



BRIDGING UNIVERSITY-FIRM AND OPEN INNOVATION LITERATURE: A CRITICAL SYNTHESIS

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Abstract

Open Innovation (OI) is a 'hot' topic in the field of innovation. Based on a bibliometric analysis, we found that most of the existing studies on OI are conceptual in nature. In the few empirical studies available, the issue of University-Enterprise relations – one of the components of the open innovation model – is analyzed in a relatively superficial manner that neglects the mechanisms by which companies could obtain competitive advantage by following a more open model of innovation based on relationships with universities. Moreover, the existing studies on U-E relations do not highlight, at least explicitly, the question of the open innovation model. Such studies are still highly focused on a unidirectional profit perspective, and are excessively centred on the advantages enterprises are able to obtain from relations with universities, failing to take into account the value that potentially goes to universities from such links.

Keywords: Open Innovation; U-E relations; Emergence; Sustainability; Benefits.

1. INTRODUCTION

The innovation process is currently undergoing profound changes in the way it is managed (Chesbrough, 2003). Innovation Management also faces new paradigms, a consequence of circumstances such as globalization and technological intensity (Chesbrough, 2003; 2004; Smith, 2004; Chesbrough and Schwartz, 2007). While some years ago it was the five generations of the innovation models

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proposed by Rothwell (1985) that came up in the most well-known scientific journals on management, and discussion on the issue of innovation had just emerged (Tidd *et al.*, 2003), today, one of the major concerns has to do with a new paradigm of innovation management that specifically mentions the concept of Open Innovation (OI), as proposed and developed by Henry Chesbrough (2003).

OI is one of the areas that has grown the most in terms of literature on the economy and innovation management in the last few years, and it could be classified as an emerging domain (Teixeira and Silva, 2010). In the OI model, not only internal but also external efforts are considered, with a view to accelerating the innovation processes and exploring new markets (Gann, 2004). In this model, "technology surplus", that is, the technologies in "stock", are explored economically, since the OI model favours different forms of accessing the market and therefore commercializing innovation, given the wide range of partnerships that can potentially be established (Chesbrough, 2003). Innovation management through an externally open model is checked both through the acquisition of technologies as well as their transfer to other organizations (Enkel *et al.*, 2005; Lichtenthaler, 2008). This is achieved in a variety of ways, namely through the licensing of intellectual property (Sheehan *et al.*, 2004), the co-development of partnerships (Piller and Walcher, 2006; Belussin *et al.*, 2008), relationships between companies and the scientific and technological system (Chesbrough, 2003; Link *et al.*, 2008), the launching of new spin off companies (Parhankangas *et al.*, 2003), and fusions and acquisitions (Parhankangas *et al.*, 2003).

It should be noted that the majority of the existing studies on the OI paradigm are of a conceptual nature (Lopes and Teixeira, 2009). In the few empirical studies available, the question of U-E relations is analyzed in a relatively superficial manner that disregards or inadequately refers to the mechanisms by which companies may obtain a competitive advantage (via innovation) through the use of a more Open Innovation model based on relationships with universities. On the other hand, the existing studies on U-E relationships do not highlight, at least explicitly, the question of the open innovation model (Rothaermel *et al.*, 2007); such studies are still highly focused on the unidirectional return perspective. In other words, they are excessively centred on the advantages that companies may obtain from relations with universities, and they fail to analyze and review the benefits that could arise for universities from such relations (Chapple *et al.*, 2005). The perspective of mutual benefit is therefore neglected in the current empirical literature (Harwing, 2004). In fact, from an empirical point of view, detailed evidence on the emergence, evolution and sustainability of U-E relationships and the ways/mechanisms by which companies and universities obtain advantages from such relations is lacking (Perkmann and Walsh, 2007).

The aim of this paper is to provide a critical review highlighting the gaps mentioned above. The paper is organized as follows: the next section (Section 2)

presents a brief description of the Open Innovation model; Section 3 summarizes the empirical literature on the Open Innovation model (OI), demonstrating the lack of attention paid to University-Enterprise (U-E) relations; in Section 4, a critical analysis of the literature on U-E relations is conducted, highlighting the relative disregard for Open Innovation business strategies. Finally, the concluding section (Section 5) describes the gaps identified in the cross-referencing conducted on the literature on OI and U-E relations.

2. A BRIEF DESCRIPTION OF THE OPEN INNOVATION MODEL

OI was introduced by Henry Chesbrough (2003) and was quickly taken on as a new concept for the 21st century. This new model, contrasting with the traditional innovation model which seems to have prevailed throughout the 20th century, the closed innovation model (Chesbrough, 2003), aims to accrue increased value for organizations, and to this end, it explores both the internal potentialities of the company and the benefits deriving from closer interaction with external sources of knowledge.

