applied. Literature review is one of the typical application contexts of mind maps (Eppler, 2006). The mind map has a center-out perspective, in which the main domain is in the center and the subtopics are branched out in a creative manner, representing the semantics or other connections (Buzan, 1995).

Table 1
Content analysis coding scheme.

Coding scheme	
T1 - Inbound	T4 - Firm performance
Breadth and depth	Customer performance
External knowledge acquisition	Financial indicators
External technology acquisition	Market share
	Profitability
T2 - Outbound	Sales growth
Breadth and depth	Turnover
Internal knowledge exploitation	
Internal technology exploitation	T5 - Innovation performance
	New product
T3 - Main players	R&D
Competitor	Intellectual property
Consultants	Turnover
Customer	
Government	T6 - Contingent variables
Network partners	Firm size
Supplier	Firm age
Universities and research institutes	Type of industry
	Country
	Competitive intensity
	Number of partners
	Technological and market uncertainties

3. Results

By analyzing the evolution of the number of published articles, it was observed that the first publication was in 2003 (see Fig. 2). It is justified by the fact that the term "open innovation" was coined in the same year by Henry Chesbrough (Chesbrough, 2003a). The number of publications began to grow in 2009. It is justified by the increasing number of publications in general, but also because of some special issues on open innovation in journals, such as R&D, Research Policy, and Management Science.

Table 2 shows a list of publications by journal and year, considering journals that published at least ten articles.

The 1228 articles are distributed over 393 journals, which indicate the multidisciplinary nature of the subject. Seven journals published approximately 26% of the articles, namely: R&D Management (JCR = 2444), International Journal of Technology Management (JCR = 1036), Research Policy (JCR = 4495), Research-Technology Management (JCR = 2429), Technovation (JCR = 3265), Technological Forecasting and Social Change (JCR = 2625), and Technology Analysis & Strategic Management (JCR = 1273).

Despite the dispersion of publications, the concentration in a few journals indicates that the theme has heavily discussed specific subjects, such as innovation management, knowledge management, research and development, and technology management. The seven journals cited are indexed with a high impact factor and recognized by managers and academic researchers.

The 37 articles with at least 100 citations can be seen in Table 3.

Fig. 3 shows the evolution of citations of these articles over time. Considering the 19,539 citations of 1228 articles, 7941 of them are related to the 37 most cited articles (~41%).

In order to analyze the evolution of the citations over time, five periods of three years were created, namely: P1 (between 2003 and 2005), P2 (between 2006 and 2008), P3 (between 2009 and 2011), P4 (between 2012 an 2014), and P5 (between 2015 and 2017). Between 2003 and 2005, only two articles received citations, as follows: Chesbrough (2003a), who conceptualized the key differences between the open innovation model and the closed innovation model; and Chesbrough (2003b), who analyzed how companies working with innovation internally managed their competencies and skills.

Between 2006 and 2008, fifteen additional articles began being cited, among them: Chesbrough (2004), who analyzed how companies could improve their business performance through the acquisition of

Fig. 2. Publications per year.

external resources, considering technological and market uncertainties; Chesbrough (2007), who researched how IBM, P&G and Air Product and Chemicals migrated their business model from closed to open innovation; Chesbrough and Appleyard (2007), who examined the possible relation between business strategy and the option for a more open innovation model; Chesbrough and Crowther (2006), who researched low-tech organizations and found that these companies were applying a series of concepts related to open innovation; Chesbrough and Schwartz (2007), who indicated partnerships for joint development as an excellent business model mechanism of companies; Christensen et al. (2005), who researched the concept of open innovation from an industrial perspective; Cooke (2005), who aimed to analyze the origins of innovation in society; Dittrich and Duysters (2007), who investigated the use of innovation networks considering technological environments under constant change; Dodgson et al. (2006), who, through a case study, analyzed technological and organizational changes related to open innovation at P&G between 2002 and 2004; Fleming and Waguespack (2007), who researched differences between brokerage and boundary spanning for a sixteen year period; Henkel (2006), who explored commercial development through a survey with 268 Linux developers; Jacobides and Billinger (2006), who investigated factors related to the boundaries of the European company Fashion Inc.; Piller and Walcher (2006), whose objective was to research new ways of organizing the innovation process, in a context of user innovation and TIC - toolkits for competitions; Tether and Tajar (2008), whose research explored specialized knowledge as a source of information in the innovation process; and West and Gallagher (2006), who, through a survey on the software industry, evaluated the key challenges of open innovation.

Between 2009 and 2011, nineteen additional articles began being cited, among them: Almirall and Casadesus-Masanell (2010), who analyzed the relation between open innovation and closed innovation through a simulation; Cooper (2008), who revisited the Stage-Gate model, while adapting it to an open innovation model; Dahlander and Gann (2010), who sought to understand the open innovation definitions in the literature, as well as the companies' lack of clarity with respect to their concept; Enkel et al. (2009), an special issue which studied the advancement of innovation linked to research and development; Faraj et al. (2011), who studied knowledge collaboration in online communities; Fuller et al. (2008), who evaluated the role of brand community members in the product development process in a case study at Volkswagen; Gassmann et al. (2010), another special issue focused on identifying future prospects so that companies may benefit even more from open innovation; Huizingh (2011), who sought to understand the

Table 2
Publications per journal and year.

Journal	Year															
	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
R&D Management				6	1	2	11	15	6	3	2	1	2	10	2	61
International Journal of Technology Management				3		1		15	3	2	8	5	4	5		46
Research Policy			2	1		2	1	8	3	2	5	11	3	4	3	45
Research-Technology Management		1	1	2	1	2	3	5	6	8	4	3	3	2	3	44
Technovation					1	1	3	3	13	1	4	4	7	3	2	42
Technological Forecasting and Social Change							1	1	4	4	3	3	3	7	14	40
Technology Analysis & Strategic Management						1		2	5	2	4	9	7	7	3	40
Journal of Product Innovation Management					1	2		2	2	3	5	4	2	7	1	29
Creativity and Innovation Management								2	3	3	1	1	8	3	1	22
International Journal of Innovation Management														12	9	21
California Management Review	1				2			3	1	3	4	4	1	1		20
Management Decision						2				4	1		2	5	2	16
Industry and Innovation						2	1	1	1	1	2	2	1		3	14
Innovation-Management Policy & Practice							1		1	6	1	1	1	2	1	14
Journal of Knowledge Management											1	2	1	3	7	14
European Journal of Innovation Management													4		9	13
Journal of Engineering and Technology Management						1				1	2	3	4	2		13
Journal of Business Research								1		2	1		1	5	2	12
Journal of Technology Transfer										2	1	1	2		6	12
Sustainability													2	8	2	12
Organization Science				1	1	1		1	2	1	1	2		1		11
Service Industries Journal											9		2			11
Asian Journal of Technology Innovation						1	1		1	1	1	1	3	1		10
Industrial Marketing Management								1			3	2	3		1	10
International Entrepreneurship and Management Journal											8			1	1	10
Technology Innovation Management Review													2	6	2	10

Note: Minimum of ten publications. In descending order of the total number of publications.

Table 3
List of the most cited articles.

