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

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Bridging University-Firm relationships and Open Innovation literature: a critical synthesis

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Abstract

Open Innovation is understood as a flow of incoming and outgoing knowledge and technology which allows, at the level of a firm, the acceleration of the innovation process, as well as a faster establishment and access to new markets, for external use of that same innovation. This type of innovation includes technological innovation, which comes from internal and external sources, as well as different modalities of accessing the market and, therefore, commercializing the innovation.

Resorting to a bibliometric analysis, using Open Innovation as the search keyword, we found that the majority of the existing studies on OI is of conceptual character. On the one hand, from the scarce existing empirical studies, the issue of the relation University – Enterprise (U-E), one of the components of the open innovation model, is analyzed in a relatively superficial way neglecting, or not referring in the most appropriated way, the mechanisms by which companies could obtain (via innovation) competitive advantage through the exploration of a more open model of innovation based on the relationships with universities. On the other hand, the existing studies on U-E relations do not highlight, at least in an explicit way, the question of the open innovation model. Such studies are still highly directed to a unidirectional profit optic, that is, are too centred on the advantages which the enterprises will be able to obtain from the relation with the universities, failing taking into account the value that potentially goes to universities from such links.

Key-words: Open Innovation; U-E relations; Emergency; Sustainability; Benefits

1. Introduction

The innovation process is facing today deep changes in the way it is managed (Chesbrough, 2003). Innovation Management also faces new paradigms, consequence of several circumstances, like globalization, technological intensity (Chesbrough, 2003; 2004; Smith, 2004; Hemphill, 2005; Gassmann, 2006; Chesbrough and Schwartz, 2007). If, some years ago it was the five generations of the innovation models proposed by Rothwell (1985) that came up in the most well known scientific magazines of the management area, and the discussion about the dilemma of the innovating was started (Tidd et al., 2003), today, one of the major worries concerns a new paradigm of innovation management, mentioning explicitly the concept of Open Innovation (OI), proposed and developed by Henry Chesbrough (2003).

OI is one of the areas that has grown the most in terms of literature in the area of economy and innovation management in these past years, and that could be classified as emerging (Silva, 2008). In the OI model, not only are the internal efforts considered but also the external ones, in the sense of accelerating the innovation processes and exploring new markets (Gann, 2004; Chesbrough and Schwartz, 2007). In this model, the “technologies surplus”, that is, the technologies in “stock” are explored economically, since the OI model privileges different forms of accessing the market and therefore commercializing innovation, given the wide range of partnerships that are possible to establish (Chesbrough, 2003). Innovation management through an external opening model is checked both through the buying of technologies as well as their transfer to other organizations (Enkel et al., 2005; Chesbrough and Crowther, 2005; Lichtenthaler, 2008), whose achievement is possible through multiple ways, namely the licensing of intellectual property (Sheehan et al., 2004), the co-development of partnerships (Piller and Walcher, 2006; Van der Meer, 2007; Chiaroni et al., 2008; Belussin et al., 2008), the relationships between the companies and the scientific and technological system (Chesbrough, 2003; Harwing, 2004; Blau, 2007; Perkmann and Walsh, 2007; Link et al., 2008), the launching of new *spin off* companies (Parhankangas et al., 2003) and the fusions and acquisitions (Parhankangas et al., 2003).

It is important to mention that the majority of the existing studies about the OI paradigms are of conceptual character (Lopes and Teixeira, 2009). From the scarce empirical studies existent, the question of the U-E relation is analyzed in a relatively superficial way disregarding, or not referring in the most appropriate way, the mechanisms through which the companies may have competitive advantage (via innovation) through the use of a more Open