In the closed innovation model, the competitive advantage of enterprises was obtained through the discovery of bigger, better ideas and was based on the efforts developed in their in-house R&D labs (Chesbrough, 2003; 2004; Hempill, 2005), particularly in cases where research processes and outcomes were developed and commercialized by the companies that invested intensively in R&D. In this context, projects which did not fall within a company's main activity would be kept in stock, waiting for an opportunity to be used (Gann, 2004; Blau, 2007), consequently running the risk of such opportunities never arising. Thus, the profits derived from the strategic position which the companies held in the market were reinvested in R&D and led to new discoveries, resulting in a vicious cycle. In this context, companies with insufficient resources to finance in-house research were at a clear competitive disadvantage; they tended to be outdone by competitors and thus became obsolete (Smith, 2004; Alio, 2005). Hence, the model is based on the idea of a company that is totally closed in on itself, and highly confined to its "walls" (Chesbrough, 2003), where the business model is centred on the development of products based on internally developed technology' and commercialized by the company itself (Chesbrough and Schwartz, 2007). Innovation thus requires tight control, and interaction between companies, agents and cooperators does not exist.

The increase in the technological diversity offered by external suppliers with strong skills (Chesbrough, 2003; 2004; 2008), the change in business strategies regarding the advantage of accessing a growing number of external options for technologies which are not used and are stored in the company (Chesbrough,

2008), the increased mobility of qualified workers, who tend to propagate tacit knowledge, making it difficult to control ideas and expertise (Smith, 2004), the expansion of risk capital (Hemphill, 2005), and the growing number of private investors who provide financing for new companies, and their efforts to commercialize ideas deriving from research labs (Chesbrough, 2003) have contributed to the decline of the traditional model of innovation, giving way to another model of innovation management – the Open Innovation Model (OI) (Chesbrough, 2003).

Factors such as globalization and the institutionalization of the information society (Anderson and Tushman, 1990; Gassmann, 2006) have enabled companies from many industries and sectors (e.g., semiconductors; communication systems; military equipment; biotechnology; automobile; pharmaceuticals) to start managing their innovation activities on the basis of an open model (Chesbrough, 2006; Chesbrough and Appleyard, 2007). OI is defined as the intentional use of incoming and outgoing flows of knowledge to accelerate internal innovation, and expand markets for the external use of innovation (Gann, 2004; Chesbrough and Schwartz, 2007). Technological innovation not only derives from internal company sources but also from external ones, since it is a model characterized by the intensification of relations with external sources. It is because of this intensification of external relations that Chesbrough (2003) mentions the need to implement an extensive network of scouts, based on a “scenario” of abundant knowledge (Kline, 1985; von Hippel, 1986; Lundvall, 1988; Powell *et al.*, 1996; Hansen and Birkinshaw, 2007), boosting an increasing flow of knowledge.

Open Innovation is based on two important components, which, although distinct, are interrelated: the acquisition of knowledge/technologies and their transfer to other organizations (Lichtenthaler, 2008). It is possible to further subdivide the model into other forms of purchase/sale of technologies, namely in terms of intellectual property rights (Sheehan *et al.*, 2004), co-development partnerships (Piller and Walcher, 2006; Van der Meer, 2007; Chiaroni *et al.*, 2008), relations between companies and the scientific and technological system (Harwing, 2004), the launching of new spin off companies (Parhankangas *et al.*, 2003), and fusions and acquisitions (Parhankangas *et al.*, 2003). Depending on the different forms of access to the market in an OI model, technologies are no longer used in the company, and this makes their commercialization possible (Chesbrough, 2003; Hastbacka, 2004; Alio, 2005). OI allows for multiple patterns of selling and acquiring innovation, granting management the choice of the most appropriate business model for their company.

Regardless of the perspective from which the OI model is analyzed, the main goal of this paradigm is to provide companies with new strategic tools that enable them to achieve a higher added value (Chesbrough, 2003). This may imply the detailed scrutiny of the needs and tastes of the consumers, greater monitoring of the aggressiveness of *players* (Goffin and Mitchell, 2005), or even

obtaining significant cost reduction at the level of R&D (Gassmann, 2006). Chesbrough (2003) mentions that these results will only be possible in a philosophy of a sharing and synergetic management, which requires a high organizational and relational level (Hastbacka, 2004; Kirschbaum, 2005). Kirschbaum (2005) mentions that all of these dynamics will only be possible if the organizations institutionalize a culture of openness, cooperation and networking, highlighting this model as an "open mind state".

According to Chesbrough and Appleyard (2007), other authors (e.g., Solow; Allen; Katz and Allen; von Hippel; Teece; Anderson and Tushman; Cohen and Levinthal; Pisano; Kodama; Moore; Shapiro and Varian) preceded Chesbrough when focusing on some questions related directly to OI, namely innovation communities and innovation ecosystems (Moore), as well as the relationship network (Shapiro and Varian). Rothwell (1992), based on the integrated and network innovation models, also highlighted aspects related to OI. Thus, in relation to the integrated innovation model, Rothwell (1992) highlights a parallelism (i.e., neither sequential and nor linear) between R&D activities and conception activities, testing, production and marketing, besides focusing on the integration of multidisciplinary work teams and the advantages of intelligent information systems (e.g., flexible production systems), as well as the active participation of technologically more advanced suppliers and customers. The integrated innovation model emphasizes, therefore, inter-company cooperation, which may take different forms and where the technological branch almost always plays an important role (Lichtenthaler, 2008). Concerning the network innovation model, Rothwell (1992) considers the company an open system, where boundaries are becoming more diffused, thanks not only to the development of information and communication technology (Gassmann, 2006), but also to the active participation of companies with external entities, namely research centres and universities (Leyden *et al.*, 2008). He notes the important support these organizations provide in supervising a product from its conception phase to its launch on the market, regardless of the geographical location of the companies (Collins, 2006; Gassmann, 2006).