Article	Journal	Number of citations
Chesbrough (2003a)	MIT Sloan Management Review	691
Dahlander and Gann (2010)	Research Policy	483
Chesbrough and Crowther (2006)	R&D Management	429
Van de Vrande et al. (2009)	Technovation	365
Enkel et al. (2009)	R&D Management	338
Huizingh (2011)	Technovation	323
Gassmann et al. (2010)	R&D Management	280
Cooper (2008)	Journal of Product Innovation Management	261
Lee et al. (2010)	Research Policy	239
Jeppesen and Lakhani (2010)	Organization Science	237
Chesbrough and Appleyard (2007)	California Management Review	227
Piller and Walcher (2006)	R&D Management	215
West and Gallagher (2006)	R&D Management	214
Henkel (2006)	Research Policy	207
Dodgson et al. (2006)	R&D Management	202
Lichtenthaler and Lichtenthaler (2009)	Journal Of Management Studies	200
Christensen et al. (2005)	Research Policy	187
Lichtenthaler (2008)	IEEE Transactions on Engineering Management	175
Fleming and Waguespack (2007)	Organization Science	171
Terwiesch and Xu (2008)	Management Science	169
Dittrich and Duysters (2007)	Journal of Product Innovation Management	165
Baldwin and Von Hippel (2011)	Organization Science	162
Lichtenthaler (2011)	Academy of Management Perspectives	159
Chesbrough (2007)	MIT Sloan Management Review	158
Faraj et al. (2011)	Organization Science	156
Tether and Tajar (2008)	Research Policy	156
Leimeister et al. (2009)	Journal of Management Information Systems	147
Chesbrough (2003b)	California Management Review	145
Stang et al. (2010)	Annals of Internal Medicine	141
Cooke (2005)	Research Policy	134
Fuller et al. (2008)	Journal of Product Innovation Management	127
Chesbrough (2004)	Research-Technology Management	123
Almirall and Casadesus-Masanell (2010)	Academy of Management Review	121
Chesbrough and Schwartz (2007)	Research-Technology Management	119
West and Lakhani (2008)	Industry and Innovation	110
Jacobides and Billinger (2006)	Organization Science	105
Bianchi et al. (2011)	Technovation	100

Note: In descending order of the number of citations.

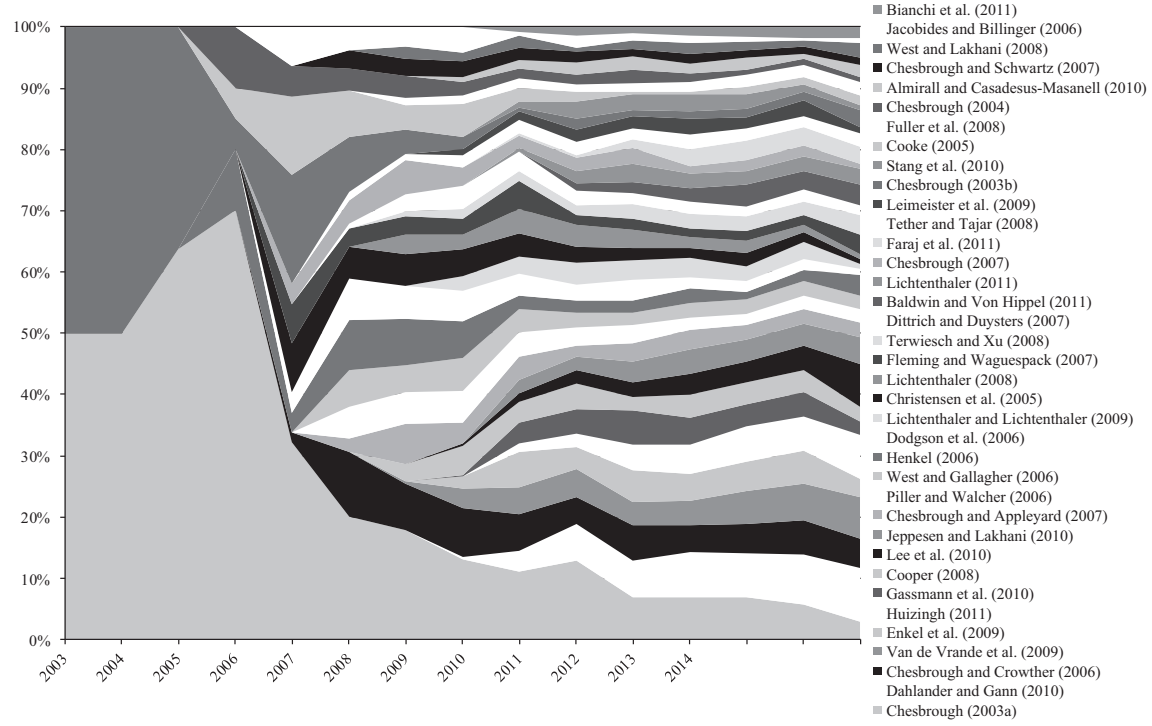

Fig. 3. Evolution of the citations of the 37 most cited articles.

concept of open innovation, considering the processes and outcomes involved, as well as how they may be implemented; Jeppesen and Lakhani (2010), who analyzed how information obtained externally may promote problem solving, and therefore performed a case study in the following companies: Coca Cola, Steelcase, Osram, Alcatel-Lucent, Toyota Scion, Endemol, Aloft and Mazda; Lee et al. (2010), who discussed the concept of open innovation studying small companies; Leimeister et al. (2009), whose research described features that can favor the information technology area; Lichtenthaler (2008), who aimed to understand how companies in various industries were adopting the concept of open innovation; Lichtenthaler (2011), who proposed future directions for open innovation, through a conceptual framework; Lichtenthaler and Lichtenthaler (2009) who developed an open innovation framework; Stang et al. (2010), who described an administration structure in a hospital setting that applies the concepts of open innovation; Terwiesch and Xu (2008), who researched some problem solving agents in the context of open innovation; and Van de Vrande et al. (2009), who tested whether the open innovation practices could be applied in small and midsize companies.

From 2012, the last article was also cited, being Baldwin and Von Hippel (2011), who researched the economic viability of an open innovation model.

Fig. 4 shows the keyword network. The links show the keywords that were mentioned together in the sample, and the thickness of the lines corresponds to the intensity of their relations. There were key connections between open innovation and research-and-development, between open innovation and knowledge, and between open innovation and performance. For this network, a minimum of twenty-eight citations for each keyword was set. (Note: This network was created using the Ucinet software through data imported by Sitkis software. Line thickness represents the intensity of relations.)

In Fig. 5, articles to reference network may be checked. Circles are articles resulting from the search, and squares are references to these articles. This network illustrates the importance of a work in relation to a specific subject. Following the criteria for the development of networks, works which were cited in the range from 1% to 10% of the sample were included, as suggested in the Sitkis software manual (Schildt, 2002). For this network, a filter of at least 70 citations for articles and references was used.

Of the 52 articles, 29 appear in the list of 37 most cited articles. The remaining 23 new articles are Berchicci (2013), who investigated the relationship between open R&D and innovative performance; Chen et al. (2011), who also considered the performance of innovation influenced by the open innovation strategy in Chinese companies; Chesbrough (2011), who analyzed the application of open innovation concepts, more explored in the literature related to product by then; Chiang and Hung (2010), who analyzed the relation between the use of several external sources of innovation in the development of incremental and radical innovation in the companies; Chiaroni et al. (2010), who aimed to understand the main organizational and managerial aspects related to the transition from a closed to an open innovation model; Chiaroni et al. (2011), who researched aspects related to the practical implementation of open innovation concepts; Di Gangi and Wasko (2009), who sought to understand the main aspects related to decision-making in companies, once they choose to find innovation beyond their frontiers; Ebner et al. (2009) an action research which developed a framework called “community engineering for innovations”; Enkel and Gassmann (2006), who analyzed the influence of the higher or lower cognitive distance in the innovation development of 25 companies; Faems et al. (2010), who researched 305 manufacturing companies in Belgium to relate the impact of technology partnerships on their financial performance; Keupp and Gassmann (2009), who aimed to understand how a company's internal factors may hinder the adoption of open innovation aspects; Kohler et al. (2009), whose aim was to prove the benefits of virtual worlds for innovation; Laursen and Salter (2014), who made progress in the literature on how to manage the open innovation paradox; Lichtenthaler (2009), that analyzed the relationship between outbound open innovation and firm performance; Lichtenthaler and Ernst (2006), who investigated the knowledge management in open innovation model, considering syndromes such as NIH – Not Invented Here; Mention (2011), who analyzed how cooperation and competition may influence the tendency of service enterprises to introduce innovations in the market; Parida et al. (2012), who researched the impact of open innovation on 252 small and medium-sized technology companies; Rohrbeck et al. (2009), who analyzed the open innovation ecosystem, considering the telecommunications sector in Germany; Sieg et al. (2010), who researched chemical companies that were in a continuum between closed innovation and open innovation,

