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The influence of open innovation on firm performance

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and Francesco Galati¹

Abstract

Innovation is crucial for growth and business development, and represents a reliable way through which to gain competitiveness within the marketplace. Open innovation is expressed through three different processes: the acquisition of external technology (inbound innovation); the external exploitation of technology (outbound innovation); and coupled innovation. Based on a comprehensive and systematic review of the literature best able to detect the main thematic areas of the research topic, the aim of this paper is to investigate how the paradigm of open innovation influences firm performance and to provide suggestions for future research avenues.

Keywords

Open innovation, firm performance, systematic review, inbound innovation, outbound innovation, coupled innovation

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1. Introduction

In economics, the term ‘innovation’ is used regularly but not often defined, despite such a concept being the cornerstone of business growth and development, and a way for companies to ensure strategic competitiveness. Until recently, it was common for companies to carry out their development processes by relying exclusively on the support of internal resources, according to a model based on the notion of ‘closed innovation’. This model considers the firm as an integrated system in which the innovation activity depends internally on research and development (R&D). As such, the company functions as its own entity, following the steps that lead to the production and marketing of its products and services.

Through the closed innovation policy, benefits are obtained when the internal R&D resources are such as to guarantee a continuous development of new products, services or technological processes; when this fails, then it is more convenient to focus on another strategy, in order to create a network that includes external actors such as research institutes, academia, start-ups and stakeholders.

In the previous decade, the scientific literature has shifted its attention from closed innovation, where knowledge and technology are developed internally by the companies themselves and the innovation processes take place exclusively within the company boundaries, to open innovation, where it is recognised that innovative ideas and knowledge flow spontaneously both internally and externally to a firm.

Indeed, the uncertainty of the markets, the complexity of innovation and the recombination of knowledge have led to greater flexibility in the organisational structures of companies and the need to interact with the external environment and stakeholders in a more open way.

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The term open innovation (OI) was first defined by the economist Chesbrough¹ to emphasise the importance of using external sources to stimulate the internal growth of a company: '[...] the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology'.² According to Chesbrough, it is no longer necessary to develop research internally to generate value; rather, companies should focus on a business model capable of exploiting and making the best use of the innovation on the market.

Nowadays, companies face ongoing challenges both internally and externally due to a competitive and ever-changing marketplace. Innovation activities have become increasingly more challenging, with leading managers employing different OI models to retain competitive advantages.³

The adopted strategies such as the acquisition of external technology and the exploitation of internal technology can greatly improve firms' innovation performance. Thus, OI can be deemed a research avenue aimed at integrating internal and external inputs for the development of novel products.⁴

To implement an OI strategy, it is necessary for companies to carry out innovation activities – the selling and purchasing of licenses and patents, and the exploitation of intellectual capacity – in order to transform the creation of value into the optimum combination of internal and external resources.

Open innovation is mainly achieved through three different modalities: the acquisition of external technology in open exploration processes (inbound innovation); the outward transfer of technology in open exploitation processes (outbound innovation); and coupled innovation.

Inbound innovation sees innovative ideas and technological knowledge entering the innovation system of a firm, which is able to access and match new external knowledge with its own internal ideas.⁵ It can be defined as the exploitation and integration of external knowledge as a way to harness, use and improve technology. Through this combination of internal ideas and external knowledge, a firm is able to create value for customers and compete within the marketplace. Inbound OI activities involve cooperation with other companies or universities, participation of R&D institutions for product development, inclusion of clients or end-users in the activities related to product development and acquisition of intellectual property rights from external organisations.⁶

Outbound innovation sees ideas and technological knowledge moving from the company in which they are located to external firms as a way to obtain economic returns. In other words, there is an exploitation of internal knowledge by the stakeholders. These activities involve

company participation in new initiatives deriving from previously developed products or from the development of technologies and products through an external contribution. Examples include the granting of licences, the sale of patents or the multiplication of technology by directing ideas or knowledge to the external technology market.^{7,8} Regarding patent activities, empirical results demonstrate that innovation behaviours measured by patenting are positively correlated with firm performance.⁹

Coupled innovation sees the joint application of both inbound and outbound OI activities. In other words, in order to bring new ideas to the market, firms develop and commercialise innovation at the same time. In general, firms pursue coupled OI activities when they are involved in different interactions with other firms. These relationships can refer, for example, to a cooperative R&D model that aims to acquire and provide complementary knowledge.¹⁰

Each one of these OI practices can be considered more or less open. Therefore, when managing OI practices, it is important to recognise that these are multi-dimensional structures.¹¹

Due to a highly competitive marketplace, innovation processes become more open when companies need to become more competitive,¹² with firms often being forced to strengthen their innovation efforts¹³ at significant financial cost.

Most of the literature has revealed the positive effect that a firm's application of OI activities has on its innovation performance. Indeed, an increase in the interactions a company has with other organisations generates greater access to new ideas, skills, technologies and other intangible assets, as well as enhanced possibilities to innovate with success.

An interesting research avenue would be to explore the effects of the dimensions of OI on firm performance¹⁴ and internal R&D, and to examine the impacts of environmental instability on the interactions between the different types of OI and firm performance.¹⁵

The influence of OI activities on firm performance has been extensively analysed by the scientific literature; in particular, the involvement of innovation performance on the cost-benefit ratio of R&D,¹⁶ the acquisition of patents and the protection of intellectual property,¹⁷ the relation between appropriability and openness on efficiency and novelty,¹⁸ and the impact on the realisation of new types of products^{19,20} or on financial performance.²¹

Detecting the main variables and elements influencing OI and firm performance is still a challenge for research. It is useful to understand the activities and processes that enable OI by taking into consideration different aspects that entail the strategies related to knowledge management²² and the role of human resources.²³ It is also relevant to analyse the effects of OI on firms with regard to organisational performance,^{24,25} innovation performance²⁶ and the efficiency of OI – still underexplored in the literature²⁷ – as

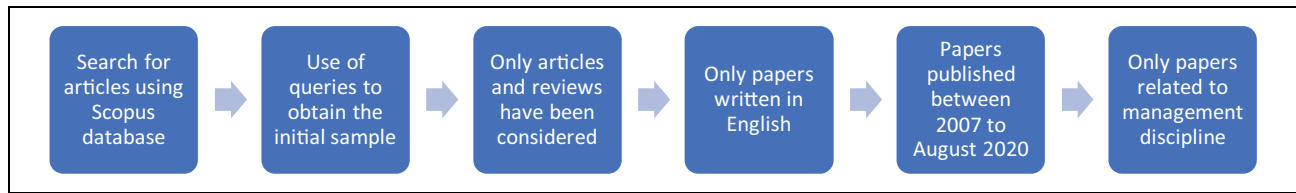


Figure 1. The methodology used for the systematic review of the literature.

well as the way to measure the effect of OI on firm performance.^{28,29}

Despite a number of existing studies addressing similar arguments,^{30–33} the aim of this paper is as follows: (i) to investigate how the OI paradigm affects firm performance, both generally and by means of a comprehensive and systematic review of such studies providing the most unique insights into the topic; (ii) to identify the main thematic areas; and (iii) provide suggestions for future research avenues.

The study analyses a corpus of articles published between 2007 and August 2020, and identifies the five most relevant trends with respect to the general research topic. This is intended to provide researchers and practitioners with a meaningful overview of the body of knowledge and an indication of future research opportunities.

The paper is organised as follows: section 2 describes and explains the proposed methodology; section 3 analyses the obtained results; section 4 provides an overview of the identified research trend; and section 5 outlines the conclusions and offers suggestions for further development.

2. The proposed methodology

The decision to perform a systematic review of the literature on OI and its effects on firm performance – a process involving a detailed and comprehensive search strategy derived a priori with the aim of identifying, appraising and synthesising all relevant studies – was justified by the need to use a rigorous, replicable structure and transparent procedures for each phase of the process carried out.^{34,35} In order to address the limitations of traditional reviews, the systematic review was performed by applying different methodologies, including bibliometrics, content analysis and meta-analysis.³⁶ Adhering to the principles of the systematic review allowed us to limit possible errors, reduce random effects, strengthen the legitimacy and authority of the resulting evidence, and provide more reliable results on which to draw conclusions and make decisions.