It is also worth mentioning here the 'chain-linked model' of Kline and Rosenberg (1986), an interactive model, which might be considered a "pre-open" model of innovation. This model recognizes interaction as a central element in the process of technological innovation. Two types of interactions can occur. The first concerns interaction processes within a corporation (i.e. intrafirm networking) such as loops that link R&D and engineering and production, and loops that link different groups within R&D. These links may be complemented by interfirm networking, the second type of interaction, with other firms and institutions of the wider science and technology environment in which the firm operates.

3. OPEN INNOVATION (OI) LITERATURE AND THE DISREGARD FOR UNIVERSITY-ENTERPRISE RELATIONS (U-E): AN OVERVIEW OF THE EMPIRICAL STUDIES

A bibliographic search conducted in the EBSCO database – more specifically the *Econlit and Business Source Complete* – on the topic ‘Open Innovation’ (search word) revealed that, until June 2009, the database contained a total of 114 papers, segmented into six major themes, which were further subdivided into 19 different topics (cf. Table 1). Furthermore, it is possible to perform a micro analysis (where the objects of study are companies, organizations or individuals) and a macro analysis (where the objects of study are economic areas or countries) of the six major themes. Hence, from the macro-type studies, we are able to determine the infrastructures that support cooperation networks and technology transfer, entrepreneurial characteristics and technology transfer, U-E cooperation/relations and the internal strategies/skills of innovation. The micro studies help to identify aspects such as human resources and entrepreneurial culture. Issues related to U-E relations are found at a micro-macro level and incorporate the segment of studies which are related to cooperation.

TABLE 1

Major themes in the area of Open Innovation

	Theme	Topic
	Conceptual	Explanation of the Open Innovation Model
Macro	Support infrastructure for networks of cooperation and technology transfer	Technology Clusters
		Technopoles
		The Importance of State Intervention
	Entrepreneurship and Technology Transfer	Startups
		Acquisition and Technology Transfer
		Business Models
		Intellectual Property
	Cooperation, U-E Relations	Partnerships and Networks Collaboration
		University-Enterprise Relations (U-E)
		The Role of Intermediaries
	Strategies/Internal expertise in innovation	Innovation Communities
		Structure of Activities of Research and Development (R&D)
		The Role of Innovation Management in the face of radical innovations
Development of Complementary Products		
Micro	Human Resources and Corporate Culture	The Role of Information Technology and Communication
		Career Development
		The Human Resource Management
		Organizational Culture

Source: Treatment of the authors based on data from EBSCO – *EconLit e Business Source Complete* (2009).

Of the 114 articles analyzed, 66 (58%) are of a conceptual nature, that is, they comprise mostly literature reviews/overviews, whereas 48 (42%) are more empirical, that is, they imply the construction of empirical evidence through data collection and seek to test a certain argument. Table 2 summarizes the number of conceptual and empirical papers by theme, as well as their importance in the total.

Upon analysis of Table 2, it can be seen that topics other than the themes that allow us to evaluate the Open Innovation model are being explored, namely, acquisition and exploration of technologies (Chesbrough and Crowther, 2005), intellectual property rights (Sheehan *et al.*, 2004), co-development partnerships (Piller and Walcher, 2006; Van der Meer, 2007), university-enterprise relations (Chesbrough, 2003; Link *et al.*, 2008), the launching of new spin off companies (Parhankangas *et al.*, 2003), and fusions and acquisitions (Parhankangas *et al.*, 2003). In fact, the OI literature reveals a noticeable focus on aspects of innovation communities, a topic which registered a total of 16 papers (14% of the total). Both the empirically- and the conceptually-based studies which discuss innovation communities are centred on the importance of integrating customers/users in the conception of new products (e.g., Enkel *et al.*, 2005) and their respective pertinence for the dissemination of new technologies, and they highlight, in equal terms, the importance of virtual communities (e.g., West and Lakhani, 2008). Also relevant, with a total of 15 papers (13.2%), are the Information and Communication Technologies (ICT) in the Open Innovation model, where the main studies focus on the contribution of technologies to the construction of on-line communities and relational networks (e.g., Rajkumar *et al.*, 2004), as well as the conception of information systems to support decision-making in Open Innovation models (e.g., Debackere and Veugelers, 2005).

Studies dedicated to explaining the Open Innovation model also reach a significant number (12), making up about 10.5% of the total papers analyzed. This topic essentially covers papers of a conceptual nature (11) and focuses especially on the major differences between the open and closed innovation models (e.g., Chesbrough, 2003), the benefits a company can accrue in adopting the OI model (e.g., Collins, 2006), and the major factors that justify the existence of the Open Innovation model (e.g., Gassmann, 2006).