Innovation model based on the relationships with the university (Perkmann and Walsh, 2007; Rothaermel et al., 2007). On the other hand, the existing studies about the U-E relationships do not highlight, at least in an explicit way, the question of the open innovation model (Perkmann and Walsh, 2007; Rothaermel et al., 2007), being such studies still very focused on an unidirectional return optics, that is, they are too concentrated on the advantages that the companies may obtain from the relations with the universities, failing in the return analysis and summing up which could arise for the universities in such relations (Chapple et al., 2005; Collins, 2006; Perkmann and Walsh, 2007; Lichtenthaler, 2008). The perspective of double benefit is therefore belittled by the current empirical literature (Harwing, 2004). Actually, from the empirical point of view, detailed evidence about the emerging, evolution and sustainability of the U-E relationships and the way/mechanisms by which the companies and universities obtain advantages from such relations is missing (Perkmann and Walsh, 2007).

The objective of the current paper is to provide a critical revision that demonstrates the gaps mentioned above. Thus, the paper is organized in the following way: in the following section (section 2), we made a brief description of the Open Innovation model; in section 3, we summarized the empirical literature in the ambit of the Open Innovation model (OI), demonstrating the disregard for the University – Enterprise (U-E) relation; in an analog way, in section 4, we made a critical analysis to the U-E relation literature, highlighting the relative disregard of the Open Innovation entrepreneurial strategies. Finally, in the final section, we number the gaps identified in the cross-referencing of the OI literatures and the U-E relation.

2. A brief description of the Open Innovation model

OI was introduced in the literature of this specialty by Henry Chesbrough (2003) and it is assumed as a new concept for the 21st century. This new model, that contrasts with the traditional innovation model, that we believe prevailed during the 20th century, designated as *Closed Innovation* (Chesbrough, 2003), aims to create an increased value for the organizations, exploring for such both the internal potentialities of the company and the benefits deriving from a higher implication with external sources of knowledge.

In the closed innovation model, the competitive advantage of the enterprises was developed by the discovery of bigger and better ideas and was based on the efforts that occurred in their internal I&D labs (Chesbrough, 2003; 2004; Gann, 2004; Smith, 2004; Hemphill, 2005; Blau, 2007), where the investigation processes were developed and commercialized by the companies which invested intensively in their I&D. In this context, the projects which did not

follow the company's main activity would be kept in stock, waiting for an opportunity to be used (Gann, 2004; Hemphill, 2005; Blau, 2007), running the risk of such opportunities never arising. Thus, the profits derived from the strategic position which the enterprises occupied in the market, being reinvested in I&D originating new discoveries, resulting in a vicious cycle. In this ambit, the enterprises which did not present resources capable of financing the internal investigation would be found in clear competitive disadvantage, with the tendency to be surpassed by the competitors, becoming therefore obsolete (Smith, 2004; Alio, 2005). In this sense, the model refers to the conception of a company totally closed within itself, being highly confined to its "walls" (Chesbrough, 2003), where the business model is centered in the development of products based in internally developed technology and commercialized by the company managers (Chesbrough and Schwartz, 2007), where innovation requires tight control, and the interaction between companies, agents and cooperators does not exist.

With the increase of technological diversity offered by external suppliers with strong skills (Chesbrough, 2003; 2004; 2008), with the change of entrepreneurial strategy concerning the advantage of the existence of external options for technologies which are not used and are put away in the company (Chesbrough, 2003; Chesbrough and Schwartz, 2007; Chesbrough, 2008), with the increase of the qualified worker mobility, making it difficult to control their ideas and expertise (Smith, 2004; Chesbrough and Schwartz, 2007), and who tend to propagate tacit knowledge, the expansion of risk capital (Smith, 2004; Hemphill, 2005), and with the growing appearance of private investors who facilitated the financing of new companies and their efforts to commercialize ideas deriving from research labs (Chesbrough, 2003), the traditional model of innovation increasingly started to give way to another model of innovation management (Chesbrough, 2003; Smith, 2004) – the Open Innovation Model (OI) (Chesbrough, 2003).