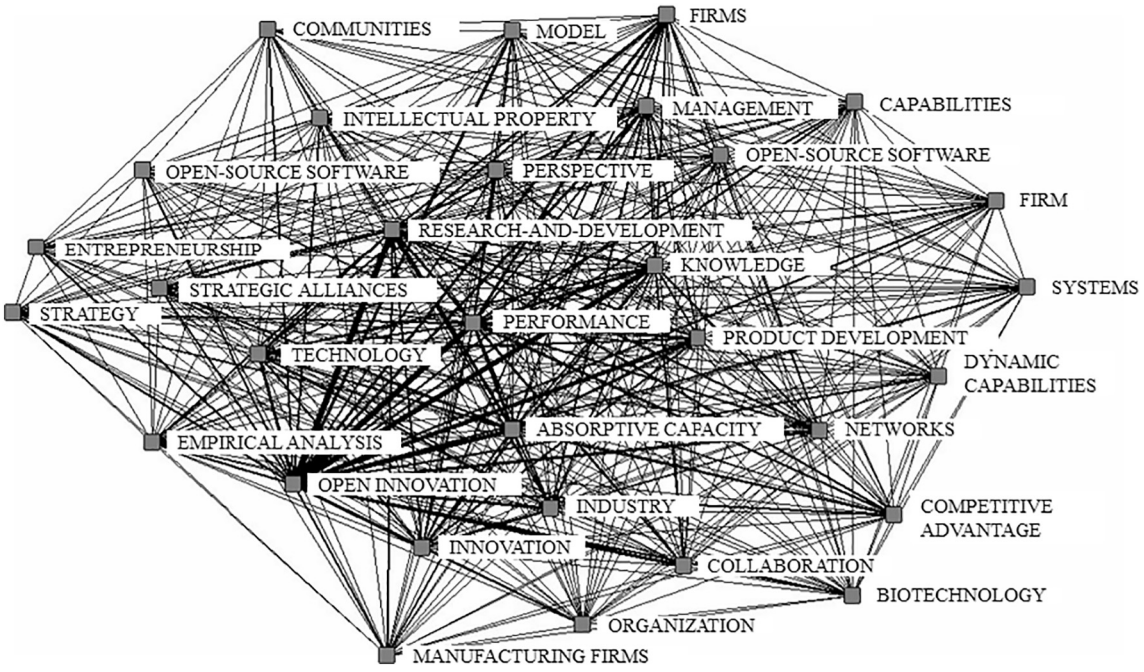

Fig. 4. Keyword network.

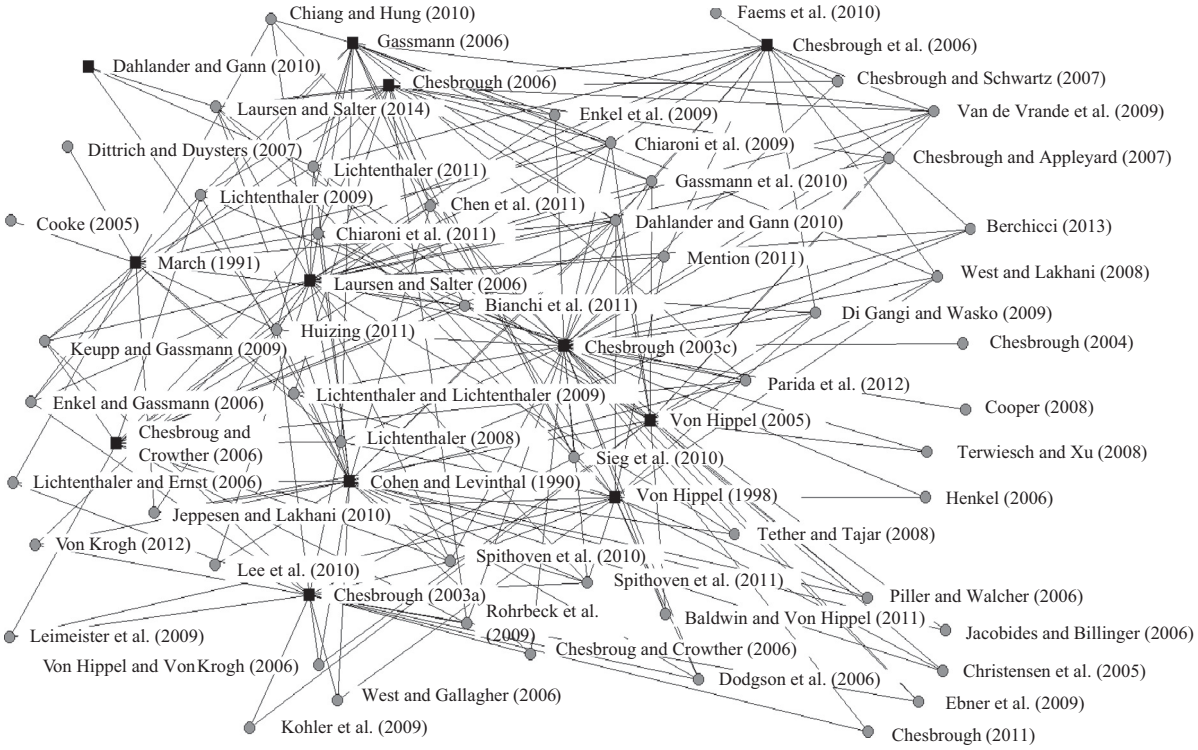

Fig. 5. Network of articles citation for references.

in order to identify the main challenges faced by these companies; Spithoven et al. (2010 and 2011),who analyzed the importance of absorptive capacity in the inbound open innovation process; Von Hippel and Von Krogh (2006), that detail the open model of software development; Von Krogh (2012), who analyzed the concept of knowledge management from the perspective of social software.

Of the 12 reference, sfive are books, namely: Chesbrough (2003c), who present the paradigms of the open innovation versus closed innovation, as well as their respective business models and transition steps; Chesbrough (2006), who brought a lot of contributions and guidelines for companies seeking to thrive with an open innovation model; Chesbrough et al. (2006), who gave an overview of open innovation, considering an empirical research and conceptual articles; Von Hippel (1988), who addressed several innovations sources; and Von Hippel (2005), who explores what he calls the democratization of innovation.

The remaining four references are Cohen and Levinthal (1990), who presented the concept of absorptive capacity; Gassmann (2006), who, through a literature review on open innovation, analyzed some trends and lines of research; Laursen and Salter (2006), who analyzed the relation between open innovation and innovation performance; and March (1991), who also researched the concept of exploration and exploitation of organizational learning.

4. Theoretical framework

Over the years, innovation has been studied from different perspectives. In an increasingly competitive and globalized innovative-driven environment, the collaborative view of innovation has stood out. Small and large companies collaborate in search of knowledge and additional resources able to promote continuous innovation and gain competitive advantage (Cheng and Huizingh, 2014; West and Bogers, 2014).

According to OECD (2008), innovation can be classified into four types: product innovation (introduction of a new or significantly improved product); process innovation (introduction of a new or significantly improved production method); organizational innovation (introduction of an organizational method that has not been used previously); and marketing innovation (introduction of a new marketing method).

The last decade was marked by the change in companies' thinking regarding research and development, when the concept of doing everything in-house became outdated (Appleyard and Chesbrough, 2017; Berchicci, 2013; Bianchi et al., 2016; Gassmann, 2006; Salter et al., 2015). An innovation pattern became increasingly collaborative with the interaction between different actors, such as companies, customers, suppliers, universities, and even competitors (Faems et al., 2005; Mention, 2011).