Another topic related to Open Innovation concerns the business models of the companies in an open-to-the-outside context, with a total of 7 papers (6.1%) in the database. The main aspects explored in this regard are centred on the strategic changes which companies will have to go through as a result of great external exposure (e.g., Lichtenthaler, 2008). We should also highlight aspects such as R&D activity structure and the role of the intermediary in the Open Innovation model. In terms of R&D activity structure, 4 papers (3.5%) are studies that focus on the development of the physical structure and the investment structure of R&D

TABLE 2

Number and distribution (%) of the articles published in EBSCO related the theme of OI

	Theme	Topic	Total artic.	% total	Nº Conce artic.	Nº Empir artic.	% Conce artic.	% Empir artic.
	Conceptual	Explanation of the Open Innovation Model	12	10.5	11	1	91.7	8.3
Macro	Support infrastructure for networks of cooperation and technology transfer	Technology Clusters	1	0.9	0	1	0.0	100.0
		Technopoles	1	0.9	1	0	100.0	0.0
		The Importance of State Intervention	1	0.9	0	1	0.0	100.0
	Entrepreneurship and Technology Transfer	Startups	1	0.9	0	1	0.0	100.0
		Acquisition and Technology Transfer	13	11.4	6	7	46.2	53.8
		Business Models	7	6.1	5	2	71.4	28.6
		Intellectual Property	7	6.1	3	4	42.9	57.1
	Cooperation, U-E Relations	Partnerships and Networks Collaboration	15	13.2	9	6	60.0	40.0
		University-Enterprise Relations (U-E)	9	7.9	5	4	55.6	44.4
		The Role of Intermediaries	3	2.6	1	2	33.3	66.7
	Strategies/Internal expertise in innovation	Innovation Communities	16	14.0	7	9	43.8	56.3
		Structure of Activities of Research and Development (R&D)	4	3.5	2	2	50.0	50.0
		The Role of Innovation Management in the face of radical innovations	2	1.8	1	1	50.0	50.0
Development of Complementary Products		1	0.9	0	1	0.0	100.0	
		The Role of Information Technology and Communication	15	13.2	10	5	66.7	33.3
Micro	Human Resources and Corporate Culture	Career Development	2	1.8	2	0	100.0	0.0
		The Human Resource Management	2	1.8	1	1	50.0	50.0
		Organizational Culture	2	1.8	2	0	100.0	0.0
		Total	114	100	66	48	57.9	42.1

Source: Treatment of the authors based on data from EBSCO – EconLit e Business Source Complete (2009).

activities in OI models (e.g., Scinta, 2008). As for the role of the intermediary, with a new innovation management model, totalling 3 papers (2.6%), their importance in the technology transfer process is particularly highlighted (Gassmann and Reepmeyer, 2005).

In relation to U-E relations, there are no significant differences between the conceptual papers (5 – 55.6%) and the empirical papers (4 – 44.4%) among the 9 papers in the total (7.9%).

Partnerships and Cooperation Networks, or co-development Partnerships, as referred to in the specialty literature (Piller and Walcher, 2006; Van der Meer, 2007), are the topics in the Open Innovation area which have the highest number of papers (15), making up 13.2% in the total studies. From these, conceptual

papers (9) dominate in comparison to those of an empirical nature (6) (Table 3). The central issues explored in these papers are the importance of networking for problem solving and the pertinence of cooperation to achieve a greater level of efficiency in R&D activities and technology commercialization (e.g., Veugelers and Cassiman, 2005). Technological Acquisition and Transfer register a significant number of papers (13), with an estimated percentage weight of 11.4%. In these papers, the most commonly discussed aspects are the role of strategic planning in the activities of technology acquisition and transfer (Lichtenthaler, 2008) and the use of an intermediary for the acquisition and exploration of technology (e.g., Wit *et al.*, 2007).

TABLE 3

Number and distribution (%) of the articles published in EBSCO related the key topic of OI

Theme	Key Topic in OI	Total articles	% total	Nº Conce articles	Nº Empir articles	% Conce articles	% Empir articles
Entrepreneurship and Technology Transfer	Startups	1	0.9	0	1	0.0	100.0
	Acquisition and Technology Transfer	13	11.4	6	7	46.2	53.8
	Intellectual Property	7	6.1	3	4	42.9	57.1
Cooperation, U-E Relations	Partnerships and Networks Collaboration	15	13.2	9	6	60.0	40.0
	University-Enterprise Relations (U-E)	9	7.9	5	4	55.6	44.4
Total of key topics in OI		45	39.5	23	22	51.1	48.9

Source: Treatment of the authors based on data from EBSCO – EconLit e Business Source Complete (2009).

Regarding University-Enterprise Relations (9 papers), the most highlighted aspects are basically technological acquisition and exploration (e.g., Lichtenthaler, 2008), university Spin-offs (e.g., Minshall *et al.*, 2007), the role of government support in the university-company partnerships (e.g., Kleyn and Kitney, 2007), the nature and type of university-enterprise relations (e.g., Perkmann and Walsh, 2007). A total of 7 papers (6.1%) focus on intellectual property, particularly the issue of the most appropriate methodologies to achieve the efficient management of intellectual property (e.g. Slowinski and Zerby, 2008). Finally, in relation to Start-ups, the database registered only one article (0.9%) of an empirical nature (0.0%), mostly centred on technology commercialization.