Factors like globalization and the institutionalization of the information society (Anderson and Tushman, 1990; Collins, 2006; Gassmann, 2006) allowed the enterprises of many industries and sectors (e.g. semiconductors; communication systems; military equipment; biotechnology; automobile; pharmaceuticals) to start managing their innovation activities with base on 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 the 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 its relations with

external sources. It is because of this external relation intensification that Chesbrough (2003) mentions the need to instrumentalize an *extensive network of scouts*, based on a “scenario” of abundant knowledge (Kline, 1985; von Hippel, 1986; Lundvall, 1988; Powell et al., 1996; Coombs et al., 2003; Chesbrough, 2006; Hansen and Birkinshaw, 2007), potentializing an increasing flow of knowledge.

Open Innovation is checked based on two important components, which, however distinct, they inter-relate among themselves: the acquisition and the transfer of knowledge/technologies to other organizations (Enkel et al., 2005; Chesbrough and Crowther, 2005; Lichtenthaler, 2008). It is still possible to subdivide the model in other forms of purchase/selling of technologies, namely the intellectual property rights (Sheehan et al., 2004), the partnerships of co-development (Piller and Walcher, 2006; Van der Meer, 2007; Chiaroni et al., 2008; Belussin et al., 2008), the relation between companies and the scientific and technological system (Harwing, 2004; Blau, 2007), the launching of new *spin offs* companies (Parhankangas et al., 2003) and fusions and acquisitions (Parhankangas et al., 2003). According to the different forms of access to the market in an OI model, technologies are not used anymore in the enterprise, making its commercialization possible (Chesbrough, 2003; Hastbacka, 2004; Alio, 2005; Hemphill, 2005). OI allows multiple patterns of selling and buying innovation, granting management the choice of the more appropriate business model for their company.

Whichever the perspective of analysis of the OI model is, the main objective of this paradigm involves allowing companies to have new strategic tools that make possible the acquisition of higher increased value (Chesbrough, 2003), which may go through a detailed accompanying of the needs and likes of the consumers (Goffin and Mitchell, 2005), an increasing accompanying of the aggressiveness of the *players* (Goffin and Mitchell, 2005) or even obtaining significant cost reduction at the level of I&D (Gassmann, 2006; Collins, 2006; Chesbrough and Schwartz, 2007). Chesbrough (2003) mentions that these results will only be possible in a philosophy of share and synergy management, which requires a high organizational and relational level (Hastbacka, 2004; Kirschbaum, 2005). Kirschbaum (2005) mentions that all of this dynamics will only be possible if the organizations institutionalize a culture of openness, cooperation and network, highlighting this model as an “open mind state”.

According to Chesbrough and Appleyard (2007), other authors (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 the innovation communities and the innovation ecosystems (Moore) and the

relationship network (Shapiro and Varian). Also Rothwell (1992), based on the integrated and network innovation models, mentioned aspects related to OI. Thus, and related to the integrated innovation model, Rothwell (1992) highlights a parallelism (i.e., not sequential and not linear) between the I & D activities and the conception activities, tests, production, and marketing, besides focusing the integration of pluridisciplinary working teams and praising the 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, the inter-company cooperation, which may take different forms and where the technological branch plays, almost always, an important role (Lichtenthaler, 2008). Concerning the network innovation model, Rothwell (1992) considers the company as an open system, with borders becoming more diffused, thanks not only to the development of the information and communication technology (Gassmann, 2006), but also due to the active participation of the companies with external entities, namely the investigation centers and the universities (Perkmann and Walsh, 2007; Lichtenthaler, 2008; Leyden et al., 2008), noticing the important support from these organizations which accompany the product from its conception phase to its launching in the market, independently of the geographical location of the companies (Collins, 2006; Gassmann, 2006).