In this paper, bibliometrics and content analysis were used to identify the most relevant scientific contributions; the related contents are presented and discussed here in a descriptive way.

The use of bibliometrics allowed us to observe the presence of patterns in the scientific literature, to identify the journals that have published most of the papers on the subject and to observe how the publications have evolved

over time.³⁷ In order to gain a more in-depth understanding of the literature, a content analysis was also performed; a process that included the complete reading of selected articles, as well as the detection of definitions and other relevant information.³⁸ The bibliometric and content analysis has allowed us to provide insights not fully understood or previously evaluated by other reviews on the topic of our research.

2.1. Database and inclusion criteria

It is important to remark that two steps are particularly crucial when conducting a systematic review: to set the inclusion criteria and to identify the strategy for selecting potential sources.

The database used to obtain the sample was Scopus: a comprehensive scientific, technical and social science database containing all relevant scientific literature, and one that offers a comprehensive suite of metrics.

The adopted strategy to search and select the articles included in the review required the definition of specific queries to be inserted into the identified database. Specifically, the following queries were entered: (TITLE-ABS-KEY ('open innovation') AND TITLE-ABS-KEY ('firm performance')) AND (LIMIT-TO (DOCTYPE, 'ar') OR LIMIT-TO (DOCTYPE, 'ip') OR LIMIT-TO (DOCTYPE, 're')) AND (LIMIT-TO (LANGUAGE, 'English')) AND (LIMIT-TO (SRCTYPE, 'j')).

Only articles and reviews were considered because they contain the necessary data for bibliometric analysis such as authors' name, abstract, keywords, journal, etc.

Considering the number of articles per year and then the publications divided by journal and year, a bibliometric indicator allowed us to identify the journals that had been more involved in the research subject as well as the evolution of the literature over time.

Figure 1 shows the methodology used for the systematic review. We decided to adopt some inclusion criteria to refine the sample:

- Only articles and reviews;
- Only papers written in English;
- Only articles and reviews published between 2007 and August 2020.

Due to the fact that the study of OI and firm performance has involved many different research fields, it was necessary to restrict the field of interest only to the management

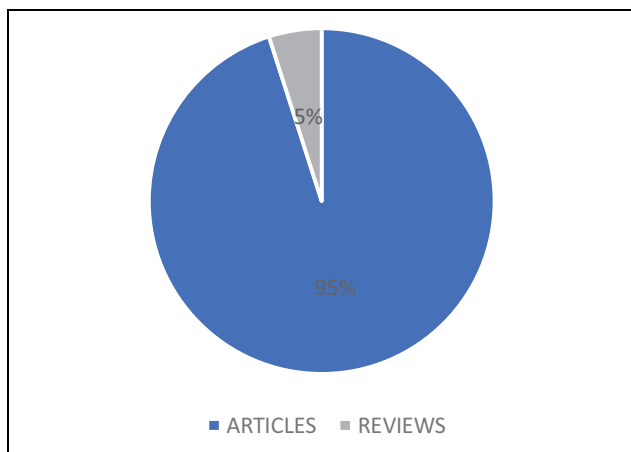


Figure 2. Types of sources.

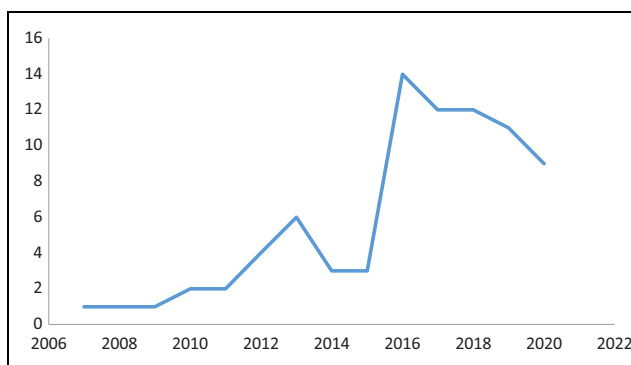


Figure 3. The publication trend.

discipline in order to make the analysis more uniform, homogeneous and consistent.

Following the application of all inclusion criteria, a sample of 81 contributions was obtained. All articles were classified according to different criteria: document type, year, journal, keywords. The analysis of the complete list of these elements is reported in the next section.

Afterwards, the content analysis was carried out. The reviewed articles were studied individually using the text reading. This procedure allowed us to identify five main research trends, detailed in section 4.

3. The review results

In this section, we summarise the articles taken into consideration for this review, clustering them into different classes.

Figure 2 shows the classification of the sources examined by document type. We selected 77 articles and 4 reviews.

The analysis of the publication trend shows that OI and firm performance is a research topic of relatively recent interest. As reported in Figure 3, most publications were released in 2016, with 14 articles, before slightly

decreasing to 12 publications per year in 2017 and 2018, and 11 publications in 2019. This decreasing trend has continued into 2020, with 9 publications released as at August 2020.

There are 16 scientific journals dealing with OI related to firm performance, with at least 2 publications being scientific papers. *Management Decision* and *Technological Forecasting and Social Change* gave the topic the most interest. Figure 4 reports the sources by journals.

An analysis was carried out to identify the words that appear most frequently among the keywords of the selected sources. As reported in Figure 5, the most frequent keywords reported by authors is 'Open innovation' followed by 'Innovation' and 'Firm performance', then 'Industrial performance', 'Innovation performance', 'Absorptive capacity', 'Inbound OI', 'Knowledge', 'External knowledge', 'Outbound OI', 'Research and development' and 'SMEs' (small and medium-sized enterprises). Certain words only appeared twice, such as 'Open innovation strategy' and 'Descriptive performance'.

4. Overview of the analysed trends

After identifying the sources, all articles were studied individually using the text reading. We recognised five macro trends that currently attract the attention of the researchers: organisation, technologies, human resources, strategies, and performance. The identification of the research trends depends on the personal judgement of the authors through the content analysis of the selected publications. This process involved identifying and extracting the most relevant contributions and allowed the authors to present them in a coherent form and to express the results of the literature review in a reasonable and clear way.

In the following subsections, we examine the main contributions relating to the identified research trends.

4.1. Organisation

Many companies are still reluctant to implement OI practices.^{39,40} Indeed, organisational culture, the absence of internal commitment and staff resistance have a significant impact on the adoption of OI activities,^{11,41} creating a potential barrier to its realisation.

Even organisational antecedents and the climate of innovation have a certain influence on OI, as well as on firm performance. Popa et al.⁴² analyse the roles played by environmental dynamisms and competitiveness in the relations between the climate of innovation and incoming and outgoing OI. Results from over 400 Spanish SMEs revealed that organisational factors – such as commitment from human resources – have a positive effect on the innovation climate, which greatly contributes to incoming and outgoing OI. It was also found that contingent factors such as environmental dynamism reinforce the positive effect of the innovation climate on outbound OI.