The issue of U-E relations is generally regarded as an extremely productive channel for establishing partnerships at the level of conception and development of new technology/knowledge (Chesbrough, 2003; Harwing, 2004; Blau, 2007), as well as a means to cut costs (Chesbrough, 2003). This matter has drawn

great attention within the field (Mowery and Nelson, 2004; Owen-Smith and Powell, 2004; Rothaermel and Ku, 2008). Research has focused on the factors/tendencies that have contributed to the increase in this type of cooperation (e.g., Shane, 2005), as well as the respective obstacles that it has given rise to (Collins, 2006). In terms of Open Innovation in particular, and according to the themes which allow us to evaluate the Open Innovation model, the matter of U-E relations is still largely ignored in a global analysis (appearing in only 7.9% of the total (114) papers analyzed, when compared to other aspects of the Open Innovation model, such as, for example, Partnerships and Cooperation Networking (13.2%) and Technology Acquisition and Transfer (11.4%). Additionally, from the studies analyzed at this level, none adequately refers to the mechanisms by which enterprises may obtain competitive advantage (via innovation) from the use of a more Open Innovation model based on relations with universities. They have not empirically demonstrated the emergence, evolution and sustainability of U-E relations in an Open Innovation context (Perkmann and Walsh, 2007; Rothaermel *et al.*, 2007).

Table 4 summarizes the number of empirical papers on U-E relations in an Open Innovation context. It is clear that they are essentially focused on developed countries (e.g. United Kingdom, USA, Switzerland, Germany, Austria), in which the analysis of industrial sectors predominates (e.g., Textile, Paper, Car Machinery, Electronics, Biotechnology). Also, a majority of the studies depend on databases, revealing a lack of empirical evidence from study cases. The studies further address an important, common question that centres on the fact that relations with universities are important and beneficial for companies; however, they disregard the advantages that may arise for universities. Also common is the fact that none of the above-mentioned studies explores the issue of the emergence, sustainability and mechanisms of the relations established between enterprises and universities.

It is important to state once again that in general the literature on U-E relations within Open Innovation is still largely underrepresented at an empirical level (7.9%), when compared with other aspects of the model (e.g., Partnerships and Cooperation Networks – 13.2%). From the very few empirical papers analyzed at this level, none focused on the mechanisms by which companies may obtain competitive advantage (via innovation) through the use of a more open model of innovation based on relations with universities, nor do they present empirical evidence regarding the issue of the emergence, evolution and sustainability of U-E links in an Open Innovation context (Rothaermel *et al.*, 2007).

4. THE LITERATURE ON UNIVERSITY-ENTERPRISE (U-E) RELATIONS AND THE DISREGARD FOR OPEN INNOVATION BUSINESS STRATEGIES: AN OVERVIEW OF THE EMPIRICAL PAPERS

Similarly to Section 3, we conducted a bibliographical search in the EBSCO database, *Econlit and Business Source Complete*, using the keyword 'Industry-University' as the search term, and we obtained a total of 171 articles, of which 159 (93%) are conceptual in nature and 12 (7%) are mostly empirical.

TABLE 4

Empirical studies that deal with U-E relations in the context of Open Innovation

Firms	Country	Sector	N. ^o Firms	Question Research	Findings	Authors (date)
GSK, Merck, Syngenta, J&J, Abbott, Tepnel Sciences, MicroTest Matrices, Imperial College London, University College London, Oxford University, Dundee University, MIT and Columbia University	UK, EU, USA	Biopharmaceutical Academic	13	What is the role of the State in the partnerships between universities and companies?	Important in achieving innovation based on R&D, adoption of more open innovation practices. The success is the appropriate organizational structures and greater flexibility in operational management to solve problems	Kleyn and Kitney (2007)
UK Large Firms	UK	Multiple Sectors	2000	What kind of knowledge sources are used by firms for innovation activities?	69% of UK businesses contact universities in order to gain knowledge for their innovation activities	Hughes (2009)
Swiss Industries	Switzerland	Textile, Leather, Wood, Paper, Printing, Chemicals, Plastics, Glass, Metallurgical, Machinery, Electronics, Vehicles, Energy, Construction, Transport, Banking, IT, Telecommunications	2428	What is the impact of university-enterprise relations in innovation and productivity activities?	Improvement in the performance of innovation in terms of intensity of R & D, as well as sales of new products	Arvanitis <i>et al.</i> (2008)
German and Austrian Industries	Germany Áustria	Biotechnology, Pharmaceutical, Chemical Engineering, Electronic Machinery, Automotive	154	What kinds of companies, although reluctant with regard to commercialization of technologies, buy part of their knowledge in universities?	These are medium-sized branch of electronic purchasing part of their knowledge in universities	Lichtenthaler (2008)

Source: Treatment of the authors based on data from EBSCO – *EconLit e Business Source Complete* (2009).