3. Open Innovation (OI) literature and the disregard of the University-Enterprise relation (U-E): a summary of empirical studies

Turning to bibliographic research made in the database EBSCO – *Condit e Business Source Complete* -, in relation to the theme ‘Open Innovation’ (search word), it was possible to determine that, until June 2009, the database contained a total of 114 papers, segmented in six big themes which were also subdivided in 19 different topics (cf. Table 1). From the six big existing themes, a micro analysis (where the study objects are companies, organizations or individuals) and a macro analysis (where the study objects are the economic areas or countries) of these themes is still possible. Therefore, and concerning the studies of macro character we can find the infrastructures which support the cooperation network and the technology transfer, the entrepreneurial character and technology transfer, the U-E cooperation/relation and the internal strategies/ skills in the innovation. Concerning the micro studies, we can find themes such as human resources and entrepreneurial culture. The issues about the U-E relation are found at a micro-macro level and incorporate the segment of studies 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	<i>Startups</i>
		Acquisition and Technology Transfer
		Business Models
	Cooperation, U-E Relations	Intellectual Property
		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).

From the 114 analyzed articles, 66 (58%) are of conceptual character, that is, they respect the literature revision/synthesis, whereas 48 (42%) are papers of empirical nature, that is, they imply the construction of empirical evidence through data collection and a test to a certain argument. Table 2 summarizes the number of conceptual and empirical papers existing by theme, as well as their importance in the total.

Table 2: Number and distribution (%) of the articles published in EBSCO related the theme of OI

Theme	Topic	Total artic.	% total	N° Conce artic.	N° 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
Innovation Communities		16	14.0	7	9	43.8	56.3	
Strategies/Internal expertise in innovation	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).

It is possible to state, through the analysis of Table 2, that besides the themes that allow us to evaluate the Open Innovation model, that is, the acquisition and exploration of technologies (Enkel et al., 2005; Chesbrough and Crowther, 2005; Lichtenthaler, 2008), the intellectual property rights (Sheehan et al., 2004), the co-development partnerships (Piller and Walcher, 2006; Van der Meer, 2007; Chiaroni et al., 2008; Belussin et al., 2008), the university-enterprise relation (Chesbrough, 2003; Harwing, 2004; Blau, 2007; Perkmann and Walsh, 2007; Link et al., 2008), the launching of the new *spin off companies* (Parhankangas et al., 2003) and the fusion and acquisitions (Parhankangas et al., 2003), other themes are being explored at the Open innovation level. Actually, a strong incidence in the OI literature about the issues of the innovation communities is seen, having this topic registered a total of 16

papers (14% of the total). Both in an empirical as in a conceptual basis, the issues about the innovation communities are centered at the level of the importance of the integration of customers/users in the conception of new products (e.g. Enkel et al., 2005) and their respective pertinence for the dissemination of new technologies, praising, in equal terms, the issue of the importance of the existence of virtual communities (e.g. West and Lakhani, 2008). With 15 papers total (13, 2%) we should still enhance the importance of the Information and Communication Technologies (ICT) in the Open Innovation model, where the main studies are directed to the contribution of technologies at the level of the construction of *on-line* communities and realtion networks (e.g. Rajkumar et al., 2004), as well as the conception of information systems which support decision making in Open Innovation models (e.g. Debackere and Veugelers, 2005).

The topic related to the explanation of the Open Innovation model, also presents a significant number (12) of papers representing about 10.5% of the total of the papers analyzed. This topic understands essentially papers of conceptual character (11) and focuses especially on the major differences between the open and closed innovation models (e.g. Chesbrough, 2003), the company benefits 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 theme related to Open Innovation concerns the business models of the companies in an open to the outside context, having the database recorded a total of 7 papers (6.1%). The major issues concerning this theme are centered in the strategic changes which the companies will have to go through due to a bigger exposure to the outside (e.g. Lichtenthaler, 2008). We should also highlight themes like I&D activity structure and the role of the middleman in the Open Innovation model. The theme of I&D activity structure, with 4 papers (3.5%), talks about the development of the physical structure and the structure of investment of the I&D activities in OI models (e.g. Scinta, 2008). In what concerns the role of the middleman, with a new innovation management model, with 3 papers (2.6%), we highlight their importance in the technology transfer process (Gassmann and Reepmeyer, 2005).