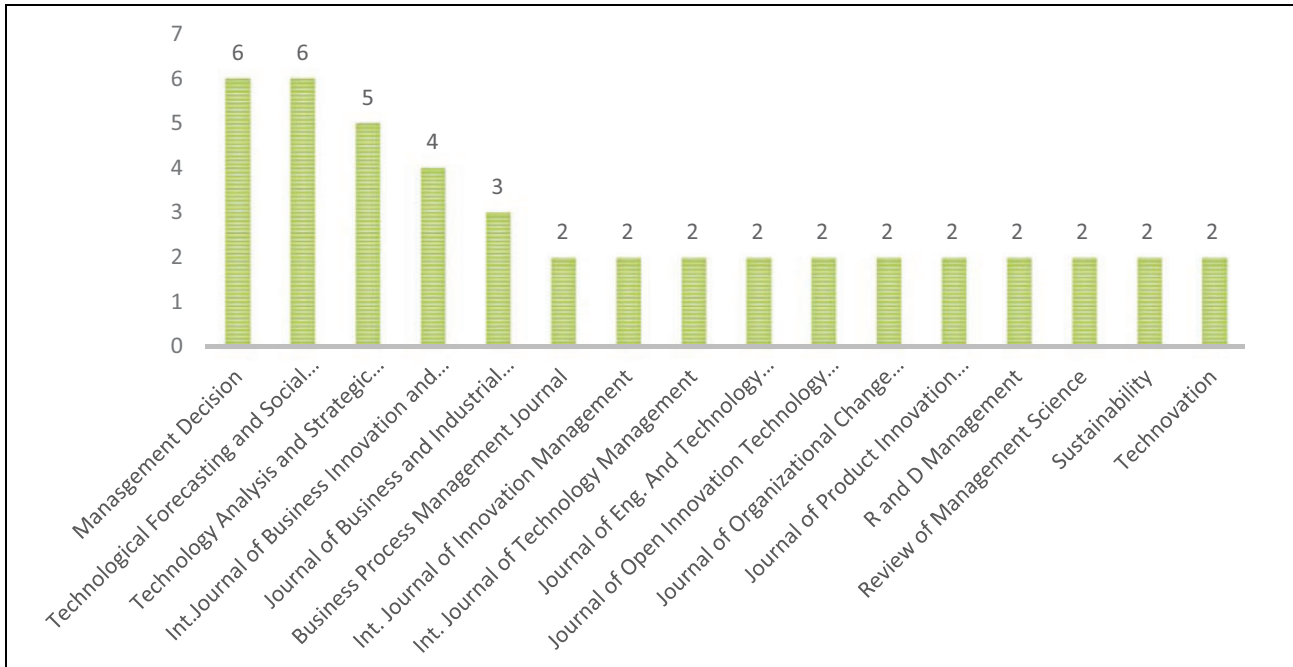


Figure 4. The sources divided by journals.

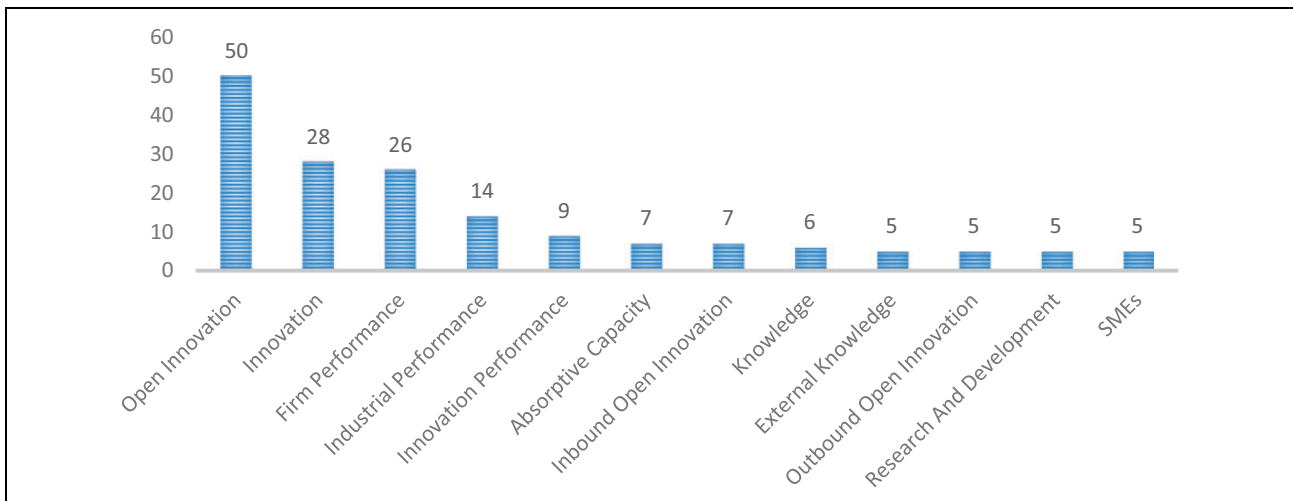


Figure 5. Keywords distribution used in the various sources.

Rehman et al.⁴³ develop a framework for enhancing the organisational capacity for outsourcing innovation, allowing firms to take advantage of its benefits such as reduced costs, improved flexibility and access to better expertise, all the while reducing risks.

4.2. Technologies

To remain competitive in the marketplace, companies are often pushed towards accelerated automation. This process leads to the conversion of value chains into intelligent data-driven systems. Companies therefore pay more attention to the acquisition, integration and improvement of external

technologies to garner greater profit from new forms of development. For this reason, companies sometimes have no choice but to introduce external flows of knowledge into their production processes as a way to increase effective innovation. This behaviour leads to a decrease in internal research; a price paid by those companies accessing the OI paradigm. Considering internal knowledge, Nylund et al.⁴⁴ shed light on the moderating role of OI processes on the economic results of companies subject to automation. On the other hand, some authors⁴⁵ confirm the positive influence of OI on supply chain competence and on firm performance.

Research on information systems has revealed the crucial role played by information technology (IT) in firm

innovation, revealing that access and integration of knowledge from sources outside the company – such as clients, competitors or research centres – is fundamental for the innovative success of businesses. Trantopoulos et al.⁴⁶ consider the knowledge-based vision of a company in order to study how research from external knowledge sources and IT for knowledge absorption influence the innovation performance. Data access systems and network relationships play a crucial role in attracting external knowledge. This is also reflected in the revenues deriving from the innovation applied to firms' processes. From the analysis carried out, it emerges that companies should be able to coordinate their strategies for acquiring external knowledge through specific investments in IT in order to improve their innovative processes.

Some empirical studies on Chinese high-tech companies demonstrate that technological aptitude increases the impact of incoming OI on firm performance. However, the relative influence of technological aptitude on the relationship between outbound OI and firm performance is still unconfirmed. A greater technological aptitude together with experienced management of market information enhances the effects of outbound OI. According to some authors,⁴⁷ when firms implement incoming innovation activities and have solid technological competence, they will obtain higher results if a reasonable level of management skills related to market information is maintained.

4.3. Human resources

The commitment and motivation of human resources with respect to innovation behaviours play an important role in the relationship between OI and firm performance.³⁰ Such a relationship is analysed by Zhang et al.⁴⁸ Their findings show that in most cases, a high level of employee education leads to an increase in the positive effect of OI. However, the authors reveal that in production-oriented companies, this does not always happen. In technology-oriented companies, as the ratio between technical and production staff increases, the financial performance of the company increases due to the implementation of an OI approach; while in companies more oriented in production activities, this event does not occur.

Ahn⁴⁹ considers the strategic aspects of OI and the responsibility of the chief executive officer for its implementation. The author affirms that openness influences firm performance, and that the characteristics of the chief executive officer positively relate to openness. Other authors⁵⁰ believe there are two factors that influence the potential for collaborative innovation, thus resulting in improved firm performance: (i) the ability to create important innovation results that are influenced by the inputs of external firms and the developments involved; and (ii) the collaborations resulting in crucial innovations (which will improve the firm's performance based on its capacity to combine and exploit these results in its performance).

Regarding the role of social relations and networks in OI contexts, some authors⁵¹ offer a model that considers social capital as a facilitator between the implementation of OI tools and firm performance. The authors state that the use of OI tools improves the social capital of an organisation; a notion that clearly relates to firm performance.

Focusing on firms in Tasmania, Corral de Zubielqui et al.⁵² examine how outside knowledge flows from market players sourced by social media affect innovation and firm performance, and the extent to which human resources management practices mitigate this relationship.

4.4. Strategies

One of the main trends in the literature on the impact of the OI approach on firm performance concerns the study of the possible strategies that companies can implement in order to make the most use of the OI paradigm.^{53–56}

The relationships between inbound and outbound OI strategies and the innovative and economic performance of the Turkish food and beverage industry are analysed by Seyfettinoğlu.⁵⁷ The author affirms that OI strategy – together with the innovation that arises from idea generation – is one of the factors with the greatest positive impact on the level of innovativeness.

Apparently, OI strategies have diverse effects at different times. Some authors⁵⁸ affirm that incoming OI negatively influences firm performance in the short term but this trend is inverted in the medium and long run. Hence, firms should retain a reasonable level of OI and improve the degree of outbound OI to increase their performance in the long run.