Goduscheit (2014) analyzed the importance of the innovation promoter (power, expert, process and relationship) in inter-organizational projects. A starting point for opening the innovation business model is the fact that more and more companies cannot innovate alone (Dahlander and Gann, 2010; Popa et al., 2017). It mobilized several studies in order to understand factors related to the opening of companies' boundaries (Greco et al., 2016; Jacobides and Billinger, 2006; Perkmann and Schildt, 2015; Powell, 1990).

The roots of open innovation are historical, however, the concept of consciously seeking external resources to implement the internal processes, as well as marketing internal opportunities is more recent, and set the time in which the term “open innovation” was coined (Huizingh, 2011; Zhao et al., 2016).

The concept behind the open innovation model is not completely new (Appleyard and Chesbrough, 2017; Chesbrough and Bogers, 2014). Cohen and Levinthal (1990) already addressed the concept of absorptive capacity, i.e., the companies' ability to recognize the value of externally acquired information, assimilating and applying it to valuable and marketable products. Additionaly authors had already explored further aspects of innovation, such as dynamic capabilities, which is the ability of a company to integrate, build and set internal and external competencies in a constantly changing environment (Teece et al., 1997); and the exploration of new possibilities regarding the exploitation of old certainties related to organizational learning (March 1991).

By coining the term in 2003, Henry Chesbrough set open innovation as something which "embraces, connects and integrates a range of existing activities" (Huizingh, 2011, p. 3).

There are different definitions of open innovation in the literature (Dahlander and Gann, 2010). The first says that "open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to the market, as the firms look to advance their technology" (Chesbrough, 2003c, p. xxiv). In the following year, this definition was refined to "open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough et al., 2006, p.1). Again, in the subsequent year, another definition emerged: "open innovation is the pooling of knowledge for innovative purposes where the contributors have access to the inputs of others and cannot exert exclusive rights over the resultant innovation" (Chesbrough and Appleyard, 2007, p.60). Lichtenthaler (2011, p.77) summarized open innovation definitions in the literature and presented the following definition: "open innovation is defined as systematically performing Knowledge exploration, retention, and exploitation inside and outside an organization's boundaries throughout the innovation process". Chesbrough and Bogers (2014, p. 13) define open innovation "as a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization's business model".

According to Gambardella and Panico (2014) there is still much potential to be explored theoretically and empirically in the OI literature. It is very important to understand the dynamics of open innovation and to carefully plan how it should be implemented (Geum et al., 2013). Another relevant aspect is that if, on the one hand, the generation of innovation is increasingly achieved through the opening of corporate boundaries, and on the other hand, the commercialization of this innovation requires protection (Laursen and Salter, 2014).

4.1. From closed to open innovation

The principles of the closed innovation model are as follows: the smartest people in the area work internally in the company; the research-related income is generated and applied internally; the company believes that being the first to place an innovation on market will make it a winner; the company also believes that being the creator of the best ideas will make it a winner; and intellectual property is controlled (Chesbrough, 2003a, b). Also according to the same article, the principles of open innovation are as follows: knowledge and the best skills may be inside or outside the company; internally developed research is part of the company's result and is complemented by external research; it is not necessary to be the first to develop a research to enjoy its positive results; building an appropriate business model is more efficient than reaching a market before the competitors; the company wins if it makes the best use of internal and external ideas; and companies may share the benefits provided by intellectual property.

The propensity of companies to cooperate in research and development emerged in the 90s, and over time companies have increasingly sought to open their innovation boundaries, making them porous (Appleyard and Chesbrough, 2017; Chesbrough, 2003a; Gassmann, 2006; Lichtenthaler and Ernst, 2006).

The analysis of the evolution from closed innovation to open innovation indicates changes in some parameters, such as type of industry, technology intensity involved in research and development, company size, processes, structure, content and the way to manage intellectual property (Gassmann et al., 2010). Cross-industry evidences from Germany suggest the critical role of collaboration governance (Gesing et al., 2015). If chemical companies were among the first to work with open innovation, then today companies in many other industries are in a continuum between closed and open innovation (Saebi and Foss, 2015; Von Krogh, 2012).

Some companies experience a dilemma when deciding between having a closed and controlled environment of research and development or, on the contrary, opening their innovation process (Almirall and Casadesus-Masanell, 2010).

It is important to keep in mind that open innovation is not the best solution for any company, and an analysis regarding the benefits arising from each of the models is required (Gassmann, 2006). Although some studies indicate a positive relation between open innovation and performance, some studies indicate a few limitations (Caputo et al., 2016; Laursen and Salter, 2006; Rubera et al., 2016; Zhao et al., 2016). Managers and academics lack a better understanding of the mechanisms involving the boundaries of the innovation process (Enkel et al., 2009; Hall, 2015; Lee and Juneseuk, 2017). For companies, the challenge has been to find the ideal balance between investment in internal activities and investment in external activities (Enkel et al., 2009).

The transition from closed innovation to open innovation requires professionals involved in decision-making related to innovation activities (Ahn et al., 2017; Huizingh, 2011). This transition involves some perspectives, such as innovation globalization; R&D outsourcing; involvement of suppliers; user as a source of innovation; and commercialization and application of external technology (Gassmann, 2006).

This transition requires that R&D leaders review some aspects, such as performance and innovation metrics, sources of knowledge and business models (Chesbrough, 2004). An example is the company P&G, which upon realizing that the solution for most of its problems was out of the company, created the "Connect and Develop" program, which differs from previous initiatives, especially with regard to changing organizational practices.

Companies which have an organizational culture, working internally on open innovation process, have higher chances of obtaining positive results when the transitioning from closed to open innovation, as well as in the relationship with external partners (Kratzer et al., 2017; Saebi and Foss, 2015).

Cooper (2008) revisited his Stage-Gate model, which is a map that represents the development of new products, considering from the idea generation to market placement. Companies like Kimberly Clark and P&G changed their Stage-Gate product development by opening their business model. For that, they created the necessary flexibility to deal with a new form of discovery, development, and commercialization of the innovation process.

"Companies can benefit from open innovation when they have the capabilities to connect closed and open approaches to innovation" (Prud'homme Van Reine, 2015, p. 71). Still according to the same research, the main capabilities involved are as follows: "capability to connect global and local networks; capability to network between big and small companies; capability to connect innovation networks to fundamental research; capability to connect formal and informal networks; capability to connect deep and wide network ties; capability to connect to customer & lead user innovator networks; capability to connect regional innovation networks; capability to connect interfunctional company networks; capability to connect to societal networks" (Prud'homme Van Reine, 2015, p. 95).

4.2. Open innovation: inbound and outbound variables

Inbound open innovation refers to use of external knowledge or technology internally (Cassiman and Valentini, 2016; Huizingh, 2011). Studies relate the inbound part of open innovation to obtaining a competitive advantage since companies do not need to rely solely on the results of their internal R&D (Bianchi et al., 2011; Cassiman and Veugelers, 2006; Chen et al., 2011; Hung and Chou, 2013; Naqshbandi, 2016; Naqshbandi et al., 2015; Naqshbandi et al., 2016; Tsai and Liao, 2011; Van de Vrande et al., 2009).

Studies prior to the inbound concept reported the importance of external technology acquisition (Nelson and Winter, 1982). Researches show that companies, to obtain technology externally, mainly look for

ideas (Hung and Chou, 2013; Naqshbandi, 2016; Naqshbandi et al., 2015; Naqshbandi et al., 2016; Sisodiya et al., 2013); intellectual property (Cassiman and Veugelers, 2006; Hung and Chou, 2013; Kim and Park, 2010; Naqshbandi, 2016; Naqshbandi et al., 2015; Naqshbandi et al., 2016; Sisodiya et al., 2013; Van de Vrande et al., 2009); knowledge (Hung and Chou, 2013; Naqshbandi, 2016; Naqshbandi et al., 2015; Naqshbandi et al., 2016, Qin and Shanxing, 2010); information (Naqshbandi, 2016; Naqshbandi et al., 2015; Naqshbandi et al., 2016, Qin and Shanxing, 2010); and technical know-how (Cammarano et al., 2017; Parida et al., 2012; Qin and Shanxing, 2010).

