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Drivers and Effects of Strategic Alliances:

Theory and Empirical Evidence from the Bio-Pharmaceutical Industry

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Introduction

In the context of increasing internationalization and globalization of markets, major companies are discovering that they cannot go it alone or survive in a world of universal technological evolution and increasing intensity of competition without any collaboration with each other (Dussauge and Garrett, 1995; Doz and Hamel, 1998). Many companies have tried different strategies to keep up with the pace of globalization, including the option of strategic alliances. Companies have relied on this approach for various reasons such as achieving their economic goals (Williamson, 1975) supporting their business activities (Parise and Henderson, 2001) reducing uncertainty (Provan, 1982; Podolny, 1994), opening up opportunities to learn (Simonin, 1999), encouraging new technologies development, and positioning themselves in new markets (Porter, 1980; Hamel and Prahalad, 1994; Mohr and Spekman, 1994; Ireland *et al.,* 2002; Lo *et al.,* 2016). They also recognize that isolation is often the cause of failure in this era of globalization.

A strategic alliance is defined by a variety of researchers as a voluntary agreement that ranges from simple deals between one or more independent firms to a complete agreement that enables them to collaborate around common interests involving exchange, sharing or co-development of resources, products, technology or services (Gulati, 1998; Elmuti and Kathawala, 2001; Deeds and Rothaermel, 2003; Faems, Looy, and Debackere, 2005). Since the 1980s, the rate of formation of strategic alliances or organizational collaboration has accelerated in multiple industries (Stuart, 2005; Gulati, 2007) and alliances are particularly dominant in environments where learning and flexibility are required, such as in high-technology sectors (Eisenhardt and

Schoonhoven, 1996; Dussauge and Garette, 1999; Hagedoorn, 2002). Inter-organizational alliances as a specific mode of collaboration (Faulkner, 1995) are regarded as strategic options for responding to new competitive realities and fast-changing technology (Teece, 1986; Dunning, 1995; Narula and Hagedoorn, 1999; Castells, 2000; Parise and Henderson, 2001), and have been widely examined in various industries such as automotive (Burger *et al,.* 1993; Dyer, 1996), chemical (Ahuja, 2000), computers (Mayer and Argyres, 2004; Gulati *et al,.* 2007) and biotechnology (Powell *et al,.* 1996; Baum, Calabresen and Siverman, 2000; Rothaermel and Deeds, 2004, Gottinger *et al,.* 2010).

In this vein, the topic of strategic alliances has been the subject of several studies conducted in the field of management. Through this dissertation, my aim is to contribute to the existing work in this field by developing objective methodology to identify the main research results that constitute the historical evolution of strategic alliances and innovation and providing some empirical evidence on motives and effects in firm's strategic alliances. Basically, this study shed further light on the firms under study to understand the extent to which the technological diversification of firms has effects on the formation of strategic alliances. Moreover, this study demonstrates that the types of strategic alliances of firms related positively with their financial performance in contrast to the negative relationship between portfolio alliances and firms' financial performance.

This subject is important because present-day firms are more and more exposed to dynamic changes in their environment and are under pressure to innovate. In response, firms seeking technological development and improvements in their performance choose to cooperate with one another in an attempt to achieve their objectives. According to earlier research (e.g., Williamson, 1975; Zajac, 1990; Das and

Teng, 1998; Kauser and Shaw, 2004), strategic alliances are considered an interesting alternative in various markets that have different kinds of hierarchies and among different sized companies and can be domestic or cross-border in scope (Bleeke and Ernest, 1995). These companies aim to minimize the costs of research and development while remaining as separate businesses, making strategic alliances distinct from mergers and acquisition (M&A). Unlike the latter, where firms unite and establish a single new legal entity, companies in strategic alliances maintain their identities through time-limited (short or long-term) agreements. None of the partners has total control over the mutual venture, expect in the areas of cooperation in which each party gains particular benefits from the agreement. However, each partner in an alliance has complete authority over the work it performs, and it retains flexibility. Consequently, this type of alliance, despite some limitations in what it can achieve, is more effective than direct acquisitions for business and it allows them to adapt to change under conditions of environmental uncertainty. Also, the rapid access to new knowledge and reduced learning time from partners appears more appropriate in strategic partnerships than formal organizational structures such as M&As (Park and Ungson, 2001; Hagedoorn, 2002).