In relation to the U-E relation, there are 9 papers from the total (7.9%) not existing a significant difference between conceptual papers (5 – 55.6%) and empirical papers (4 – 44.4%) in this area of study.

The Partnerships and Cooperation Networks, or co-development Partnerships, as mentioned in the specialty literature (Piller and Walcher, 2006; Van der Meer, 2007; Belussin et al.,

2008; Chiaroni et al., 2008), is the Open Innovation area which has the greatest number of papers (15), which represents an importance of 13.2% in the total of studies presented, registering a greater number of conceptual papers (9) if compared to those of empirical nature (6) (Table 3). The central analysis issues are focused at the level of the importance of networking for problem solution and the pertinence of cooperation for the achievement of a greater efficiency at the level of I&D activities and technology commercialization (e.g. Veugelers and Cassiman, 2005). The issues of Technological Acquisition and Transfer present a significant number of papers (13), with an estimated percentage weight of 11.4%. In these papers, the most discussed aspects are the role of strategic planning in the activities of technology acquisition and transfer (Lichtenthaler, 2008) and the use of a middleman 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	N° Conce articles	N° 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 the University-Enterprise Relation (9 papers), the most highlighted aspects are basically at the level of technological acquisition and exploration (e.g. Lichtenthaler, 2008), the 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 relation (e.g. Perkmann and Walsh, 2007). With a total of 7 papers (6.1%), we find the issue of intellectual property, whose research follows the methodologies towards an efficient management of intellectual property (e.g. Slowinski and Zerby, 2008). Finally, and in relation to the *Startups* question, the database registered only one article (0.9%), and of empirical nature (0.0%), where the analysis slope is directed to technology commercialization.

The issue of the U-E relation has been seen as an extremely productive means for partnerships at the level of conception and development of new technology/knowledge

(Chesbrough, 2003; Harwing, 2004; Blau, 2007) as well as cost reducing (Chesbrough, 2003), where we can notice a significant scientific improvement in this field (McMillan and Hamilton, 2003; Hall, 2004; Mowery and Nelson, 2004; Owen-Smith and Powell, 2004; Link et al., 2008; Rothaermel and Ku, 2008). The investigation in this area has focused on factors/tendency that originate this increasing cooperation (e.g. Shane, 2005 *in* Perkmann and Walsh, 2007), as well as the respective obstacles deriving from this cooperation (Collins, 2006). At the level of Open Innovation, in particular, and according to the themes which allow us to evaluate the Open Innovation model, the issue of the U-E relation is still very little explored in a global analysis (involving only 7.9% of the total (114) of the analyzed papers, if compared with other aspects of the Open Innovation model, as for example, the Partnership and Relationship Networking (13.2%) and the Technology Acquisition and Transfer issue (11.4%). Additionally, from the studies analyzed at this level, none adequately referred the mechanisms through which the enterprises may obtain competitive advantage (via innovation) from the use of a more Open Innovation model based on the relation with the universities, not empirically demonstrating the emergence, evolution and sustainability of the U-E relation in an Open innovation context (Perkmann and Walsh, 2007; Rothaermel et al., 2007).

Table 4 summarizes the number of existent empirical papers at the level of U-E relation in an Open Innovation context. It is possible to confirm that the studies in analysis talk, essentially, about developed countries (e.g. United Kingdom, USA, Switzerland, Germany, Austria), predominating the analysis to the industrial sectors (e.g. Textile, Paper, Car Machinery, Electronics, Biotechnology). It is also understood that the majority of the studies depend on databases, demonstrating a lack of empirical evidence about study cases. The studies present still a common question which is very important, centered in the fact that the relation between the universities is important and beneficial for the companies, disregarding, however, the advantages that may occur for the universities for relating with the organizations. Common is also the fact that none of the previous studies explores the issue of the emergence, sustainability and mechanisms in the relation established between enterprises and universities.