Na et al.⁵⁹ affirm that firms have to foster their innovation strategy by taking into account the role of their customers. In terms of OI behaviour, companies should create a network of relationships with academies, other firms and users. The implemented strategy can consider exploitation and/or exploration approaches and identify its consequences on firm performance. Oguguo et al.⁶⁰ observe how the role of national institutions impacts the benefits a firm may derive from R&D collaboration.

Observing the innovation activities of service companies in Indonesia, Yunus⁶¹ focuses on the strategies that such companies pursue by contrasting closed versus open innovation models and by exploring the impact of innovation strategies on innovativeness and the influence of a strong innovation capacity on firm performance. The outcome of the research shows a change in the firms' strategies towards OI due to the growing use of external innovation sources and outward collaborations, resulting in a positive effect on firm performance. This effect is also confirmed by the intensification of vertical collaboration – in particular, with suppliers and customers – and the growth of knowledge-intensive collaboration, especially with university and research centres.

A strategy to access OI is the use of social media.⁶² Firms can use social media to gather information on customer needs and unknown technological solutions. Roberts et al.⁶³ indicate that utilisation of information from social media channels can lead to higher firm performance, though this activity is influenced by the formalisation of new product development processes. The authors observe that the ability of a company to benefit from external search in social media depends on its internal practices. Managers need to be cautious when collecting information from social media, especially for crucial projects, since such information could be somewhat minimal in terms of its contribution.

Some authors study the framework in which OI activities are applied, taking into account the development processes of novel products.⁶⁴ Two different OI practices are considered: the first occurs in the development phase, and the second arises in the marketing phase. The research findings indicate the need to differentiate the OI activities according to the role played by new product development capabilities in influencing such practices. Cruz-González et al.⁶⁵ focus their research on breadth and depth as two different open search strategies and affirm that, in addition to their diverse benefits in terms of learning and innovation, it is also relevant to consider their costs. The authors demonstrate that the effect of these two open search approaches on firm performance depends on the dynamism of the technological environment in a reverse way. While search breadth is positively related with performance in low technological environments, it seems to decrease firm performance in more dynamic situations. On the other hand, search depth has a positive influence on performance in high-tech dynamic contexts, while it seems to damage firm performance in stable conditions.

Studying the relations between a firm's strategy, OI and innovation performance, Crema et al.⁶⁶ explore the effect of firm strategy on the level of openness adopted and the impact of OI on firm performance. Findings underline that firms pursuing an innovative strategy are those who invest more in technical skills and core competencies. Firms that follow a diversification strategy are expected to use management practices of OI, while firms concentrated on a strategy of efficiency are more prone towards OI activities and less towards improving core capabilities.

Regarding the strategies that refer to intellectual property assets, Sun et al.⁶⁷ affirm that the effects of OI strategies on firm performance are related to intellectual property enforcement and to intermediation market development that may enable or limit the influence of OI. Hung and Chiang⁶⁸ propose a measure that considers the OI proclivity of a company, i.e. the tendency of a firm to use outside knowledge to match its business model in order to gain benefits from selling its intellectual property assets. Bhas-karabhatla and Hegde⁶⁹ show that intra-organisational forces such as financial pressures and new leadership shape

a firm's commitment to, and potential success of, patent management practices. According to the authors, a strategy that considers the protection of intellectual property through the use of patents associated with the adoption of OI practices could be able to stem the free flow of knowledge beyond the borders of the organisation. In terms of the role played by licensing activities in firm performance, some authors³³ state that, due to interdependencies with product development activities in a company, it is not useful to manage licensing as a standalone business. In its place, integrated approaches help firms to overcome managerial bottlenecks and benefit from OI. Such findings have important implications for both management and research on technology exploitation, licensing, OI and technology markets.

Wu et al.⁷⁰ consider external openness as a search for outside knowledge that can be used to innovate, and internal openness as open knowledge within a company. The influence of openness with respect to value creation is strongly influenced by the firm's capacity to innovate, which involves intrinsic characteristics of the knowledge assets, absorptive capacity and entrepreneurial positioning. In most cases, the process of transforming innovative ideas into positive performance depends on the innovation capabilities of companies. Some firms are able to benefit from the effects of external technology transfer while others encounter various difficulties. To overcome these management challenges, companies should implement strategic planning processes that consider the growing importance of commercialised external technology. Two tools can help firms to combine external technology exploitation with internal technology planning. The first is a product-technology roadmap that should include the external technology development; the second concerns the concept of the functional market, which moves from the vision of product markets to that of technological markets.¹²

In deciding whether to keep or sell knowledge, i.e. whether to market knowledge resources externally or to exploit them within the organisation, potential conflicts can arise. It is therefore necessary for companies to reach a decision that provides strategic adaptation of the decisions taken. Lichtenthaler⁷¹ investigates how firms can react to potential conflicts when deciding whether to keep or sell by achieving strategic fit. Due to the high opportunities and threats of outwardly developing knowledge, the decision to keep or sell represents one of the main areas of conflict between strategies at different levels; in particular, innovation versus production strategies, business strategies versus business units and R&D versus marketing strategies.

The influence of OI on strategy, and consequently on firm performance, is also analysed by Reed et al.⁷² The authors detect the break points between the benefits of OI and the costs related to the loss of innovation skills, taking into account the impact on these effects on intellectual property assets.

4.5. Performance

Several authors study how OI can influence firm performance.^{31,32,73–80} However, from an in-depth analysis of the sources, we have identified some sub-themes within the ‘performance’ macro trend in which the attention of the literature is concentrated, such as the influence of external knowledge on firm performance, the influence of outbound innovation activities and empirical analyses of SMEs.

The influence of external knowledge. Studying the impact of incoming knowledge on firm performance, Moretti and Biancardi⁸¹ identify three dimensions: economic performance (indicated as the amount of firm turnover); firm financial performance (measured as the value of shares); and human resource performance (quantified as the level of employment). Their findings indicate that the effects of internal knowledge development and outward acquisition are positive within the different dimensions, but their outputs change in terms of extent and distribution. In particular, both variables are positively and meaningfully related to the economic performance.

Analysing the relationship among customer knowledge management, incoming OI and firm performance, Wen et al.⁸² affirm that customer knowledge management has a positive influence on firm performance, and identify the three elements of the OI process: resource acquisition, resource integration, and the interaction mechanism. Resource acquisition and the interaction mechanism have a limited role in interceding between customer knowledge management and firm performance, while resource integration has a greater influence on firm performance.

Wang⁸³ posits that in the case of research centres, the increase in the occurrence of incoming OI is essential for generating efficiency and high performance.

Oltra et al.⁸⁴ analyse 244 low and medium technology Spanish companies, revealing that incoming OI activities, which involve cooperation with partners in an R&D environment, have an encouraging influence on firm performance. Even the outbound activities, either through the revenues of licence payments or through indirect marketing, have a positive influence on firm performance. Coupled activities, which concern the participation in innovation districts and networks, have a great effect on firm performance. In the observed industrial environment, decentralisation generates a positive effect that increases the influence of outbound activities, while formalisation practices reduce their positive influence.

Wang et al.⁸⁵ analyse how the acquisition of external knowledge resources impacts a firm’s innovation positioning as well as its performance. The authors affirm the importance of knowledge scouting as a precursor of possible alliances characterised by horizontal and vertical knowledge acquisitions. Based on a large-scale survey of high-tech firms, the authors find that the capabilities to

build external relations enhance the efficacy of incoming OI in reaching greater results.

A successful acquisition of external technological knowledge also depends on the company’s technology and market orientation. Lichtenthaler⁸⁶ develops a conceptual framework with propositions relating to technology orientation, receptive market orientation and proactive market orientation with respect to the absorptive capacity of a firm.

According to Vrontis et al.,⁸⁷ the effect of external knowledge sourcing is positively enhanced in cases of organisational ambidexterity in knowledge-intensive firms.