The majority (66.7%) of the empirical studies on the university-business relationship are primarily focused on the analysis of enterprises, organizations, or individuals. Only three of the studies (25%) are centred on regions, sectors or industries, while one of the articles (8.3%) is mixed, that is, it combines a micro and meso analysis. It is also important to note that an empirical analysis of the articles on U-E relations can be gathered into three major themes (cf. Table 5): 1) regional/industrial development deriving from relations with universities; 2) business and academic benefits deriving from cooperation, and 3) Open Innovation. From the analysis of Table 4, we conclude that the studies mostly examine developed countries (e.g., UK, USA, China) and are centred on activity sectors that are considered industrial (e.g., electronics, catalyst, automobile), as well as including some reference to other sectors such as biotechnology and ICT. The majority of the studies are based on databases, given the great number of analysis observations, and a study case analysis is rare (only 3 studies). From the 12 empirical papers analyzed, 8 explore the benefits companies obtain from cooperation with universities. Compiling the information obtained in the studies reveals that the benefits include: 1) a greater tendency for the companies to become more active in terms of R&D (Baba *et al.*, 2009) and internationalization (Heidrick *et al.*, 2005); 2) greater business participation in research projects promoted by State bodies, demonstrating the possibility of an increase in funds for such cooperation (Sáez *et al.*, 2002); 3) significant changes in organizational strategy (Sáez *et al.*, 2002); 4) diversity/expansion of product lines and technological capacity achievement (Heidrick *et al.*, 2005; Smith and Bagchi-Sen, 2006); 5) a decrease in the uncertainties and technological difficulties of enterprises (Hall *et al.*, 2003), demonstrating a greater capacity for problem solving (Heidrick *et al.*, 2005), namely in cases of high levels of technological complexity (Kim and Lee, 2003); 6) a growing business tendency to develop and commercialize technologies faster and greater awareness of the importance of research in problem solving (Hall *et al.*, 2003); 7) efficiency at the level of strategic planning and better critical awareness regarding the issues related to business culture (Dale, 2004); 8) possibility for the companies to use academic labs (Heidrick *et al.*, 2005); 9) considerable increase at the level of sales and profit (Macpherson and Ziolkowski, 2005); 10) improvement in the competitive position of companies, given the possession of more and better products and services and the application of technologies in related business areas (Heidrick *et al.*, 2005); 11) quick return from the investments and operational efficiencies obtained in multiple segments of production and marketing based on *Total Quality Management* practices and the ISO norms, enabling substantial reductions in defect material, defect tax reduction and obtainment of scale economies (Macpherson and Ziolkowski, 2005); 12) networking increase with national and international companies, as well as multinational companies (Sáez *et al.*, 2002), in addition to a higher participa-

tion in international knowledge networks; and 13) improvement of the business/corporate image (Hadjimanolis, 2006).

Only 2 of the empirical papers analyzed (Heidrick *et al.*, 2005; Hadjimanolis, 2006) mentioned the issue of benefits universities could obtain from links with companies. The main merits are based on (Heidrick *et al.*, 2005): 1) quality increase in the contents taught; 2) commercialization opportunities for the developed technology; 3) development of more research activities; 4) closer relations with managers and enterprises (which leads to a qualitative increase in knowledge both for teachers and for students; 5) knowledge increase regarding the use of technologically more advanced material, reputation gain in certain research fields; 6) recognition by the academic community for the work developed in relevant areas and acquisition of equipment donated by the companies. In addition, the work of Hadjimanolis (2006) allows us to list some further advantages universities obtain from collaborating with companies. These include outputs in the form of papers at conferences and papers published in scientific journals, as well as advantages at the level of the possibility that the scientific community can use the business labs for scientific testing.

From the papers analyzed, 3 (Hendry *et al.*, 2000; Guan *et al.*, 2005; Macpherson and Ziolkowski, 2005) mention the contribution of universities to the development of regions (and their industries), namely with regard to: 1) the acquisition of relevant quantitative and qualitative scientific and technological knowledge for corporate business, deriving from relations with academic specialists (Hendry *et al.*, 2000); 2) greater outputs for industrial technological innovation as cooperation with universities increases (Guan *et al.*, 2005); and 3) increase in the level of employment; diffusion of the best industrial production practices; greater encouragement in boosting industrial production to maximum levels of excellence; and greater credibility associated with local industrial business based on specialized techniques (e.g., *Total Quality Management and ISO norms*) (Macpherson and Ziolkowski, 2005).

Lam (2007) is the only author to mention the Open Innovation model in relation to U-E links, concluding that both universities and companies have a greater responsibility in the creation of an open cooperation model. Thus, with regard to the companies, for this open model to be possible, Lam (2007) mentions that it is necessary to establish long-term relationships with researchers, which enable career progress and will lead to a quality increase in the tasks accomplished, given the motivation created. Thus, the speed and flow of new knowledge and the continuity in R&D projects, translating a significant increase of competitiveness in business R&D, are considered important benefits, resulting from an open-to-the-outside model, based on relations with universities. According to Lam (2007), universities also play an important role in developing a stimulus system for cooperation, supplying the necessary resources and competences for the career progress of researchers.