It is important to state once again that the literature about the U-E relation, in the ambit of Open Innovation, in general, is still very little explored at an empirical level (7.9%), if compared with other forms of the model (e.g. Partnerships and Cooperation Networks – 13.2%). From the scarce empirical papers analyzed at this level, there was not any focus on the mechanisms by which the companies may obtain competitive advantage (via innovation) through the use of a more open model of innovation based on the relation with the

universities, not showing empirical evidence regarding the issue of emergence, evolution and sustainability of the U-E connections in an Open Innovation context (Perkmann and Walsh, 2007; Rothaermel et al., 2007).

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 the innovation of R & D, the adoption of a 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 is used by firms for innovation activities?	69% of UK businesses contact with universities in order to gain knowledge for their innovation activities.	Hughes (2007)
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 et al. (2008)
German and Austrian Industries	Germany Austria	Biotechnology, Pharmaceutical, Chemical Engineering, Electronic Machinery, Automotive	154	What kind of companies that, although reluctant to commercialization of technologies, buys 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).

4. The University-Enterprise (U-E) relation literature and the disregard of the Open Innovation business strategies: a summary of the empirical papers

In a similar way to Section 3, resorting to bibliographical research done on the *EBSCO – Condit e Business Source Complete* - database, but this time using the key word ‘Industry-University’ for research, we obtained a total of 171 articles, from which 159 (93%) are of conceptual nature and 12 (7%) are of empirical character. From the empirical studies analyzed about the university-business relationship, the majority (66.7%) has as major objective the analysis to enterprises, organizations, or individuals. Only three of the studies (25%) have as

target regions, sectors or industries, whereas one of the articles (8.3%) presents a mixed study, that is, it joins a micro and meso analysis. It is also important to state that the empirical analysis of the articles that talk about the U-E relation could be gathered in three great themes (cf. Table5): 1) regional/industrial development occurring from the relation with the universities; 2) business and academic benefits occurring from the cooperation and 3) Open Innovation.

From the analysis of the previous table, we conclude that there is some incidence in developed countries (e.g. UK, USA, China), where the analysis is centered in activity sectors considered industrial (e.g. electronics, catalyst, automobile), also making reference to several sectors like biotechnology and ICT. The majority of the studies are based on databases, given the great number of analysis observations, where the study case analysis is sparing (only 3 studies).

From the 12 empirical papers analyzed, 8 talk about the benefits that the companies obtain for relating with the universities. Compiling the information obtained in the studies, the benefits include: 1) a greater tendency for the companies to become more active in terms of I&D (Hadjimanolis, 2006; Baba et al., 2009) and internationalization (Heidrick et al., 2005); 2) greater business participation in investigation projects promoted by State entities, demonstrating the possibility of fund increase for such cooperation (Sáez et al., 2002); 3) significant changes in the 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); 4) decrease of the uncertainties and technological difficulties in the enterprises (Hall et al., 2003), demonstrating a greater capacity in problem solution (Heidrick et al., 2005), namely in cases of high levels of technological complexity (Kim and Lee, 2003); 5) greater business tendency to develop and commercialize technologies faster and conscience gaining facing the importance of the investigation for problem solution (Hall et al., 2003); 6) efficiency at the level of strategic planning and better critical conscience reagrding the issues related to business culture (Dale, 2004); 7) possibility for the companies to use the academic labs (Heidrick et al., 2005); 8) considerable increase at the level of sales and profit (Macpherson and Ziolkowski, 2005); 9) improvement in the competitive position of the companies, given the possession of more and better products and services and the application of technologies in related business areas (Heidrick et al., 2005);