Analysing the direct and interactive influence of outward knowledge acquisition and external technology exploitation on firm performance, Hung and Chou¹⁵ focus on 176 high-tech manufacturing firms in Taiwan. The authors affirm that external technology acquisition positively influences firm performance, while external technology exploitation does not, instead intensifying the relationship between external technology exploitation and firm performance. Both outside knowledge acquisition and external technology exploitation are positively related to firm performance in cases of high internal R&D investment and a turbulent market environment. Sisodiya et al.⁸⁸ recognise the key elements that allow inbound OI and enhance its efficacy in a business context. Since OI relies on external connections, and in particular on the firm’s capacity to create and manage relationships with other companies, these relationships should improve the effects of incoming OI on firm performance. The firm’s capacity to build relationships with other companies in an environment characterised by knowledge richness, as well as its flexibility in terms of responsiveness and adaptability, increases the effects of inbound OI.

Despite observations that an excessive use of outward research and different external innovation channels can reduce the marginal returns of OI,⁸⁹ when a company combines the internal patents and the resources deriving from the sale of new products with the inputs collected through external knowledge in the most profitable way, it obtains better efficiency and an increase in revenues.⁹⁰ This combination increases the effectiveness of the company’s new product resource bases; a process that decreases or maybe even eliminates the need to maintain extensive and costly internal R&D activities.

The influence of outbound knowledge. Considering the relationship between outbound OI and firm performance, Lichtenthaler⁹¹ affirms that the former may have either a positive or negative effect on the latter based on possible benefits and the threats of technology transfer. How these effects occur differs from internal factors, i.e. absorptive capacity, external factors and appropriability behaviour. So, an efficient management of outbound OI is important to avoid potential threats and to capture the achievable benefits.

It should be noted that external technology commercialisation can sometimes reduce a firm's competitive advantages due to the disclosure of internal knowledge or the inefficient exploitation of its internal R&D resources. These occurrences can negatively affect firm performance.⁹²

Choi⁹³ states that an internal knowledge-oriented innovation attitude has a positive influence on firm performance. On the other hand, an external knowledge-oriented innovation attitude has a positive effect on innovation performance only for large firms, lacking any real influence on SMEs' innovation performance.

Ahn et al.⁹⁴ assert the important role of managers in the adoption and implementation of OI practices. Authors compare the levels of openness of different firms active in various sectors in order to determine similar behaviours and differences with respect to the OI approach. The analysis of data acquired from a survey of Korean companies indicates important relations among openness, OI abilities and firm performance. The authors reveal that desorptive capacity, i.e. the ability to release knowledge and technology (which supports the outbound OI activities), should be strongly sustained by knowledge management capacity.

Empirical analysis of SMEs. Analysing SMEs in the South Korean manufacturing sector, Yun et al.⁹⁵ reveal that the use of OI increases firm performance, with R&D investments of SMEs in such a sector having had a remarkable effect on performance in the short term and on OI activities. In the medium and long term, these effects are significantly reduced.

Focusing on SMEs in the healthcare IT sector, Kim and Kim⁹⁶ believe that firms need to have innovative technology and should be able to commercialise technology for sustainable growth. Some SMEs collaborate with other companies in the production process, as an OI system; however, this collaboration is sometimes difficult and involves certain risks. In this context, it is important that SMEs develop high-quality patents and cooperation strategies with external companies to improve their innovation performance. Hernandez-Vivanco et al.⁹⁷ examine 220 Spanish companies and investigate the role of OI and innovation management systems in pursuing innovation efficiency. The relationship between innovation efficiency and firm performance is studied from the point of view of innovative sales productivity.

Ramirez-Portilla et al.⁹⁸ analyse data from 48 specialised SMEs involved in manufacturing supercars. They affirm that the adoption of OI models and practices tends to increase firm innovativeness and improve the performance of SMEs. Specifically, it was found that OI intensely affects two dimensions of performance: environmental and social performance. Kim et al.⁹⁹ focus on the causes of OI activity in the IT manufacturing industry in Korea. The authors offer a novel OI framework by adopting a knowledge-flow standpoint by means of patent citation data.

Based on a survey of Malaysian high-tech SMEs, Hameed and Naveed¹⁰⁰ reveal that cooperation enhances a firm's OI performance. Huang et al.¹⁰¹ analyse 141 manufacturing SMEs in Taiwan and assess how OI practices can influence possible changes in case of organisation inertia, as well as the ways in which they are able to stimulate the generation of new business models

The impact of higher education institutions in a distributed OI system is studied by Howells et al.^{102,103} who observe the phenomenon by means of a survey of 600 firms in United Kingdom, followed by a survey of 400 firms.

The role of openness. Openness is a crucial prerequisite for innovation.¹⁰⁴ Analysing the dynamic relations between openness and firm performance (with particular consideration of the 2008 financial crisis), Ahn et al.¹⁰⁵ affirm the positive influence of openness on firm performance in the long run. Indeed, an increase in openness enhances the firm dynamic capability and its resilience. Furthermore, an increase of collaborations with other firms has a strong influence on turnover recovery, as collaborations with new partners improve the aptitude to changes and increase the acquisition of novel knowledge.

According to other authors, the performance of a company is the result of complex relationships. Analysing Indonesian SMEs, Pratonono¹⁰⁶ demonstrates that companies with a large network of relationships may have difficulties in benefiting from the flow of knowledge between network partners, since it is necessary to develop trust with all said partners to overcome any opportunistic behaviour.

Caputo et al.²⁴ study the relations between the openness of firms and their innovation and financial performances. For the former, the ratio between R&D productivity and revenues to patents decreases with high openness, while it seems that patent growth is not affected by the implementation of OI activities. For the latter, sales growth shows a positive trend with respect to openness, while operating profit and turnover decrease with the adoption of OI practices.

Closed versus open innovation practices. Ahmed et al.¹⁰⁷ claim that closed innovation practices would also play an important role in improving the performance of small and medium hospitals in India. Their research conceptualised a model based on principles of closed and open innovation that could be used to enhance the performance of such hospitals. Bae and Chang¹⁰⁸ investigate the differences between closed and open innovation in terms of firm performance in Korean manufacturing companies.

Inbound versus outbound innovation. It seems that both inbound and outbound OI have a positive influence on firm development. Zhang et al.¹⁰⁹ observe that both environment competitiveness and environment munificence weaken the relationship between inbound OI and firm growth.

Analysing the influence of inbound, outbound and coupled OI practices on firm performance in the biopharmaceutical industry, Mazzola et al.¹¹⁰ consider the effect of specific OI activities on innovation and on economic and financial outcomes.

Absorptive capacity. Lichtenthaler¹¹¹ adopts a knowledge-based view to offer an integrative framework for the performance results of absorptive capability. The relation among firms' absorptive capacity and networking, OI and firm performance is deeply analysed by Agramunt et al.¹¹² De Zubielqui et al.¹¹³ affirm that the entry of external knowledge from market actors and academia influence firms' innovation in different ways: external knowledge inflows from market actors positively and directly affect firms' innovation, while external knowledge inflows from academia affects firms' innovation indirectly through absorptive capacity. The relation between absorptive capacity and OI and their impact on firm performance is also studied by Rangus et al.¹¹⁴

5. Conclusions, limitations and future directions

The issue of OI with respect to firm performance continues to garner interest within the scientific literature, as evidenced by the trend of publications, especially in recent years. The performed review shows the presence of five macro trends that currently attract the attention of researchers, namely: organisation, technologies, human resources, strategies, and performance.

From the various papers analysed, it emerges that the use of OI has, in general, a positive influence on firm performance, should companies have the capacity to enact it.

In terms of inbound innovation, it will be crucial for firms to refine their ability to manage relations with the companies from which they acquire technology and to define a strategic plan to combine internal knowledge with those acquired in order to avoid inefficiencies. As for outbound innovation, to achieve the best impact in terms of benefits, firms need to critically consider their absorptive capacity and implement an efficient intellectual property protection strategy in order to avoid potential risks deriving from the outward transfer of technology. Regarding coupled OI, companies can benefit, not only by acquiring knowledge, but also by collaborating with other organisations. Such collaborations can foster the exchange of knowledge and reduce technological inefficiencies. Furthermore, the development of shared innovation among different partners leveraging the capabilities of all can generate an increase in returns for all partners. However, it is necessary to consider that maintaining many collaboration channels involves additional costs and requires expenses to support coordination activities, causing a decrease in innovation returns. Indeed, the development of shared innovation involves high efforts to protect the intellectual property

and knowledge of the instigating company in order to prevent opportunistic behaviours.