TABLE 5

Empirical studies on the U-E relationship

Firm/ Institution	Country	Sector	N. ^o Firms	Question Research	Main Findings	Studies
Regional and industrial development from relations with universities (Studies related to regions, sectors or industries – "Meso" Studies)						
Small and Medium Enterprises of Optical-Electronic Sector	UK and USA	Optical and Electronic	59	Do universities contribute to the technological development of regional clusters for companies in the optical-electronic sector?	The contribution of the relationships studied is clear for innovation activities. Corporate earnings are given at 3 levels: (i) relationship with specialists with relevant scientific and technological knowledge, (ii) the recruitment of experienced engineers and (iii) collaboration of expertise in the improvement of products and processes.	Hendry <i>et al.</i> (2000)
University of Buffalo (Center for Industrial Efficiency)	USA	Automotive, Industrial Machinery, Electronic, Metal, Medical Instruments and Food	48	What are the businesses' input to the relations established with the University of Buffalo, and the importance of such cooperation for regional development in Western New York?	Business contributions: from sales improvement to the significant reduction of defective materials, through the possibility of economies of scale in production. Regional contributions: from significant increases in employment until the promotion of best practices in production, giving credibility to local businesses.	Macpherson and Ziolkowski (2005)
Medium and Large Enterprises Production	China	Industrial	950	What is the influence of partnerships between universities and industries in Beijing in terms of innovation?	Positive relationship between academic research and industrial innovation, i.e., the greater the collaboration, the larger technological outputs. The collaboration is less efficient in parameters such as sales and profits.	Guan <i>et al.</i> (2005)
Academic and business benefits resulting from cooperation (Micro Studies)						
Small and Medium Enterprises of Industrial Sector	Spain	Industrial	747	What benefits do companies gain by cooperating with universities and R & D?	The main business benefits range from increased activity in terms of R & D up to greater participation in other companies (domestic and foreign), to a greater involvement in international networks of knowledge.	Sáez <i>et al.</i> (2002)
Electronics Industry Project	Korea	Electronics Industry	82	In what situations do firms use universities and what are the benefits?	In situations of technological complexity and uncertain demand. The benefits are given in terms of opportunities to expand / diversify the product line and achieve technological capabilities.	Kim and Lee (2003)
Projects of Program "Advanced Technology Program (ATP)"	USA	Information Technology, Electronics, Biotechnology, Chemical and Energy	192	What kind of role do universities play and what are their contributions to entrepreneurship?	The role consists of reducing uncertainties and difficulties and increasing knowledge. The contributions are found in (i) acquisition of more knowledge to solve problems, (ii) increased preparedness to develop and commercialize technologies quickly and (iii) gaining awareness to investigate solutions to problems.	Hall <i>et al.</i> (2003)

Continue

Firm/ Institution	Country	Sector	N.º Firms	Question Research	Main Findings	Studies
TNT	USA	Professional Equipment Security	1	What contributions resulted from the cooperation between the University of Occupational Therapy in Indianapolis and TNT?	The contributions are at the level of increased awareness and knowledge in areas such as partnerships, strategic planning, corporate culture and shared values, needs and objectives.	Dale (2004)
University of Alberta (Engineering Center)	USA	Engineering	20 (27 projects)	What benefits (mutual) are gained when companies and universities cooperate?	Business Benefits: From the expansion of business in new directions to the greater international exposure. Academic benefits: from the increase in quality of knowledge to teach classes to the opportunities to commercialize the technology, through the gains in reputation in certain fields of research.	Heidrick <i>et al.</i> (2005)
Small Business	UK	Biotechnology	297	What is the university that contributes most to the success of companies and to what extent?	University of Oxford in the development of technological systems for the biotechnology industry. The proximity to the University of Oxford is leading the list of factors that contribute most to business success (progress) of the 297 companies analyzed.	Smith and Bagchi-Sen (2006)
Academic and business benefits resulting from cooperation (Micro Studies)						
University of Cyprus (School of Applied Sciences) and Small and Medium-Sized Enterprises (Alpha - fictitiousname)	Cyprus	Chemical-Agrarian	1	What are the critical factors that lead to relationships between the University of Cyprus and the company Alpha, and what the mutual benefits arising from the collaboration?	The relationships were due to factors such as the existence of informal contacts, development of a formal contract, academic ability to produce, transmit and disseminate knowledge of quality. Business Benefits: increase the potential of R & D, increased contacts with multinational and improving the image of the company due to its relationship with the University of Cyprus. Academic benefits: conference papers (6) and publications in scientific journals (1) and use of the company's laboratories by the scientific community for testing.	Hadjimanolis (2006)
Advanced Materials Company	Japan	Catalysts	455	Do the most experienced researchers contribute to better performance in terms of business innovation? To what extent?	Negative correlation between the experience of researchers and innovative business performance. Positive correlation between less experienced scientists and innovative business performance. The main business benefits focus on productivity increases in the R & D activities.	Baba <i>et al.</i> (2009)
				Open Innovation (Micro Studies)		
Large Firms (ICT1, ICT2, Pharma - Fictitious names)	UK	Information Technology and Communication and Pharmaceuticals	3	What conditions should be created for companies and universities to adopt an open model of cooperation and what are the benefits?	Establishing long-term relationships between researchers and companies that will allow scientists to develop in their careers, which results in rapid flow of new knowledge and continuity in R & D projects, reflecting significant increases in competitiveness in R & D enterprise. Universities should develop systems to encourage their researchers.	Lam (2007)

Source: Treatment of the authors based on data from EBSCO – EconLit e Business Source Complete (2009).