Table 5: Empirical studies on the U-E relationship

Firm/ Institution	Country	Sector	N.° 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 evident 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 et al. (2000)
University of Buffalo (Center for Industrial Efficiency)	USA	Automotive, Industrial Machinery, Metal, Medical Instruments and Food	48	What are the business 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 are the largest technological outputs. The collaboration is less efficient in parameters such as sales and profits.	Guan et al. (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 ranging 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 et al. (2002)
Electronics Industry Project	Korea	Electronics Industry	82	In what situations 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 their contributions to entrepreneurship?	Role there is at reducing uncertainties and difficulties and increases 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) gains consciousness to investigate solutions to problems.	Hall et al. (2003)
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) provide companies and universities relate?	Business Benefits: Since 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 reputation in certain fields of research.	Heidrick et al. (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)

Firm/ Institution	Country	Sector	N.° Firms	Question Research	Main Findings	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?	Academic and business benefits resulting from cooperation (Micro Studies) 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	Contribute the most experienced researchers 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 et al. (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 career development, resulting 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)
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Source: Treatment of the authors based on data from *EBSCO – EconLit e Business Source Complete (2009)*.

10) 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, allowing substantial reductions of defect material, defect tax reduction and obtainment of scale economies (Macpherson and Ziolkowski, 2005); 11) networking increase with national and international companies, as well as multinational companies (Sáez et al., 2002; Hadjimanolis, 2006), besides a higher participation in international knowledge networks; and 12) 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 the profits that the universities could obtain if they relate with the companies, where the main merits are based in (Heidrick et al., 2005): 1) quality increase in the content taught; 2) commercialization opportunities for the developed technology; 3) production of more investigation activities; 4) closer relation with managers and enterprises (which provides a qualitative knowledge increase both for the teachers and for the students; 5) knowledge increase regarding the use of technologically more advanced material, reputation gaining in determined research fields; 6) recognition by the academic population for the work developed in relevant areas and acquisition of equipment donated by the companies. Also, the work of Hadjimanolis (2006) allows us to count up some of the advantages that the universities obtain from relating with companies, where the excellence is centered at the level of the papers in conferences and the papers published in scientific magazines, as well as the advantages at the level of the possibility of the scientific community to use the business labs for scientific tests.

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

Lam (2007) was the only author to mention the Open Innovation model in issues related to the U-E relation, concluding that both universities and companies have bigger responsibility in the

creation of an open cooperation model. Thus, concerning the companies, for this open model to be possible, Lam (2007) mentions that it is necessary to establish long term relationships with the researchers, which make possible career progress, which will lead to a quality increase in the tasks done, given the motivation created. This way, the speed and flow of new knowledge and the continuity in I&D projects, translating a significant increase of competitiveness in the business I&D, are considered important benefits, resulting from an open to the outside model, based on the relation with the universities. According to Lam (2007), the universities also have an important role, developing a stimulus system to the cooperation, supplying the necessary resources and competency for the career progress of the researchers.

A micro-segmentation of Table 5 is still possible in what concerns the analysis of factors that originate the relation developed by universities and enterprises, where the papers state that the relationship starts based on informal contacts (having the need to, afterwards, elaborate a formal contract) and based on the capacity of the university to produce, transmit and diffuse quality knowledge (Hadjimanolis, 2006), enhancing the geographical proximity as the major element in these relationships (Smith and Bagchi-Sen, 2006).

According to the brief summary made about the empirical literature concerning the U-E relation, it is possible to notice that one of the papers (Lam, 2007) referred explicitly to the OI model, explaining which mechanisms both companies and universities should develop to institutionalize a more open cooperation model with universities/companies. There is not, in the remaining (1) empirical papers, at least in an explicit way, a direct mentioning to the Open Innovation model. In the same way, from the (12) empirical studies, only 2 (Heidrick et al., 2005; Hadjimanolis, 2006) mention the issue of the profit obtained by the universities for relating with the companies, where the remaining (10) studies are very focused on the unidirectional gain, belittling, thus, the advantage that the universities may get for relating with companies (Harwing, 2004).