In this dissertation, I have chosen to explore the biopharmaceutical industry, which has an extremely high level of responsibility for providing secure and safe treatment for patients (Toma Pysny, 2011). In addition, this industry is an example of a dynamic international network, and it is one of the most profitable industries in the high-technology sectors. Therefore, this industry offers a suitable field for this study, because of the regular establishment and increasing number of alliances created between companies in this area (Hagedoorn, 1993; Rothaermel and Deeds, 2006; Marhold, Kim, and Kang, 2016). Furthermore, this industry facilitates the transfer of

technology and best practices (Koka and Pescott, 2008), and it is in a constant state of change.

Therefore, in this environment, which is characterized by rapid innovation, strong competition and significant investment, firms are obliged to join forces if they want to progress and survive (Rothaermel, 2001). Even the large bio-pharmaceutical companies cannot impose themselves on the market without resorting to the skills, expertise and capabilities of others (Hegdoorn, 1993). They are facing a significant challenge with this revolution among industries.

Since the early 1960s, the concept of strategic alliances has emerged, and in the bio-pharmaceutical industry the development of the penicillin drug was a determinant in this (Makelvey and Orsenigo, 2001). Some scholars, such as Belussi and Orsi (2015), cite this period as the start of a partnership between the public sector and private sector organizations in providing drugs. Over the years, the concept has evolved a solid body of information has formed regarding strategic alliances within this industry.

Given the importance and extensive nature of strategic alliances, this study draws from two major streams of research in the management literature: internal technological innovation and firm performance with particular reference to strategic alliances. A rich body of literature has been compiled on both subjects over the years, drawing from many theoretical backgrounds. Although many studies have identified different factors driving firms' engagement in bio-pharmaceutical alliances and their different impact on their partners, none of them focuses on specific types of strategic alliance, and they do not provide empirical evidence regarding technological diversification and firms' financial performance. For all these reasons, the investigation of the contributing factors that influence firms to collaborate with one another and of the

impact of specific types of strategic alliances on firms' performance within the bio-pharmaceutical alliances has been selected as an appropriate research topic. Further investigation and identification of opportunities in these fields would be of significant value to both academics and business management sector.

This study aims to investigate the principal motives driving strategic alliances and the impact of these alliances within the bio-pharmaceutical industry. To achieve this aim, this dissertation makes three main contributions. The first contribution is to improve comprehension of this phenomenon by highlighting the knowledge structure associated with the product innovation field in recent years. The second contribution is to deepen understanding of the role of internal technological innovation in propelling companies to forge strategic alliances with other firms. Previous research does not show in what situation the diversification of technology leads the organization to engage in alliances, knowing this would enable managers to improve their strategies and use innovation more effectively. The third contribution is to analyze the outcome of inter-organizational partnership types and their associated portfolios on internal performance by considering the financial aspect, identifying the types of strategic alliance that influence the financial performance of firms, enabling managers to understand better which type they should choose to improve their performance. Additionally, managers should be better able to understand the significance of choosing to engage in one or more alliances.

To achieve this goal, this thesis addresses four research questions:

RQ1: what is the intellectual structure of strategic alliances and product innovation in the past years?

RQ2: how can technological development lead companies to engage in different strategic alliances?

RQ3: Do alliances portfolios affect partners' financial performance?