A study presented some critical success factors of the open innovation inbound, among them: stimulate practices of open innovation; keep initiatives always aligned with the company's business goals, seek innovations that can add value, create an integrated management system, and align the performance metrics of internal and external environment (Chesbrough and Crowther, 2006). According to a research carried out with high-level technology companies in Malaysia, companies, which have relations with universities/research institutes, and government bodies facilitate and foster inbound open innovation (Naqshbandi and Kaur, 2014). According to Naqshbandi et al. (2015), inbound open innovation is facilitated when a company has a strongly integrative organizational culture.

On the other hand, outbound OI refers to the transmission of knowledge or technology to an external environment (Cassiman and Valentini, 2016; Huizingh, 2011). Studies relate the outbound part of OI to obtaining a competitive advantage when companies send knowledge to the external environment (Cassiman and Veugelers, 2006; Hung and Chou, 2013). Researches show that, to send technology to the external environment, the companies mainly export technical know-how (Hung and Chou, 2013; Naqshbandi et al., 2015; Naqshbandi et al., 2016; Parida et al., 2012); intellectual property (Cassiman and Veugelers, 2006; Hung and Chou, 2013; Lichtenthaler, 2009; Tsai and Liao, 2011; Van de Vrande et al., 2009); and knowledge (Hung and Chou, 2013).

According to Zuppo et al. (2016), some factors influence the positive effect of outbound open innovation, such as the competitive degree and intensity of the technology involved. The literature on outbound open innovation is less frequent and little explored when compared to the one on inbound open innovation, thus proving to be a good opportunity for future researches (Hsieh et al., 2016; Lichtenthaler, 2015).

Laursen and Salter (2006, p. 131) introduced the concept of breadth and depth of OI "as two components of the openness of individual firms' external search strategies". Other researches use the same 16 external research sources proposed by Laursen and Salter (2006), totally or partially, to investigate aspects related to inbound and outbound open innovation (Bei et al., 2008; Chiang and Hung, 2010; Greco et al., 2016; Keupp and Gassmann, 2009).

4.3. Relationship of open innovation with performance

Understanding how to maximize open innovation efficiency is a recent and relevant research issue (Greco et al., 2017). Open innovation efficiency is novel to the open innovation literature and states that "a firm is more efficient in its open innovation approach than another if it obtains better innovation outputs starting from similar open innovation inputs" (Greco et al., 2017).

Some authors measured the performance considering firm indicators, including objective financial performance indicators (Popa et al., 2017). The firm's performance can be measured considering indicators such as turnover (Bren et al., 2017; Caputo et al., 2016) and sales growth (Caputo et al., 2016; Cheng and Huizingh, 2014; Kocoglu et al., 2011; Law and Ngai, 2008; Rubera et al., 2016). Other financial indicators are ROA (Return on Assets) (Cassiman and Veugelers, 2006), ROI (Return on Investment) (Cheng and Huizingh, 2014), and ROS (Return on Sales) (Lichtenthaler, 2009).

Other researchers have measured the firm's performance using as indicators market share (Cheng and Huizingh, 2014; Kocoglu et al., 2011; Law and Ngai, 2008; Sisodiya et al., 2013), profitability margin (Cheng and Huizingh, 2014; Faems et al., 2010) and profitability relative to the overall performance of the sector (Kocoglu et al., 2011; Law and Ngai, 2008). Finally, firms evaluated their performance by measuring customer performance (Cheng and Huizingh, 2014) that encompasses retention and satisfaction (Kocoglu et al., 2011; Law and Ngai, 2008).

Another form to measure performance is using some innovation indicators. Previous researches measured innovation performance considering some aspects related to Research and Development, such as R&D through collaboration (Cammarano et al., 2017; Greco et al., 2017), R&D expenditures (Bei et al., 2008; Hagedoorn and Cloodt, 2003), in-house R&D versus outsourced R&D (Berchicci, 2013; Cammarano et al., 2017), R&D intensity (Ahn et al., 2017), number of employees working in R&D (Berchicci, 2013), and cost reduction in R&D (Qin and Shanxing, 2010).

Aspects related to new products are also used as indicators of innovation performance, such as costs and sales of new products (Bei et al., 2008; Chen et al., 2011; Laursen and Salter, 2006), service success and service innovativeness related to new product development (Cheng and Huizingh, 2014), the number of new products which are developed and commercialized (Bei et al., 2008; Bianchi et al., 2011; Greco et al., 2016; Qin and Shanxing, 2010), and the speed of new product development (Bei et al., 2008; Chen et al., 2011). Hochleitner et al. (2016) analyzed the influence of OI on the development of new products and found a positive effect on the following activities: cooperation among customers, suppliers and competitors; acquisition of information coming from consultants, universities and public institutions, as well as the acquisition of external R&D.

Other researches related innovation performance with intellectual property considering the number of patent deposited and/or cited (Bei et al., 2008; Caputo et al., 2016; Chen et al., 2011; Hagedoorn and Cloodt, 2003; Qin and Shanxing, 2010; Wang et al., 2012).

Researchers measured the innovation performance through the variable turnover of new products or products, which had significant improvements (Bei et al., 2008; Berchicci, 2013; Faems et al., 2010; Greco et al., 2016; Greco et al., 2017).

Chesbrough and Bogers (2014) relate the impact of open innovation to the company's business strategy, product development models, the innovation process itself and the role of universities in this context. Still according to the same research, there is a lack of empirical researches, which analyze the limits, risks and costs to adopt OI concepts.

De acordo com West et al. (2014) one of the great challenges for the second decade of the open innovation paradigm is to look for newer and better indicators to measure its impact.

Zhao et al. (2016) analyzed the concept of open innovation efficiency and identified some key factors, such as the company's strategy, its technological skills and intake capacity, its culture and even the company's ecosystem. Greco et al. (2017, 2014) state that "a firm is more efficient in its open innovation approach than another if it obtains better innovation outputs starting from similar open innovation inputs".

Recent studies show the growing interest of academics and managers in understanding the particularities of the open innovation concept in the context of small and medium-sized companies (Bren et al., 2017; Brunswicker and Vanhaverbeke, 2015; Dufour and Son, 2015; Popa et al., 2017). Brunswicker and Vanhaverbeke (2015) investigated the influence of the search for external knowledge on the innovation development of small and medium-sized companies and concluded that two dimensions are the most impacted: the launch of an innovation and value appropriation in new services or products.

According to Dufour and Son (2015), the main barriers that small and medium-sized companies face to apply the open innovation model are related to culture and organizational structure, as well as how their

Table 4
Hypotheses on open innovation and performance.

Hypotheses	#	References
H1a: OI impact Firm Performance	10	Bren et al. (2017); Caputo et al. (2016); Cassiman and Veugelers (2006); Cheng and Huizingh (2014); Faems et al. (2010); Kocoglu et al. (2011); Law and Ngai (2008); Lichtenthaler (2009); Rubera et al. (2016); Sisodiya et al. (2013)
H1b: OI impact Innovation Performance	15	Ahn et al. (2017); Bei et al. (2008); Berchicci (2013); Bianchi et al. (2011); Cammarano et al. (2017); Caputo et al. (2016); Chen et al. (2011); Cheng and Huizingh (2014); Faems et al. (2010); Greco et al. (2016); Greco et al. (2017); Hagedoorn and Cloodt (2003); Laursen and Salter (2006); Qin and Shanxing (2010); Wang et al. (2012)

networks are structured and how the acquired knowledge is managed. Small and medium-sized companies may benefit from the open innovation model, mainly considering that these companies have limited sources, little internal information and fewer financial resources to invest in technology (Verbano et al., 2015).