Also Rothaermel et al. (2007) literature summary about *Entrepreneurial University*, involving 85 papers that cover the period from 2001 to 2005, follows the same direction of the results exposed before. We notice that, regarding this literature summary, none of the papers in analysis makes, explicitly, reference to the issues of Open Innovation. On the other hand, from the same 85 papers, only one (Gulbrandsen and Smeby, 2005), approaches, even if in a very superficial way, the issue of summing up the university gain for relating with companies. More specifically, Gulbrandsen and Smeby (2005) investigated the contribution of the relation with the enterprises for the Norwegian universities, both in the investigation area as in the

entrepreneur area. Through a questionnaire to 1967 professors of 4 Norwegian Universities, Gulbrandsen and Smeby (2005) concluded that there was a positive effect in the performance of the universities due to the respective relationship with the companies. The main benefits are centered at the level of the contacts with foreign researchers, in the increase in scientific publications and in the increase of applied investigation.

We must mention that the majority of the studies presented by Rothaermel et al. (2007) talk about other lines of investigation rather than OI, namely, the reasons by which there are other universities which are more entrepreneurial than others (e.g. Meseri and Maital, 2001); the factors that may make a very successful university in terms of academic entrepreneurial character (e.g. Clarysse and Moray, 2004); the academic obstacles in the commercialization of technologies (e.g. Moray and Clarysse, 2005); the characteristics and roles of the universities and the nature of the technology to be commercialized (e.g. Grandi and Grimaldi, 2005); and the academic relation with external sources (e.g. Gubeli and Doloreux, 2005).

It is important to mention that, at an empirical level, the literature about the U-E relation does not enhance, at least in an explicit way, the issue of the Open Innovation model, being this literature still very centered in the advantages which the companies may take from their relation with the universities, failing in the summing up and analysis of the achievements which may arise for the universities in such a relation (Teixeira and Costa, 2006; Collins, 2006; Perkmann and Walsh, 2007; Clarysse et al., 2007; Lichtenthaler, 2008). The perspective of mutual benefit is therefore belittled by the current empirical literature (Harwing, 2004).

It is based on these gaps identified in the literature, namely the disregard of the empirical literature by not focusing explicitly on the issue of OI in the U-E relation and the scarce empirical evidence regarding the achievements obtained by the universities in the relation established with the companies that the current paper obtains scientific importance.

5. Open Innovation and the rediscovery of the importance of the University-Enterprise Relation: identified literature gaps

In the summary presented in the previous sections we noticed that the empirical literature which talks about the U-E relation and explains in an appropriate way the dynamics of the OI model is scarce (Perkmann and Walsh, 2007; Rothaermel et al., 2007). The great majority of the papers analyzed is centered in the optics of unidirectional gain, that is, they focus especially on the advantages which the companies may obtain from the interaction with the universities, failing in the counting and analysis of advantages which may derive for the universities in such

a relation (Teixeira and Costa, 2006; Collins, 2006; Perkmann and Walsh, 2007; Clarysse et al., 2007; Lichtenthaler, 2008), underestimating the perspective of mutual benefit (Harwing, 2004).

We additionally noticed that the current literature does not talk about, empirically, the mechanisms by which the companies may obtain competitive advantage (via innovation) in the use of a more Open Innovation model based on the relation with the universities not demonstrating the issue of the emergence, development and sustainability of the U-E relation, in the Open Innovation context (Perkmann and Walsh, 2007; Rothaermel et al., 2007).

Actually, there is a certain bias of the studies focusing on business realities to which the relation with the universities constitutes a real trump in the management of innovation activities, as well as an advantage portfolio which the universities receive for relating with the enterprises. It is based on these facts/gaps that we propose to investigate the issue of the emergence, development and sustainability of the U-E relation, in an Open Innovation context, besides trying to understand the type of advantage that the universities obtain for relating with the business tissue. To achieve this, we turned to the research done by Brisa, a Portuguese company which operates in the area of the transport infra-structures, which shows a remarkable opening index in terms of innovation (Lopes and Teixeira, 2009) and to which the relation with universities constitutes a real trump in the management of its innovation activities.

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