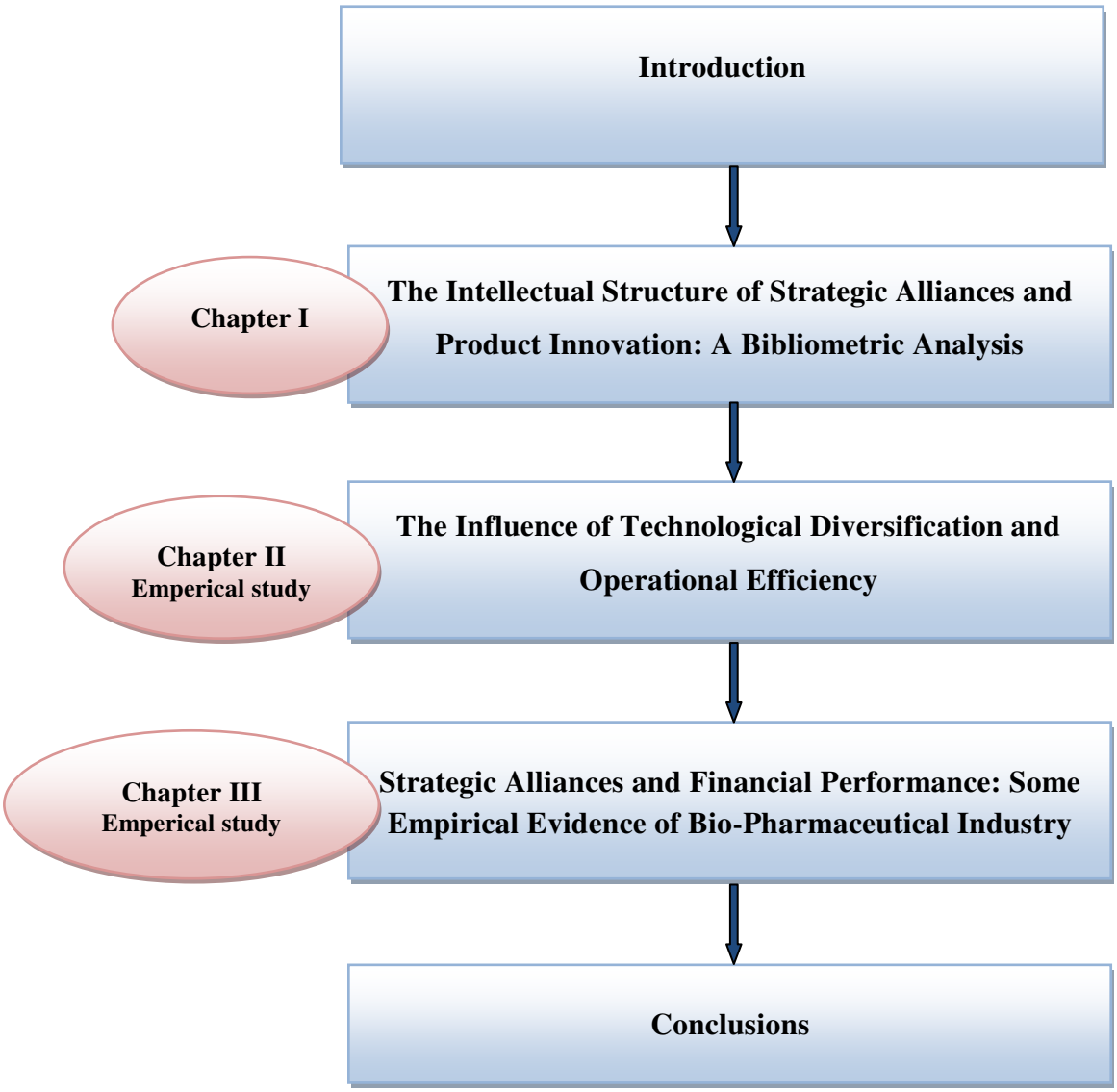
RQ4: What kind of strategic alliances allow organizations to attain financial performance results in their partnership?

To answer these questions, both quantitative and qualitative research methods are employed.

The thesis is structured as follows. After this introduction, which provides motivations and goals to be reached, chapter I sets out the intellectual structure of strategic partnerships and innovation in the recent years. An overview of the literature on previous research is discussed. In addition, different research streams integrating the various elements contributing to the creation and development of the main clusters in this area are identified and reviewed. Then, chapter II covers the role of firms' internal performance in forging partnerships between two or more parties in their market arena. A sample of literature and definitions of strategic alliances and diversified technology are presented. In chapter III, the focus is on the outcome of inter-organizational partnership types and their portfolios on internal performance by looking at the financial aspect. Finally, the conclusion will summarize key findings, limitations and set up an agenda for future research.

Such a study is highly relevant both at the theoretical level and at the managerial level as it allows researchers and also managers to understand better the elements that contribute to the emergence and development of this field of the study of strategic alliances.

Figure 1: Structure of the present dissertation



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Chapter I

The Intellectual Structure of Strategic Alliances and Product Innovation: A Bibliometric Analysis.

Abstract

The purpose of this study is to identify the intellectual structure of strategic alliance and product innovation studies embedded in all the articles published amongst the journals in Social Science Citation Index (SSCI), and Science Citation Index Expended (SCI-Expended) during the period of 1997 – 2016. A total of 399 research papers were extracted to conduct bibliometric citation and co-citation analysis by using social network techniques to perform a visualization of the past and present structure of this field. The results of analysis allowed us to identify four main clusters, mapped and labeled as follows: Strategic network, technological change and organizational capabilities, competitive and coordination, and collaboration and innovation.