A micro-segmentation of Table 5 is still possible in terms of the analysis of factors that are at the base of the relations developed by universities and enterprises. The studies found that the relationship starts on the basis of informal contacts (it later becoming necessary to establish a formal contract) and the capacity of the university to produce, transmit and diffuse quality knowledge (Hadjimanolis, 2006). Geographical proximity is the major element in these relationships (Smith and Bagchi-Sen, 2006).

From the brief overview of the empirical literature on U-E relations, it can be seen that one of the papers (Lam, 2007) explicitly refers to the OI model, explaining which mechanisms both companies and universities should develop to institutionalize a more open cooperation model. The Open Innovation model is not explicitly mentioned in the remaining (1) empirical papers. In the same way, among the (12) empirical studies, only 2 (Heidrick *et al.*, 2005; Hadjimanolis, 2006) mention the issue of gains obtained by universities from their relationship with companies; the remaining (10) studies are very focused on unidirectional gain, underrating, thus, the advantage that universities may obtain from such a relationship (Harwing, 2004).

Furthermore, the literature overview on the *Entrepreneurial University* by Rothaermel *et al.* (2007), involving 85 papers that cover the period from 2001 to 2005, is largely in line with the results presented above. It should be noted that none of the papers analyzed in this literature overview make explicit reference to the issues of Open Innovation. On the other hand, among the same 85 papers, only one (Gulbrandsen and Smeby, 2005) approaches, albeit in a very superficial manner, the question of gauging the gains to universities from collaborating with companies. More specifically, Gulbrandsen and Smeby (2005) examine the contribution of relations with enterprises for Norwegian universities, both in the research and business areas. Based on the results of a questionnaire directed to 1967 professors of 4 Norwegian Universities, Gulbrandsen and Smeby (2005) concluded that there was a positive effect in the universities' performance deriving from relations with companies. The main benefits are centred at the level of contacts with foreign researchers, an increase in scientific publications and an increase in applied research.

It should be noted that the majority of the studies presented by Rothaermel *et al.* (2007) follow lines of research other than OI, namely the reasons why some universities are more entrepreneurial than others (e.g., Meseri and Maital, 2001); the factors that may contribute to a very successful university in terms of academic-entrepreneurial nature (e.g., Clarysse and Moray, 2004); academic obstacles to the commercialization of technologies (e.g., Moray and Clarysse, 2005); the characteristics and roles of universities and the nature of the technology to be commercialized (e.g., Grandi and Grimaldi, 2005); and academic relations with external sources (e.g., Gubeli and Doloreux, 2005).

It is important to mention that, at an empirical level, the literature on U-E relations does not highlight, at least explicitly, the issue of the Open Innovation model. Its focus remains the advantages that companies may obtain from their relationship with universities, failing to analyze the gains which may arise for universities (Teixeira and Costa, 2006; Clarysse *et al.*, 2007). The perspective of mutual benefit is therefore largely overlooked by the current empirical literature (Harwing, 2004).

It is based on these gaps identified in the literature, namely the fact that the empirical literature has not focused explicitly on the issue of OI in U-E relations and the scarce empirical evidence regarding the gains obtained by universities from the relations established with companies, that this paper contributes to the field.

5. OPEN INNOVATION AND THE REDISCOVERY OF THE IMPORTANCE OF UNIVERSITY-ENTERPRISE RELATIONS: GAPS IDENTIFIED IN THE LITERATURE

In the overview presented in the previous sections, it is clear that empirical literature that focuses on U-E relations and adequately explains the dynamics of the OI model is scarce (Perkmann and Walsh, 2007; Rothaermel *et al.*, 2007). The large majority of the papers analyzed privilege unidirectional gain, that is, they focus especially on the advantages which companies may obtain from interactions with universities, failing to take into account and to analyze the advantages which may accrue to universities from such relations (Clarysse *et al.*, 2007; Lichtenthaler, 2008), and underestimating the perspective of mutual benefit (Harwing, 2004).

We additionally note that the literature pays little attention, empirically, to the mechanisms by which companies may obtain competitive advantage (via innovation) from the use of a more Open Innovation model based on relations with universities. None of the studies have explored the issue of the emergence, development and sustainability of U-E relations in the Open Innovation context (Perkmann and Walsh, 2007).

In fact, there is a certain bias in the studies focusing on business realities, in which relations with universities represent a trump in the management of innovation activities, as well as an advantageous portfolio which universities receive for relating with enterprises. It is based on these facts/gaps that we argue that a challenging and interesting path for future research would be the issue of the emergence, development and sustainability of U-E relations in an Open Innovation context by trying to understand the type of advantages that universities obtain from interacting with the corporate world.

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