Based on this discussion, two research hypotheses were proposed supported by the surveyed literature, as presented in Table 4.

4.4. Knowledge flow in open innovation

Studies that proceeded the open innovation paradigm, related to transaction cost theory, had already highlighted the importance of external knowledge acquisition through licenses, joint ventures, and research and development agreements (Pisano, 1990).

Internally developing the skills necessary to explore knowledge externally is crucial for innovation performance (Cheng and Shiu, 2015; Gjisetti et al., 2015; Laursen and Salter, 2006). It is necessary that companies have the internal expertise to use this knowledge effectively so that they can receive the benefits provided by the acquisition of external knowledge. Having the ability to combine internal and external information sources is a difference that can generate competitive advantage (Cassiman and Veugelers, 2006; Seungmin et al., 2016).

Acquiring technological knowledge also results in obtaining a competitive advantage, since companies can benefit from cost reduction and differentiation of its products, which in turn generates financial and strategic benefits (Lichtenthaler, 2007). In addition, according to this study, the motivation for technology licensing may arise from several factors, including the most important: freedom to work, gain knowledge, have access to new markets and increase the number of products sold.

Lichtenthaler and Lichtenthaler (2009) developed a theoretical framework that divides knowledge management, in the context of open innovation, into three key processes: exploration, retention, and exploitation. The authors describe each capacity as follows: inventive capacity refers to the ability to generate and exploit knowledge internally; absorptive capacity refers to the ability to exploit external knowledge and use it in the best way internally; transformative capacity refers to the company's ability to maintain the acquired knowledge over time; connective capacity refers to the ability to maintain knowledge in intercompany relations; innovative capacity refers to the ability of the company to generate innovations from new knowledge; and desorptive capacity refers to the ability of the company to pass the knowledge to the market.

According to Naqshbandi (2016), the success of the process of open innovation flow of knowledge requires that companies be able to explore, transform and commercialize the knowledge that is acquired externally (absorptive capacity). Still according to the same research, keeping the managers in touch with people from different companies, universities, education institutions or even government bodies positively influences the companies' capacity to deal with the knowledge acquired beyond their frontiers.

Jiménez-Barrinuevo et al. (2011) validated a tool to measure the absorptive capacity considering four main phases: acquisition, assimilation, transformation and exploitation. Zobel (2017) stated, through a survey, a positive relation between the access to external resources and competitive advantage, influenced by the company's absorptive capacity. Ahn et al. (2016) and Kokshagina et al. (2017) also presented the company's absorptive capacity as an intermediator between open innovation and performance.

Huang et al. (2015) researched the main barriers Chinese companies face when adopting open innovation, and low absorptive capacity proved to be one of the most relevant factors. The absorptive capacity may be considered a constraint on open innovation (Kim et al., 2016; Martín de Castro, 2015; Patterson and Ambrosini, 2015; Spithoven et al., 2010).

Based on this discussion, a research hypothesis was proposed as supported by the surveyed literature, concerning the moderate effect of knowledge flow, as presented in Table 5.

4.5. Contingent variables affecting open innovation relationship

The main variables treated as moderator variables in the researches which assessed the relation among open innovation, firm and innovation performance were the following: firm size (Ahn et al., 2017; Berchicci, 2013; Brunswicker and Vanhaverbeke, 2015; Caputo et al., 2016; Cassiman and Veugelers, 2006; Chang, 2003; Chen et al., 2011; Cheng and Huizingh, 2014; Chiang and Hung, 2010; Faems et al., 2010; Gesing et al., 2015; Greco et al., 2016; Hsieh et al., 2016; Keupp and Gassmann, 2009; Kratzer et al., 2017; Laursen and Salter, 2014; Lichtenthaler, 2009); firm age (Berchicci, 2013; Brunswicker and Vanhaverbeke, 2015; Caputo et al., 2016; Chen et al., 2011; Hsieh et al., 2016; Keupp and Gassmann, 2009); type of industry (Cammarano et al., 2017; Caputo et al., 2016; Chang, 2003; Cheng and Huizingh, 2014; Faems et al., 2010; Hsieh et al., 2016), and country (Chang, 2003; Gesing et al., 2015; Greco et al., 2016). The main variables treated as control variables were the following: competitive intensity (Cheng and Huizingh, 2014; Hsieh et al., 2016; Keupp and Gassmann, 2009); number of partners (Chang, 2003; Greco et al., 2016), and technological and market uncertainties (Cheng and Huizingh, 2014; Chiang and Hung, 2010).

Based on this discussion, the contingent variables were deployed into the control and moderate variables according to the hypotheses presented in Table 6, as supported by the surveyed literature.

Table 5
Hypothesis on knowledge flow moderate effect.

Hypotheses	#	References
H2: Knowledge Flow affect the relation between OI and Innovation Performance	13	Ahn et al. (2016); Cassiman and Veugelers (2006); Cheng and Shiu (2015); Gjisetti et al. (2015); Kim et al. (2016); Kokshagina et al. (2017); Laursen and Salter (2006); Martín de Castro (2015); Naqshbandi (2016); Patterson and Ambrosini (2015); Seungmin et al. (2016); Spithoven et al. (2010); Zobel (2017)

Table 6
Hypothesis on contingent variables effect.

Hypotheses	#	References
H3a: Contingent Variables affect the relation between OI and Firm Performance	6	Caputo et al. (2016); Cassiman and Veugelers (2006); Cheng and Huizingh (2014); Faems et al. (2010); Hsieh et al. (2016); Lichtenthaler (2009)
H3b: Contingent Variables affect the relation between OI and Innovation Performance	18	Ahn et al. (2017); Berchicci (2013); Brunswicker and Vanhaverbeke (2015); Cammarano et al. (2017); Caputo et al. (2016); Chang (2003); Chen et al. (2011); Cheng and Huizingh (2014); Chesbrough and Sabine (2014); Chiang and Hung (2010); Edwards et al. (2005); Faems et al. (2010); Gesing et al. (2015); Greco et al. (2016); Hsieh et al. (2016); Keupp and Gassmann (2009); Kratzer et al. (2017); Laursen and Salter (2014)

Table 7
Codification of the main constructs and their references.