Keywords: *Strategic alliance, Product innovation, Bibliometric, Citation analysis, Co-citation analysis, Clusters.*

1. INTRODUCTION

Over the past decades, strategic alliances (SAs) have increased steadily since the mid-1980s (Hagedoorn, 1993; De Man and Duysters, 2005). They can be defined as collaborative agreements among two or more organizations to share different resources (Anand and Khanna, 2000), entering novel markets and increasing their strength in one or more key strategic area like technology and products (Yashino and Rangan, 1995; Harzing, 2002; Koza and Lewin, 1998), for the purpose to pursuing common goals that would be difficult to attain by acting alone (Dussauge and Garrett, 1995; Doz and Hammel, 1998). Strategic alliances are voluntary agreements involving the sharing of knowledge and expertise among partners, or co-development of new products, technologies or services exchange (Gulati, 1998; Dacin, Oliver, and Roy, 2007). In context, there are different kinds of alliances categorized as equity and non equity agreement joint ventures, license agreement, long-term supply agreements, and other forms of inter-firm collaboration (Porter, 1990; Preece, 1995).

The research on strategic alliances and product innovation has advanced substantially especially in the last two decades, producing a greater number of books, journal articles and other documents. Once a scientific discipline has attained a certain stage of maturity, the next step by academics and researchers interested on the discipline will be to conduct literature reviews and empirical studies to assess the general state of the art (Ramos-Rodriguez and Ruiz-Navarro, 2004). The literature on the subject of strategic alliances contains many analyses of alliances and alliance-related innovation (Di Guardo and Harrigan, 2012). However, it is commonly asserted that this field is largely dispersed and fragmented and lacks a coherent identity (Nag *et al.,* 2007). Thus, while the relevance of alliance research is not questioned, there are still various

interpretations about its key theoretical contributions to the different research it draws upon and the need to create a coherent framework to map it (Meier, 2011). Consequently, it is of interest in the present study to evaluate the existing literature by conducting a bibliometric study for the combined strategic alliances and product innovation fields. Of course, bibliometric research methods have been employed to review and identify the major academic topics in several scientific disciplines without subjective bias (Zupic and Cater, 2015). Moreover, it will be helpful to visualize the division of this specific thematic field, as well as to map the knowledge structure and the evolution of literature in this domain over the years in order to understand its accumulated knowledge, thus setting some potential future directions of research by which experienced and novice scholars may structure their research agendas in a proper way.

In this paper, we employ bibliometric techniques on 399 articles published over a period of twenty years in several ranked business and management journals. Our decision to focus our study on the period from 1997 to 2016 is justified due to the increase in research articles being published about strategic alliances and the product innovation field during the period. Our sample was collected from Clarivate Analytics *Web of Science* (WoS) database developed by the *Institute for Scientific Information* (ISI) of Philadelphia, This database is the most frequently-used database for bibliometric studies and is already integrated in most university subscriptions so it is easily accessible for academic researchers. This source contains citation and co-citation data for numerous academic publications and bibliographic references as well as the development of the major commonly used software packages (e.g, BibExcel and VOSviewer) for conducting bibliometric analyses. We adopt a quantitative method (White and McCain 1998), by performing analyses of citation frequencies and co-

citation networks in order to posit an intellectual structure and examine the major knowledge subfields within the academic literature that deals with strategic alliances and product innovation.

Through this research, we intend to contribute to the combine alliances and product innovation literature in three ways. First, delineate the most cited publications about inter-firm alliances and product innovation and determine their evolvement in this area as represented in the academic literature. Second, determine the relationships, if any, between the subfields. Third, mapping the intellectual structure of the main clusters of this area in a two-dimensional space, and visualize general relations among them.

This paper is structured as follows. In the next section "Methodological Overview", we provide an overview of the previous bibliometric studies and methods involved in strategic alliances and product innovation. Then the section of "Methodology", we explain the database constructed for analysis and the method of analysis applied to evaluate the evolution of intellectual structure of this field. Next in the "Results" section, we present the results of the analysis. And finally, we present the conclusions.