A firm that intends to adopt OI practices must take into account the risks deriving from an openness towards external knowledge and technologies, and consider the costs it will have to incur not only to exploit incoming technologies but also to protect itself from threats.

The implementation of OI models involves some hazards for a company; in particular, the possibility of revealing internal knowledge that the company does not intend to share, the danger of potential knowledge leakage and the knowledge appropriability for the strategic resources.

A company that intends to adopt OI behaviours must be able to cope with these drawbacks to avoid the possible loss of a competitive advantage (for example, from disclosing its patent-protected assets) and must be capable to modify its strategies in order to realign its innovation policies to maximise the returns from incoming innovation.

It is also essential that companies increase their absorptive capacity – i.e. the ability to not only discover and absorb external knowledge but to acquire it and distribute it internally – in order to transform and make the best use of the outward knowledge.

Companies must also be able to develop an adoptive capacity that includes awareness of the opportunities offered by the market, and the ability to rapidly implement marketing policies to respond to these new opportunities and increase the speed in responsiveness.

On the other hand, notwithstanding these potential threats, under the right conditions, OI can bring significant benefits to a company and offer the significant advantage of increasing its performance. Open innovation boosts knowledge flow and can be seen as a vehicle for generating new patents and fostering the development of new products, services and markets. Additionally, it can support a more efficient use of the underutilised resources for improving firm performance.

Although various papers claim that OI as a process can enhance firm performance and competitive advantage, we believe that there is still scope for further research to better define the relationship between OI and firm performance. In particular, it could be interesting to find adequate measures to obtain more information on the implications linked to firm performance with respect to the use of OI practices. We refer to the use of indicators relating to: the management of intellectual property (i.e. the number of patent acquisitions); the amount of the budget devolved to R&D and specialised training for internal staff; the level of openness and attitude to change; the use of acquiring knowledge of best practices; risk tolerance in case of failure; and the management system to monitor and manage novel ideas in a structured approach.

Future research could also consider organisational antecedents that enable companies to pursue OI with a greater chance of success. Successful implementation of OI practices requires companies to use dedicated resources and

special skills to better address the risks associated with these activities. Furthermore, it could be interesting to deepen the analysis of the existing literature through the use of additional statistics that refer to the number and evolution of citations and to represent and comment on the network of citations of the leading articles.

The analysis of the quantitative measurement of the influence of OI on the organisational and innovative performance of companies could be further investigated by identifying the critical factors linked to the achievement and maintenance of the competitive advantage of companies that choose to open their own innovation business model. Another topic that deserves to be explored is the analysis of the transition from closed innovation to OI over time, since most studies only present a limited snapshot of the current situation of companies.

Our contribution through this paper is to inform companies and managers that investments and application of innovation models can significantly influence the effects of OI on firm performance. Companies should make efforts to improve their absorptive ability since this aptitude allows for results acquired through OI to generate competitive benefit.

In terms of the limitations of our research, these derive from the choice to adopt inclusion criteria to select the sample of articles taken into consideration in this review. Since articles published in non-peer-reviewed journals, books and papers written in languages other than English have not included, it is possible that other relevant contributions have been omitted. Furthermore, our analysis is based on the recurrence of keywords; an alternative methodology to map the contributions could have generated a slightly different grouping of elements. The collected data could be selected differently and be filtered in such a way as to be able to obtain more related information. Additionally, it must be considered that in these processes there is always a high degree of subjectivity. Further studies can use multiple databases to search and compare more accurate data. However, these limitations are somewhat mitigated through the use of a content analysis, which allows for a more analytical and qualitative approach.

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References

- Chesbrough H. *Open innovation: the new imperative for creating and profiting from technology*. Boston, MA: Harvard Business Press, 2003.
- Chesbrough H, Vanhaverbeke W and West J. *Open innovation: researching a new paradigm*. Oxford: Oxford University Press, 2006.
- Tsou HT and Hsu HY. e-Service innovation within open innovation networks. *World Acad Sci Eng Technol Int J Eco Manag Eng* 2011; 5(1): 31–35.
- Bigliardi B, Ferraro G, Filippelli S, et al. The past, present and future of open innovation. *Eur J Innov Manag* 2020. DOI: 10.1108/EJIM-10-2019-0296.
- Martini A, Aloini D and Neirotti P. Degree of openness and performance in the search for innovation. *Int J Eng Bus Manag* 2012; 4(37): 1–15.
- Parida V, Westerberg M and Frishammar J. Inbound open innovation activities in high-tech SMEs: the impact on innovation performance. *J Small Bus Manag* 2012; 50(2): 283–309.
- Lichtenthaler U. Outbound open innovation and its effect on firm performance: examining environmental influences. *R&D Manag* 2009; 39(4): 317–330.
- Arora A and Fosfuri A. Licensing the market for technology. *J Econ Behav Organ* 2003; 52(2): 277–295.
- Kazuyuki M. Innovation and entrepreneurship: a first look at the linkage data of Japanese patent and enterprise census. *Seoul J Eco* 2016; 29(1): 69–94.
- Mazzola E, Bruccoleri M and Perrone G. The effect of inbound, outbound and coupled innovation on performance. *Int J Innov Manag* 2012; 16(6): 1240008 (27 pages).
- Huizingh EK. Open innovation: state of the art and future perspectives. *Technovation* 2011; 31(1): 2–9.
- Lichtenthaler U. Opening up strategic technology planning: extended roadmaps and functional markets. *Manag Decis* 2008; 46(1): 77–91.
- Lazzarotti V and Manzini R. Different models of open innovation: a theoretical framework and an empirical study. *J Innov Manag* 2009; 13: 1–22.
- Lazzarotti V, Manzini R, Nosella A, et al. Innovation ambidexterity of open firms. The role of internal relational social capital. *Technol Anal Strateg Manag* 2017; 29(1): 105–118.
- Hung K and Chou C. The impact of open innovation on firm performance: the moderating effects of internal R&D and environmental turbulence. *Technovation* 2013; 33: 368–380.
- Caloghirou Y, Kastelli I and Tsakanikas A. Internal capabilities and external knowledge sources: Complements or substitutes for innovative performance? *Technovation* 2004; 24(1): 29–39.
- Rothaermel FT and Alexandre MT. Ambidexterity in technology sourcing: the moderating role of absorptive capacity. *Organ Sci* 2009; 20(4): 759–780.
- Stefan I and Bengtsson L. Unravelling appropriability mechanisms and openness depth effects on firm performance across stages in the innovation process. *Technol Forecast Soc Change* 2017; 120: 252–260.