Main code	Coding deployment	#	References
Inbound	External technology acquisition	11	Cammarano et al. (2017); Cassiman and Veugelers (2006); Hung and Chou (2013); Kim and Park (2010); Naqshbandi (2016); Naqshbandi et al. (2015); Naqshbandi et al. (2016); Parida et al. (2012); Qin and Shanxing (2010); Sisodiya et al. (2013); Van de Vrande et al. (2009)
	External knowledge acquisition	9	Bianchi et al. (2011); Cassiman and Veugelers (2006); Chen et al. (2011); Hung and Chou (2013); Naqshbandi (2016); Naqshbandi et al. (2015, 2016); Tsai and Liao (2011); Van de Vrande et al. (2009)
	Breadth and Depth	4	Bei et al. (2008);Chiang and Hung (2010); Greco et al. (2016); Keupp and Gassmann (2009); Laursen and Salter (2006)
Outbound	Internal technology exploitation	8	Cassiman and Veugelers (2006); Hung and Chou (2013); Lichtenthaler (2009); Naqshbandi et al. (2015); Naqshbandi et al. (2016); Parida et al. (2012); Tsai and Liao (2011); Van de Vrande et al. (2009)
	Breadth and Depth	4	Bei et al. (2008); Chiang and Hung (2010); Greco et al. (2016); Keupp and Gassmann (2009); Laursen and Salter (2006)
	Internal knowledge exploitation	2	Cassiman and Veugelers (2006); Hung and Chou (2013)
Main players	Universities and research institutes	14	Brunswicker and Vanhaverbeke (2015); Cassiman and Veugelers (2006); Chen et al. (2011); Chiang and Hung (2010); Greco et al. (2016); Greco et al. (2017); Hochleitner et al. (2016); Laursen and Salter (2006); Laursen and Salter (2014); Naqshbandi (2016); Naqshbandi et al. (2015, 2016); Rubera et al. (2016); Sisodiya et al. (2013)
	Customer	14	Brunswicker and Vanhaverbeke (2015); Chiang and Hung (2010); Greco et al. (2016); Greco et al. (2017); Hochleitner et al. (2016); Laursen and Salter (2006); Laursen and Salter (2014); Naqshbandi (2016); Naqshbandi et al. (2015, 2016); Rubera et al. (2016); Sisodiya et al. (2013); Tsai and Liao (2011); Van de Vrande et al. (2009)
	Supplier	13	Brunswicker and Vanhaverbeke (2015); Chen et al. (2011); Chiang and Hung (2010); Greco et al. (2016); Greco et al. (2017); Hochleitner et al. (2016); Laursen and Salter (2006); Laursen and Salter (2014); Naqshbandi (2016); Naqshbandi et al. (2015, 2016); Rubera et al. (2016); Sisodiya et al. (2013)
	Competitor	12	Chen et al. (2011); Chiang and Hung (2010); Greco et al. (2016); Greco et al. (2017); Hochleitner et al. (2016); Laursen and Salter (2006); Laursen and Salter (2014); Naqshbandi (2016); Naqshbandi et al. (2015, 2016); Rubera et al. (2016); Sisodiya et al. (2013)
	Consultants	7	Chiang and Hung (2010); Greco et al. (2016); Greco et al. (2017); Hochleitner et al. (2016); Laursen and Salter (2006); Laursen and Salter (2014); Rubera et al. (2016)
	Network partners	6	Brunswicker and Vanhaverbeke (2015); Chen et al. (2011); Hung and Chou (2013); Rubera et al. (2016); Tsai and Liao (2011); Van de Vrande et al. (2009)
	Government	5	Chen et al. (2011); Chiang and Hung (2010); Greco et al. (2016); Greco et al. (2017); Laursen and Salter (2006)
Firm performance	Sales growth	5	Caputo et al. (2016); Cheng and Huizingh (2014); Kocoglu et al. (2011); Law and Ngai (2008); Rubera et al. (2016)
	Market share	4	Cheng and Huizingh (2014); Kocoglu et al. (2011); Law and Ngai (2008); Sisodiya et al. (2013)
	Profitability	4	Cheng and Huizingh (2014); Faems et al. (2010); Kocoglu et al. (2011); Law and Ngai (2008)
	Financial indicators	3	Cassiman and Veugelers (2006); Cheng and Huizingh (2014); Lichtenthaler (2009)
	Customer performance	2	Cheng and Huizingh (2014); Kocoglu et al. (2011); Law and Ngai (2008)
	Turnover	2	Bren et al. (2017); Caputo et al. (2016)
Innovation performance	New product	7	Bei et al. (2008); Bianchi et al. (2011); Chen et al. (2011); Cheng and Huizingh (2014); Greco et al. (2016); Laursen and Salter (2006); Qin and Shanxing (2010)
	R&D	7	Ahn et al. (2017); Bei et al. (2008); Berchicci (2013); Cammarano et al. (2017); Greco et al. (2017); Hagedoorn and Cloodt (2003); Qin and Shanxing (2010)
	Intellectual property	6	Bei et al. (2008); Caputo et al. (2016); Chen et al. (2011); Hagedoorn and Cloodt (2003); Qin and Shanxing (2010); Wang et al. (2012)
	Turnover	5	Bei et al. (2008); Berchicci (2013); Faems et al. (2010); Greco et al. (2016); Greco et al. (2017)
Contingent variables	Firm size	19	Ahn et al. (2017); Berchicci (2013); Brunswicker and Vanhaverbeke (2015); Caputo et al. (2016); Cassiman and Veugelers (2006); Chang (2003); Chen et al. (2011); Cheng and Huizingh (2014); Chesbrough and Sabine (2014); Chiang and Hung (2010); Edwards et al. (2005); Faems et al. (2010); Gesing et al. (2015); Greco et al. (2016); Hsieh et al. (2016); Keupp and Gassmann (2009); Kratzer et al. (2017); Laursen and Salter (2014); Lichtenthaler (2009)
	Firm age	6	Berchicci (2013); Brunswicker and Vanhaverbeke (2015); Caputo et al. (2016); Chen et al. (2011); Hsieh et al. (2016); Keupp and Gassmann (2009)
	Type of industry	6	Cammarano et al. (2017); Caputo et al. (2016); Chang (2003); Cheng and Huizingh (2014); Faems et al. (2010); Hsieh et al. (2016)
	Country	3	Chang (2003); Gesing et al. (2015); Greco et al. (2016)
	Competitive intensity	3	Cheng and Huizingh (2014); Hsieh et al. (2016); Keupp and Gassmann (2009)
	Number of partners	2	Chang (2003); Greco et al. (2016)
	Technological and market uncertainties	2	Cheng and Huizingh (2014); Chiang and Hung (2010)

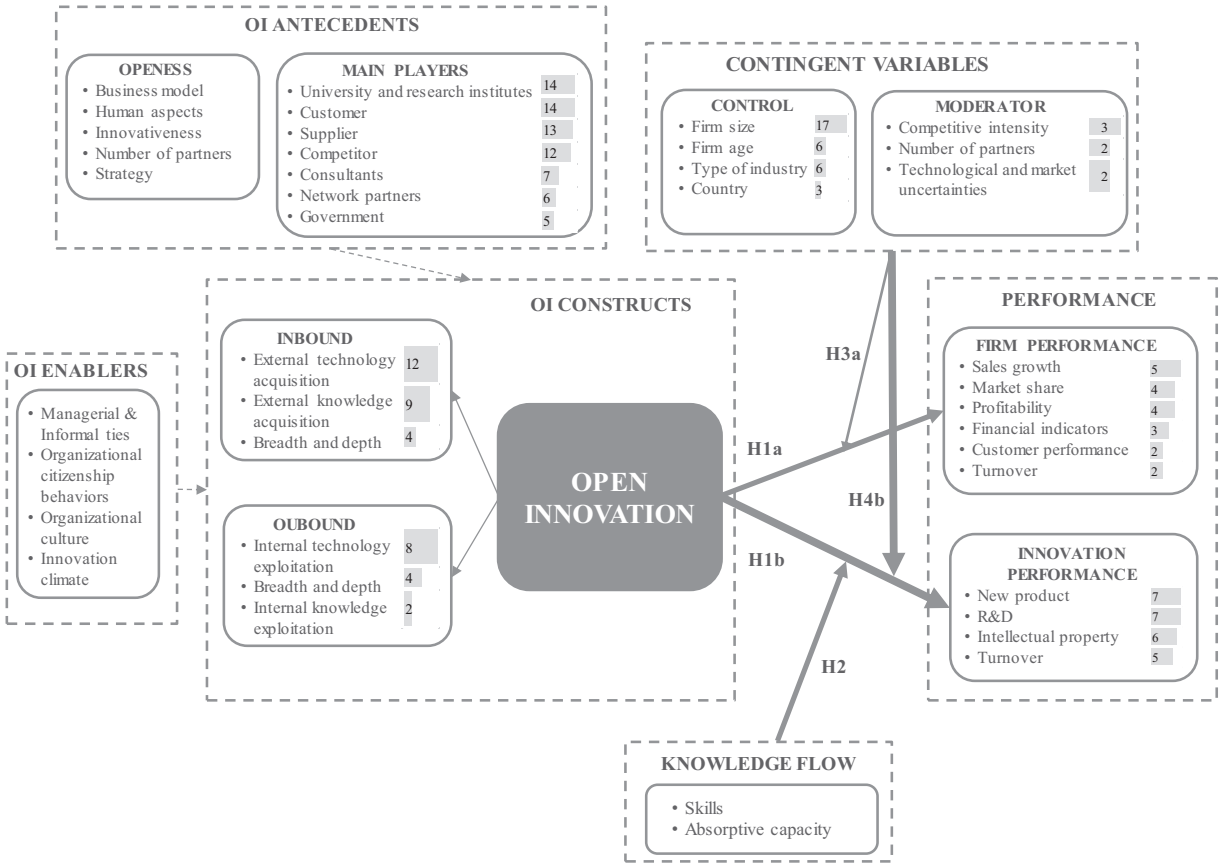

Fig. 6. Contingent conceptual model on OI performance.