2. METHODOLOGICAL OVERVIEW

Pritchard (1969) was the first who coined the term bibliometrics defined as "the applications of mathematics and statistical methods to books and other media of communication" (Pitchard 1969, *p.349*) before this methodology began to be used in other disciplines. Recently, De Bellis (2009) defined bibliometrics as a set of methods to analyze scientific and technological literature quantitatively. In the same line, Henderson et al. (2009) confirmed that recently bibliometrics have been used in quantitative research assessment exercises of academic output for the purpose of

cataloging, classifying and quantifying knowledge in a specific discipline. Moreover, this type of analysis refers to "the collection, the handling, and the analysis of quantitative bibliographic data, derived from scientific publications" (Veerbek *et al.,* 2002).

Bibliometrics is a traditional and established tool for statistically analyzing the literature in a field (Garfield 1993; Small 1993). Bibliometric studies use different methods to trace relationships amongst academic journal citations. The most commonly used bibliometric methods are citation and co-citation analysis. So, it can be used to map the knowledge structure and the use of literature. Citation analysis is based on the examination of the frequency, patterns, and graphs of citations in articles and books (Garfield, 1983) to draw links between works or researchers. Most of the researchers in a given discipline tend to communicate among themselves to enhance the validity of a scientific study on a given concept. Citation analysis posits that Authors cite the important references in their field when doing their research, supposing that the document cited are likely to have a greater effect on the study field than those that are not mentioned (Small, 1973). Co-citation analysis is also one of the most efficient tools which grew in popularity in the 1970s as a method used for identifying and visualizing the relationships among articles or authors in a specific thematic field, thus understanding its intellectual structure (White and McCain, 1998; Ponzi, 2002; Ramos-Rodriguez and Ruiz-Navaro, 2004; Di Stefano *et al.,* 2010) through the maps, and the changes in the literature over time. Two documents are co-cited when they are both cited by the same third document. Co-citation analysis, records the frequency with which a pair of documents are cited together and how that mutual citing evolves over time (Pilkington and Meredith, 2009), it can be used as an indicator of the past and present activities in a scientific field (Garfield, 1993; Small, 1993). The co-citation

studies identify which areas, Authors, sources, and research methods are central to a field and its changes over time (Di Guardo and Harrigan, 2012).

Management scholars are not strangers to bibliometrics research (McCain, 1991), several areas of management research have applied bibliometric methods to assess their progress, among them strategic management (Ramos-Rodriguez and Ruiz-Navarro, 2004; Nerur *et al.,* 2008; Furrer *et al.,* 2008 ;Di Stefano *et al.,* 2010; Petraf *et al.,* 2013; Ferriera, Fernandes, and Ratten, 2016), innovation (Fagerberg *et al.,* 2012; Merigo *et al.,* 2016), research in human resource management (Garcia-Lillo, Ubeda-Garcia, and Marco-Lajara, 2016; Markoulli *et al.,* 2016), and operation management research (Fahimnia, Sarkis, and Davarzani, 2015; Merigo and Yang, 2016).

To attain our objectives in this study we conduct bibliometric methods of citation and co-citation analysis to the most important publications addressing strategic alliances and product innovation.

3. METHODOLOGY

The citation and co-citation data was gathered from *Social Science Citation Index* (SSCI) and the *Science Citation Index Expended* (SCI-Expended), available on the online *Web of Science* (WoS) database developed by the *Institute for Scientific Information* (ISI) of Philadelphia. This database contains many academic publications and bibliographic information identifying authors, affiliations and the frequently of citations.

Table 1.1. *Strategic alliances & product innovation publications counts on the WoS for the period of 1997-2016*

Year of Publication	Sum of SAs & PIs documents Published on WoS	Year of Publication	Sum of SAs & PIs documents Published on WoS	Year of Publication	Sum of SAs & PIs documents Published on WoS	Year of Publication	Sum of SAs & PIs documents Published on WoS
1997	3	2002	8	2007	14	2012	36
1998	6	2003	12	2008	22	2013	30
1999	2	2004	13	2009	29	2014	33
2000	10	2005	11	2010	30	2015	36
2001	5	2006	17	2011	40	2016	42

The research incorporated the *Web of Science Core Collection* database without any chronological filter, searching the key terms in the option TOPIC, the software searched every article by either title, abstract, or keywords "strategic alliances*" and "product innovation*" related to the subject in order to ensure the broadest possible search. The articles about strategic alliances and product innovation published in management and business category journals were our unit of analysis.