19. Grimpe C and Sofka W. Search patterns and absorptive capacity: low- and high-technology sectors in European countries. *Res Policy* 2009; 38(3): 495–506.
20. Laursen K and Salter A. Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. *Strat Manag* 2006; 27(2): 131–150.
21. Bigliardi B. The effect of innovation on financial performance: a research study involving SMEs. *Innovation* 2013; 15(2): 245–255.
22. Cammarano A, Caputo M, Lamberti E, et al. Open innovation and intellectual property: a knowledge-based approach. *Manag Decis* 2017; 55: 1182–1208.
23. Ahn JM, Minshall T and Mortara L. Understanding the human side of openness: the fit between open innovation modes and CEO characteristics. *R&D Manag* 2017; 47: 727–740.
24. Caputo M, Lamberti E, Cammarano A, et al. Exploring the impact of open innovation on firm performances. *Manag Decis* 2016; 54(7): 1788–1812.
25. Cheng CCJ and Huizingh EKRE. When is open innovation beneficial? The role of strategic orientation. *J Prod Innov Manag* 2014; 31: 1235–1253.
26. Chen J, Chen Y and Vanhaverbeke W. The influence of scope, depth, and orientation of external technology sources on the innovative performance of Chinese firms. *Technovation* 2011; 31: 362–373.
27. Greco M, Grimaldi M and Cricelli L. Hitting the nail on the head: exploring the relationship between public subsidies and open innovation efficiency. *Technol Forecast Soc Change* 2017; 118(1), 213–215.
28. Kratzer J, Meissner D and Roud V. Open innovation and company culture: internal openness makes the difference. *Technol Forecast Soc Change* 2017; 119: 128–138.
29. Bigliardi B and Galati F. Which factors hinder the adoption of open innovation in SMEs? *Technol Anal Strateg Manag* 2016; 28(8): 869–885.
30. Carranza G, Garcia M and Sanchez B. Activating inclusive growth in railway SMEs by workplace innovation. *Transport Res Interdiscipl Perspec* 2020; 7, article number 100193.
31. Odriozola-Fernández I, Berbegal-Mirabent J and Merigó-Lindahl JM. Open innovation in small and medium enterprises: a bibliometric analysis. *J Organ Chang Manag* 2019; 32(5): 533–557.
32. Lopes APVBV and de Carvalho MM. Evolution of open innovation paradigm: towards a contingent conceptual model. *Technol Forecast Soc Change* 2018; 132: 284–298.
33. Lichtenthaler U and Frishammar J. The impact of aligning development and technology licensing: a contingency perspective. *J Prod Innov Manag* 2011; 28(1): 89–103.
34. Carvalho MM, Fleury A and Lopes AP. An overview of the literature on technology road mapping (TRM): contributions and trends. *Technol Forecast Soc Change* 2013; 80(7): 1418–1437.
35. Littell JH, Corcoran J and Pillai V. *Systematic reviews and meta-analysis*. New York: Oxford University Press, 2008.
36. Takey SM and Carvalho MM. Fuzzy front end of systemic innovations: a conceptual framework based on a systematic literature review. *Technol Forecast Soc Change* 2016; 111: 97–109.
37. Prasad S and Tata J. Publication patterns concerning the role of teams/groups in the information systems literature from 1990 to 1999. *Info Manag* 2005; 42(8): 1137–1148.
38. Ramos-Rodríguez AR and Ruíz-Navarro J. Changes in the intellectual structure of strategic management research: a bibliometric study of the *Strategic Management Journal*, 1980–2000. *Strateg Manag J*. 2004; 25: 981–1004.
39. de Wit J, Dankbaar B and Vissers G. Open innovation: The new way of knowledge transfer? *J Bus Chem* 2007; 4(1): 11–19.
40. Lichtenthaler U and Ernst H. Opening up the innovation process: the role of technology aggressiveness. *R&D Manag* 2009; 39(1): 38–54.
41. Harison E and Koski H. Applying open innovation in business strategies. Evidence from Finnish software firms. *Res Policy* 2010; 39(3): 351–359.
42. Popa S, Soto-Acosta P and Martínez-Conesa I. Antecedents, moderators, and outcomes of innovation climate and open innovation: an empirical study in SMEs. *Technol Forecast Soc Change* 2017; 118: 134–142.
43. Rehman S, Tiwari A, Turner C, et al. A framework for innovation outsourcing. *Int J Bus Innov Res* 2018; 16(1): 79–111.
44. Nylund PA, Ferras-Hernandez X and Brem A. Automating profitably together: Is there an impact of open innovation and automation on firm turnover? *Rev Manag Sci* 2020; 14(1): 269–285.
45. Roldán Bravo ML, Lloréns Montes FJ and Ruiz Moreno A. Open innovation in supply networks: an expectation disconfirmation theory perspective. *J Bus Ind Mark* 2017; 32(3): 432–444.
46. Trantopoulos K, Von Krogh G, Wallin MW, et al. External knowledge and information technology: implications for process innovation performance. *MIS Q Manag Inf Syst* 2017; 41(1): 287–300.
47. Liao S, Fu L and Liu Z. Investigating open innovation strategies and firm performance: the moderating role of technological capability and market information management capability. *J Bus Ind Mark* 2020; 35(1): 23–39.
48. Zhang S, Yang D, Qiu S, et al. Open innovation and firm performance: evidence from the Chinese mechanical manufacturing industry. *J Eng Technol Manag* 2018; 48: 76–86.
49. Ahn JM. The hierarchical relationships between CEO characteristics, innovation strategy and firm performance in open innovation. *Int J Entrep Innov Manag* 2020; 24(1): 31–52.
50. Hernandez-Espallardo M, Osorio-Tinoco F and Rodríguez-Orejuela A. Improving firm performance through inter-organizational collaborative innovations: the key mediating role of the employee's job-related attitudes. *Manag Decis* 2018; 56(6): 1167–1182.
51. Rass M, Dumbach M, Danzinger F, et al. Open innovation and firm performance: the mediating role of social capital. *Creativity Innov Manag* 2013; 22(2): 177–194.

52. Corral de Zubielqui G, Fryges H and Jones J. Social media, open innovation & HRM: implications for performance. *Technol Forecast Soc Change* 2019; 144: 334–347.
53. Moreno-Mondéjar L, Triguero Á and Sáez-Martínez FJ. Successful eco-innovators: exploring the association between open inbound knowledge strategies and the performance of eco-innovative firms. *Bus Strategy Environ* 2020; 20(3): 939–953.
54. Cappa F, Oriani R, Pinelli M, et al. When does crowdsourcing benefit firm stock market performance? *Res Policy* 2019; 48(9), article number 103825.
55. Chege SM and Wang D. The influence of the entrepreneur's open innovation strategy on firm performance: empirical evidence from SMEs in Kenya. *Info Resour Manag J* 2019; 32(4): 20–41.
56. Park E and Kwon SJ. Effects of innovation types on firm performance: an empirical approach in South Korean manufacturing industry. *Int J Bus Innova Res* 2018; 15(2): 215–230.
57. Seyfettinoğlu ÜK. Analysis of relationships between firm performance and open innovation strategies and stages in the Turkish food and beverage industry. *New Medit* 2016; 15(1): 42–52.
58. Fu L, Liu Z and Zhou Z. Can open innovation improve firm performance? An investigation of financial information in the biopharmaceutical industry. *Technol Anal Strateg Manag* 2019; 31(7): 776–790.
59. Na C, Kim E and Shin K. Can user innovation grow a firm? The case of the Korean smart media industry. *Electronics (Switzerland)* 2019; 8(10), article number 1114.
60. Oguguo PC, Bodas Freitas IM and Genet C. Multilevel institutional analyses of firm benefits from R&D collaboration. *Technol Forecast Soc Change* 2020; 151, article number 119841.
61. Yunus EN. Towards the open innovation strategy: a longitudinal study of service firms in an emerging market. *Int J Bus Innov Res* 2017; 14(4): 519–541.
62. Tajudeen FP, Jaafar NI and Sulaiman A. External technology acquisition and external technology exploitation: the difference of open innovation effects. *J Open Innov: Technol Market Compl* 2019; 5(4), article number 97.
63. Roberts DL, Piller FT and Luüttgens D. Mapping the impact of social media for innovation: the role of social media in explaining innovation performance in the PDMA comparative performance assessment study. *J Prod Innov Manag* 2016; 33: 117–135.
64. Rubera G, Chandrasekaran D and Ordanini A. Open innovation, product portfolio innovativeness and firm performance: the dual role of new product development capabilities. *J Acad Mark Sci* 2016; 44: 166–184.
65. Cruz-González J, López-Sáez P, Navas-López JE, et al. Open research strategies and firm performance: the different moderating role of technological environmental dynamism. *Technovation* 2015; 35: 32–45.
66. Crema M, Verbano C and Venturini K. Linking strategy with open innovation and performance in SMEs. *Meas Bus Excell* 2014; 18(2): 14–27.
67. Sun F, Hong J, Ma X, et al. Subnational institutions and open innovation: evidence from China. *Manag Decision* 2017; 55(9): 1942–1955.
68. Hung K-P and Chiang Y-H. Open innovation proclivity, entrepreneurial orientation, and perceived firm performance. *Int J Technol Manag* 2010; 52(3–4), 257–274.
69. Bhaskarabhatla A and Hedge D. An organizational perspective on patenting and open innovation. *Organ Sci* 2014; 25(6): 1744–1763.
70. Wu Y-C, Lin B-W and Chen C-J. How do internal openness and external openness affect innovation capabilities and firm performance? *IEEE Trans Eng Manag* 2013; 60(4): 704–716.
71. Lichtenthaler U. Hierarchical strategies and strategic fit in the keep-or-sell decision. *Manag Decis* 2007; 45(3): 340–359.
72. Reed R, Storrud-Barnes S and Jessup L. How open innovation affects the drivers of competitive advantage: trading the benefits of IP creation and ownership for free innovation. *Manag Decis* 2012; 50(1): 58–73.
73. Liem NT, Khuong NV and Khanh THT. Firm constraints on the link between proactive innovation, open innovation and firm performance. *J Open Innov: Technol Market Complex* 2019; 5(4), article number 88.
74. Hungund S and Kiran KB. Open innovation practices among Indian software product firms: a pilot study. *Int J Innovat Sustain Dev* 2017; 11(4): 355–376.
75. Santoro G. Innovation in small and medium enterprises: the impact of open innovation practices on firm's performance. *Glob Bus Econ Rev* 2017; 19(5): 508–520.
76. Yun JJ, Avvari MV, Jeong E-S and Lim D-W. Introduction of an objective model to measure open innovation and its application to the information technology convergence sector. *Int J Technol Policy Manag* 2014; 14(4): 383–400.
77. Lichtenthaler U. Toward an innovation-based perspective on company performance. *Manag Decis* 2016; 54(1): 66–87.
78. Mu J. Networking capability, new venture performance and entrepreneurial rent. *J Res Market Entrep* 2013; 15(2): 101–123.
79. Yu D and Hang CC. A reflective review of disruptive innovation theory. *Int J Manag Rev* 2010; 12(4): 435–452.
80. Yun JJ, Won D, Jeong E, et al. Dismantling of the inverted U-curve of open innovation. *Sustainability (Switzerland)* 2017; 9(8), article number 1423.
81. Moretti F and Biancardi D. Inbound open innovation and firm performance. *J Innov Knowl* 2020; 5(1): 1–19.
82. Wen X, Wu G, Kang Q, et al. A study on customer knowledge management, inbound open innovation and firm performance. *Hum Syst Manag* 2020; 39(2): 183–195.
83. Wang X. The effect of inbound open innovation on firm performance in Japanese manufacturing firms: comparative study between research centre and business unit. *Int J Innov Manag* 2018; 22(7): 1850054.
84. Oltra MJ, Flor ML and Alfaro JA. Open innovation and firm performance: the role of organizational mechanism. *Bus Process Manag J* 2018; 24(3): 814–836.
85. Wang C-H, Chang C-H and Shen GC. The effect of inbound open innovation on firm performance: evidence from high-