4.6. Open innovation antecedents and enablers

The literature mentions some enablers related to the inbound and outbound constructs of open innovation. One of them refers to citizenship behaviors, such as altruism, conscientiousness, sportsmanship, courtesy and civic virtue, which may foster the aspects of inbound and outbound OI (Naqshbandi et al., 2016). Naqshbandi et al. (2015) researched the influence of organization culture on open innovation and concluded that a more integrative organization culture benefits inbound, while a more hierarchical organization culture delays both inbound and outbound.

Naqshbandi (2016, p. 2266) presented another enabler by analyzing the relation between managerial ties and open innovation and concluded "that managers who have associations with external parties, such as people in other firms, universities/research institutes or government bodies, help their firms in sourcing, acquiring, transforming and utilizing new knowledge thereby supporting inbound and outbound open innovation".

Similarly, Zhu et al. (2017, p. 208) researched the relation between informal ties (business, government and university) and open innovation and concluded, "all three types of informal ties positively affect inbound innovation openness, whereas only business ties facilitate outbound innovation openness." According to Popa et al. (2017), innovation climate contributes to inbound and outbound.

Researches show that a company's openness may be considered an antecedent of inbound and outbound open innovation according to innovativeness (Ahn et al., 2017; Brunswicker and Vanhaverbeke, 2015; Caputo et al., 2016; Hochleitner et al., 2016; Hung and Chiang, 2010; Kocoglu et al., 2011; Wu et al., 2013); human aspects, such as patience, voluntariness (Ahn et al., 2017), transparency, accessibility, replicability (Balka et al., 2014), and human asset specificity (Hsieh et al., 2016); strategy (Brunswicker and Vanhaverbeke, 2015; Wu et al., 2013); business model (Hung and Chiang, 2010), and number of partners (Hsieh et al., 2016).

The literature also mentions the choice of the partner as an antecedent of inbound and outbound open innovation. The main players indicated by the literature were universities and research institutes (Brunswicker and Vanhaverbeke, 2015; Cassiman and Veugelers, 2006; Chen et al., 2011; Chiang and Hung, 2010; Greco et al., 2016; Greco et al., 2017; Hochleitner et al., 2016; Laursen and Salter, 2006; Laursen and Salter, 2014; Naqshbandi, 2016; Naqshbandi et al., 2015, 2016; Rubera et al., 2016; Sisodiya et al., 2013); customer (Brunswicker and Vanhaverbeke, 2015; Chiang and Hung, 2010; Greco et al., 2016; Greco et al., 2017; Hochleitner et al., 2016; Laursen and Salter, 2006; Laursen and Salter, 2014; Naqshbandi, 2016; Naqshbandi et al., 2015, 2016; Rubera et al., 2016; Sisodiya et al., 2013; Tsai and Liao, 2011; Van de Vrande et al., 2009); supplier (Brunswicker and Vanhaverbeke, 2015; Chen et al., 2011; Chiang and Hung, 2010; Greco et al., 2016; Greco et al., 2017; Hochleitner et al., 2016; Laursen and Salter, 2006; Laursen and Salter, 2014; Naqshbandi, 2016; Naqshbandi et al., 2015, 2016; Rubera et al., 2016; Sisodiya et al., 2013); competitor (Chen et al., 2011; Chiang and Hung, 2010; Greco et al., 2016; Greco et al., 2017; Hochleitner et al., 2016; Laursen and Salter, 2006; Laursen and Salter, 2014; Naqshbandi, 2016; Naqshbandi et al., 2015, 2016; Rubera et al., 2016; Sisodiya et al., 2013); consultants (Chiang and Hung, 2010; Greco et al., 2016; Greco et al., 2017; Hochleitner et al., 2016; Laursen and Salter, 2006; Laursen and Salter, 2014; Rubera et al., 2016); network partners (Brunswicker and Vanhaverbeke, 2015; Chen et al., 2011; Hung and Chou, 2013; Rubera et al., 2016; Tsai and Liao, 2011; Van de Vrande et al., 2009); and the government (Chen et al., 2011; Chiang and Hung, 2010; Greco et al., 2016; Greco et al., 2017; Laursen and Salter, 2006).

These variables are not well established in the literature, emerging in recent articles. Therefore, it was not possible to infer on relational

hypotheses related to open innovation and performance, and further researches are needed to better explore these variables.

Based on the discussion carried out in this section, a contingent conceptual model on open innovation and performance is presented, as shown in Fig. 6. The thickness of the model's arrows represents the quantity of studies, which has already analyzed the relation presented by its respective hypothesis.

5. Conclusions

Although several works refer to open innovation as a process that allows competitive advantage, and also considering that many studies have tried to understand the whole context of the concept in the last years, many studies will still be needed to better clarify the relationship between open innovation and firm and innovation performance.

This papers contributes to the open innovation literature in four ways. First, it identifies the key variable of the open innovation construct, deploying it into inbound and outbound latent variables and its manifest variables. Second, it presents the key variables of performance, deploying them into firm and innovation latent variables and theirs manifest variables. Third, it analyzes the moderator effect of knowledge flow on the relation between open innovation and innovation performance. Finally, contingent variables (control and moderator), antecedents and enablers are identified and discussed. As a result, a contingent conceptual model on open innovation and performance was proposed.

The main managerial contribution is to show firms and their managers that efforts, investments and the effective application of the innovation model may positively influence their innovation results, as well as organizational performance. Another relevant managerial implication is that firms must work to develop their skills and absorptive capacity in the best possible way. This competence allows the results obtained through open innovation to effectively generate competitive advantage. Firms should invest time and resources to better understand their antecedents and enablers, which are still in an emerging stage in the literature, and they should also be aware of how important contingent variables are in the relation between open innovation and performance. Future researches may qualitatively explore the literature with a view to proposing new models which explain the main relations of the open innovation theory.

This study has limitations arising from its methodological choices. The first relates to the use of the ISI Web of Science database to generate the initial sample. The ISI Web of Science is a valuable database where all journals are indexed, and it facilitates the use of JCR for calculating a journal's impact factor. It was reasonable to assume that this database would be able to capture the key contributions that had been published on the subject of open innovation. On the other hand, the ISI Web of Science has a limited number of titles, so it is possible that some relevant documents were not included in the sample. Another limitation is the bias that could have resulted from the bibliometric analysis as this methodology focuses on the most cited works, as well as those which had the greatest impact on a knowledge area. In practice, the articles and the most cited references tend to be the oldest ones, thereby generating a temporal bias. However, these limitations were partially mitigated through the use of a content analysis and the “snowball” method, which are techniques that offer a more analytical and qualitative approach.

Finally, this study concludes by highlighting directions for future researches on open innovation. Literature in this area could be enhanced by future researches in the following areas: quantitative measurement of the open innovation impact on companies' organizational and innovation performance, considering contingent variables (control and moderating; identification of critical success factors related to gaining and sustaining the competitive advantage of companies that choose to open their innovation business model; analysis of key concepts of open innovation focused on SMEs, as of yet little explored in the literature; analysis of the transition from closed innovation to open innovation over time, since most studies show a picture of the current situation of each of the companies studied).

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