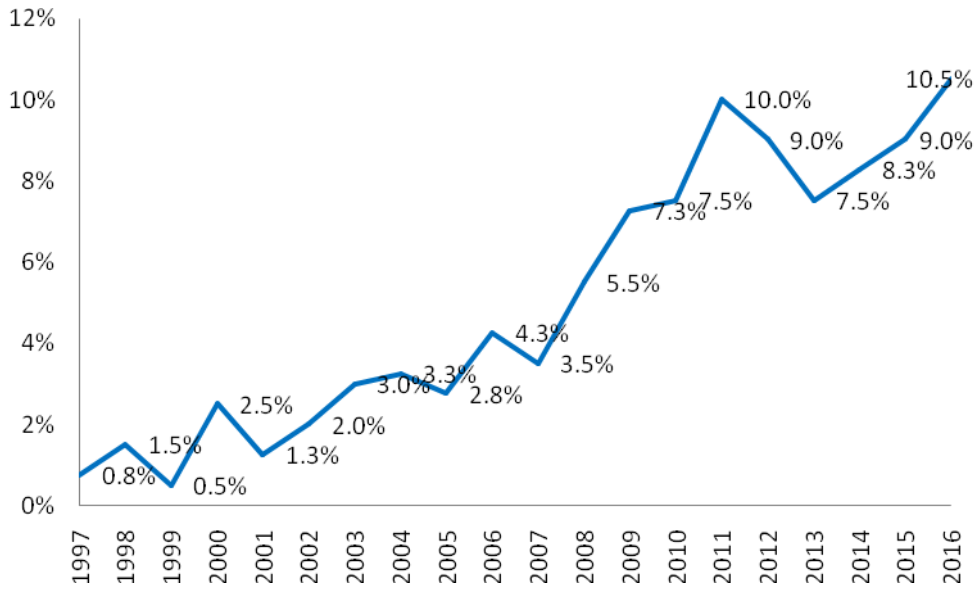


Figure 1.1. *Evaluation of Publications on Strategic Alliances & Product Innovation.* ***Source****:*https://apps.webofknowledge.com/CitationReport.do?product=WOS&search_mode=CitationReport&SID=R2WLhl42YvUUnkX3X8n&page=1&cr_pqid=1&viewType=summary&colName=WOS.

We identified a total sample size of 399 articles published between 1997 and 2016 (see *Table 1.1* & *Figure 1.1*) that comprise our final sample distributed in Management (338 documents) and Business (237 documents) areas, with 19 441 cited references, with an average of 48.72 references per paper. It is likewise important to highlight that only articles published in the listed journals were taken in consideration.

The 30 academic journals with the most relevant impact during the period studied in the field of management and business yielded a set of 295 contributions corresponding to 9.8% of the total references returned by the search shown in the *Table 1.2*. Using a large sample of documents collected from different academic journals avoided the possible bias that a study conducted in a single journal could have produced (Ferreira, Storopoli, and Serra 2014).

The Journal of Production Innovation Management takes the first rank in terms of the number of articles (35) that form the cited sample, followed by the International of Technology Management, Strategic Management Journal, and the Technovation (22), Research Policy (19), Industrial Marketing Management and R&D Management (15), and Journal of Business Research and Technology Analysis and Strategic Management (12).

The selection of citations from articles constitutes standard practice adopted in the implementation of this type of study which helps to increase the reliability of the results obtained (Garcia-Lillo, Ubeda-Garcia, and Marco-Lajara, 2016). The documents retrieved were directly downloaded in (tab-delimited (win)) plain text format to be treated, after their conversion, through BibExcel program, a public domain software program downloadable from the Internet for free, developed by Professor Olle Persson *et al.,* (2009) to collect and organize the dataset.