- tech industry. *Technol Forecast Soc Change* 2015; 99: 222–230.
86. Lichtenthaler U. Determinants of absorptive capacity: the value of technology and market orientation for external knowledge acquisition. *J Bus Indus Market* 2016; 31(5): 600–610.
 87. Vrontis D, Thrassou A, Santoro G, et al. Ambidexterity, external knowledge and performance in knowledge-intensive firms. *J Technol Trans* 2017; 42(2): 374–388.
 88. Sisodiya SR, Johnson JL and Grégoire Y. Inbound open innovation for enhanced performance: enablers and opportunities. *Ind Market Manag* 2013; 42(5): 836–849.
 89. Greco M, Grimaldi M and Cricelli L. An analysis of the open innovation effect on firm performance. *Eur Manag J* 2016; 34(5): 501–516.
 90. Dittrich K and Duysters G. Networking as a means to strategy change: the case of open innovation in mobile telephony. *J Prod Innov Manag* 2007; 24(6): 510–521.
 91. Lichtenthaler U. A note on outbound open innovation and firm performance. *R&D Manag* 2015; 45(5): 606–608.
 92. Helm R, Endres H and Hüsig S. When and how often to externally commercialize technologies? A critical review of outbound open innovation. *Rev Manag Sci* 2019; 13(2): 327–345.
 93. Choi B. The role of firm size and IT capabilities in open and closed innovation. *Asia Pacific J Info Sys* 2019; 29(4): 690–716.
 94. Ahn JM, Ju Y, Moon TH, et al. Beyond absorptive capacity in open innovation process: the relationships between openness, capacities and firm performance. *Technol Anal Strateg Manag* 2016; 28(9): 1009–1028.
 95. Yun JJ, Zhao X and Hahm SD. Harnessing the value of open innovation: change in the moderating role of absorptive capability. *Knowl Manag Res Pract* 2018; 16(3): 305–314.
 96. Kim H and Kim E. How an open innovation strategy for commercialization affects the firm performance of Korean healthcare IT SMEs. *Sustainability* 2018; 10(7): 2476.
 97. Hernandez-Vivanco A, Cruz-Cázares C and Bernardo M. Openness and management systems integration: pursuing innovation benefits. *J Eng Technol Manag* 2018; 49: 76–90.
 98. Ramirez-Portilla A, Cagno E and Brown TE. Open innovation in specialized SMEs: the case of supercars. *Bus Process Manag J* 2017; 23(6): 1167–1195.
 99. Kim S, Kim H and Kim E. How knowledge flow affects Korean ICT manufacturing firm performance: a focus on open innovation strategy. *Technol Anal Strateg Manag* 2016; 28(10): 1167–1181.
 100. Ul Hameed W and Naveed F. Coopetition-based open-innovation and innovation performance: role of trust and dependency evidence from Malaysian high-tech SMEs. *Pakistan J Comm Soc Sci* 2019; 13(1): 209–230.
 101. Huang H-C, Lai M-C, Lin L-H, et al. Overcoming organizational inertia to strengthen business model innovation: an open innovation perspective. *J Organ Chang Manag* 2013; 26(6): 977–1002.
 102. Howells J, Ramlogan R and Cheng S-L. Universities in an open innovation system: a UK perspective. *Int J Entrepreneurial Behav Res* 2012; 18(4): 440–456.
 103. Howells J, Ramlogan R and Cheng S-L. Innovation and university collaboration: paradox and complexity within the knowledge economy. *Cambridge J Econ* 2012; 36: 703–721.
 104. Ferdinand J-P and Meyer U. The social dynamics of heterogeneous innovation ecosystems: effects of openness on community-firm relations. *Int J Eng Bus Manag* 2017; 9: 1–16.
 105. Ahn JM, Mortara L and Minshall T. Dynamic capabilities and economic crises: Has openness enhanced a firm's performance in an economic downturn? *Ind Corp Change* 2018; 27(1): 49–63.
 106. Pratono AH. Network structure and open innovation: the role of trust in product development. *Int J Bus Innov Res* 2018; 15(1): 44–61.
 107. Ahmed S, Halim HA and Ahmad NH. Open and closed innovation and enhanced performance of SME hospitals – A conceptual model. *Bus Perspect Res* 2018; 6(1): 1–12.
 108. Bae Y and Chang H. Efficiency and effectiveness between open and closed innovation: empirical evidence in South Korean manufacturers. *Technol Anal Strateg Manag* 2012; 24(10): 967–980.
 109. Zhang L, Cui Y and Zheng M-B. Two-way open innovation and firm growth: the moderating effect of external environment. *Asian J Technol Innov* 2016; 24(1): 123–141.
 110. Mazzola E, Bruccoleri M and Perrone G. Open innovation and firms performance: state of the art and empirical evidences from the bio-pharmaceutical industry. *Int J Technol Manag* 2016; 70(2–3):109–134.
 111. Lichtenthaler U. (a) Absorptive capacity and firm performance: an integrative framework of benefits and downsides. *Technol Anal Strateg Manag* 2016; 28(6): 664–676.
 112. Agramunt LF, Berbel-Pineda JM, Capobianco-Uriarte MM, et al. Review on the relationship of absorptive capacity with interorganizational networks and the internationalization process. *Complexity* 2020; 2020, article number 7604579.
 113. De Zubietaqui GC, Jones J and Lester L. Knowledge inflows from market- and science-based actors, absorptive capacity, innovation and performance – A study of SMEs. *Int J Innov Manag* 2016; 20(6), article number 1650055.
 114. Rangus K, Drnovšek M, Di Minin A, et al. The role of open innovation and absorptive capacity in innovation performance: empirical evidence from Slovenia. *J East Eur Manag Stud* 2017; 22(1): 39–62.