Table 1.2. *Distribution of articles by journal (Top 30)*

Journals	Impact Factor 2016 (a)	5-Year Impact Factor	Number Of Articles (b)	% (c)
Journal of Product Innovation Management	3.759	4.358	35	1.2
International Journal of Technology Management	1.036	1.106	22	0.7
Strategic Management Journal	4.461	6.652	22	0.7
Technovation	3.265	4.822	22	0.7
Research Policy	4.495	6.265	19	0.6
Industrial Marketing Management	3.166	4.402	15	0.5
R & D Management	2.444	2.913	15	0.5
Journal of Business Research	3.354	4.108	12	0.4
Technology Analysis & Strategic Management	1.273	1.686	12	0.4
Academy of Management Journal	7.417	11.901	9	0.3
Journal of Engineering And Technology Management	2.419	2.985	9	0.3
Long Range Planning	3.547	6.297	9	0.3
Journal of Business Venturing	5.774	8.284	8	0.3
Journal of Management Studies	3.962	7.236	8	0.3
IEEE Transactions on Engineering Management	1.188	1.943	6	0.2
Industrial And Corporate Change	1.777	2.36	6	0.2
International Journal of Operations & Production Management	3.339	4.211	6	0.2
Journal of Marketing	3.654	5.31	6	0.2
Journal of Technology Transfer	2.631	2.777	6	0.2
Organization Science	2.691	6.145	6	0.2
Journal of Operations Management	5.207	8.618	5	0.2
Management Decision	1.396	2.515	5	0.2
Management Science	2.822	4.131	5	0.2
Technological Forecasting And Social Change	2.625	3.226	5	0.2
Asia Pacific Journal of Management	2.024	2.647	4	0.1
British Journal of Management	2.982	3.754	4	0.1
Journal of Management &Organization	0.539	0.807	4	0.1
Research-Technology Management	2.429	2.441	4	0.1
Industry And Innovation	0.791	1.534	3	0.1
International Journal of Project Management	4.034	4.383	3	0.1

Notes: *(a) Data retrieved from JCR Journal Citation Reports 2016. (b) Number of articles published in the journal for the period 1997 to 2016. (c) Percentage of articles published.*

Then we applied VOSviewer version 1.6.5 software (Van Eck and Waltman, 2009; 2010) for the creation, visualization, and exploration of bibliometric maps which combine the VOS mapping technique with VOS clustering technique. The VOSviewer is a new mapping technique that can be used as an alternative of the well-known

technique of Multidimensional Scaling (MDS) (Van Eck and Waltman, 2010) in order to construct and visualize co-occurrence networks of most terms extracted from a body of scientific literature. This new software includes an option to cluster authors, journals or institutions by similar topic or field in colorful nodes. In our study this software was used in order to identify citation and co-citation relationships between articles of our field and to map these linkages.

4. RESULTS

The results obtained at the end of the various stages are present in this section. As mentioned previously, in this paper we conducted a bibliometric study comprising citation and co-citation analyses. It was our objective to identify the most cited articles within our sample to create a basis for cluster development. To achieve our goal we employed citation analysis, which involved collecting all bibliographic references from the 399 articles in the sample published on the Web of Science in order to examine citations. The original 399 documents cited 19 441 publications. The *table 1.3* illustrates the set of most cited articles with a minimum of 30 citations per article about strategic alliances and product innovation as determined by the citations counts during the period from 1997 to 2016. The descriptive study of the mentioned articles shows the article by Brown (1997) was the most cited documents with a total of 1304 citations received. It was followed by Stuart (2000), Rothaermel and Deeds (2004), and Grant (2004). They were cited 698, 641 and 607 times, respectively. In addition, articles by Rosenkopf and Almedia (2003), Li (2001), Dhanaraj and Parkhe (2006), Andersson *et al.,* (2002), Faems *et al.,* (2005), Belderbos *et al.,* (2004) were among the top ten cited documents.

Table 1.3. *The set of most cited articles on strategic alliances and product innovation during 1997 to 2016, (from most to least cited).*

Rank	***Author/Year***	***Total Citations***
1	Brown (1997)	1304
2	Stuart (2000)	698
3	Rothaermel (2004)	641
4	Grant (2004)	607
5	Rosenkopf (2003)	480
6	Li (2001)	459
7	Dhanaraj (2006)	424
8	Andersson (2002)	419
9	Faems (2005)	380
10	Belderbos (2004)	380
11	Gans (2003)	357
12	Rothaermel (2001)	339
13	Oxley (2004)	324
14	Hoang (2005)	299
15	Lichtenthaler (2009)	272
16	Lavie (2010)	251
17	Zahra (2002)	250
18	Schilling (2001)	247
19	Leiblein (2003)	244
20	Rothaermel (2006)	221
21	Gilsing (2008)	220
22	Lichtenthaler (2009)	211
23	Robertson (1998)	196
24	Dittrich (2007)	183
25	Narula (2004)	180
26	Fang (2008)	164
27	Lichtenthaler (2011)	163
28	Gerwin (2002)	160
29	Rothaermel (2001)	159
30	Tiwana (2008)	158
31	Rothaermel (2006)	148
32	Knudsen (2007)	146
33	Miller (2007)	143
34	Rigby (2002)	143
35	Wadhwa (2006)	139
36	Fey (2005)	138
37	Tsai (2009)	136
38	Zahra (2000)	134
39	Lin (2007)	123
40	Santamaria (2009)	116
41	Bierly (2009)	114
42	Mesquita (2008)	111
43	Bingham (2011)	110
44	Li (2002)	110
45	Swaminathan (2009)	108
46	Blomqvist (2005)	107
47	Nicholls-Nixon (2003)	103
48	Bekkers (2002)	99
49	Quintana-Garcia (2004)	98

Rank	*Author/Year*	*Total Citations*
50	Faems (2010)	95
51	Nielsen (2009)	94
52	Hess (2011)	93
53	Lichtenthaler (2006)	89
54	Soh (2003)	82
55	Chen (2011)	79
56	Maurer (2011)	78
57	Azadegan (2010)	77
58	Arranz (2008)	77
59	Carey (2011)	74
60	Gerwin (2004)	74
61	Mudambi (2010)	73
62	Kalaignanam (2007)	73
63	Deeds (1999)	73
64	Chung (2003)	72
65	Schilke (2014)	71
66	Duysters (2011)	69
67	Kwak (2009)	69
68	Bhaskaran (2009)	67
69	Cooper (2000)	67
70	Su (2009)	66
71	Gerwin (2004)	66
72	Rosenkopf (2007)	65
73	Ritala (2013)	63
74	Deeds (2003)	63
75	Lin (2012)	62
76	Belderbos (2010)	62
77	Lee (2007)	62
78	Maurer (2010)	60
79	Sherwood (2008)	60
80	Tatikonda (2003)	58
81	Bozdogan (1998)	58
82	Chiesa (2004)	57
83	Li (2008)	56
84	Azadegan (2008)	56
85	Wu (2012)	53
86	Hughes (2007)	53
87	Mayer (2006)	52
88	Fukugawa (2006)	49
89	Bosch-Sijtsema (2009)	48
90	Perez-Luno (2011)	47
91	Padula (2008)	46
92	Bouncken (2013)	44
93	Knudsen (2011)	44
94	Perks (2006)	44
95	Wagner (2010)	43
96	Burgers (2008)	43
97	Rothaermel (2002)	43
98	Yamakawa (2011)	42
99	Zhang (2010)	42
100	Cui (2012)	41
101	Harryson (2008)	41

Rank	Author/Year	Total Citations
102	Nambisan (2011)	40
103	Tsai (2009)	40
104	Hernandez-Espallardo (2011)	39
105	Patzelt (2008)	38
106	Park (2014)	37
107	Kohtamaki (2013)	37
108	Robertson (2012)	37
109	Zhao (2011)	37
110	Alguezaui (2010)	37
111	Talke (2010)	36
112	Freeman (2007)	36
113	Ritala (2015)	35
114	Tsai (2011)	35
115	Fang (2011)	35
116	Li (2009)	35
117	Lavie (2012)	33
118	Corsaro (2012)	33
119	Al-Laham (2011)	33
120	Lin (2010)	33
121	Witzeman (2006)	33
122	Hofmann (2012)	32
123	Valkokari (2012)	32
124	Durand (2008)	32
125	Chesbrough (2008)	32
126	Grunwald (2007)	32
127	Chen (2005)	32
128	Dunlap-Hinkler (2010)	31
129	Lee (2007)	31
130	Kodama (2007)	31
131	Defee (2010)	30

Overall, observation tells us that the most cited articles were published (except Brown's article 1997) in the period of 2000-2004. The distribution of these articles by top 30 journal indentify *Strategic Management Journal* as far and away the single largest source of citations (4059) among the most 100 cited documents, followed by Research Policy (1764), *Academy of Management Journal* (1727), *Journal of Production Innovation Management* (1495), and *Journal of Management Studies* (1173) respectively, making them the most prominent journals in the field. The 30 journals with greatest number of citations are presented in *Table 1.4*.

Table 1.4. *Distribution of citations by journal (Top 30)*

Journals	**Total Citations**	**Proportion (TC) (a)**
Strategic Management Journal	4059	184.5
Research Policy	1764	92.8
Academy of Management Journal	1727	191.9
Journal of Product Innovation Management	1495	42.7
Journal of Management Studies	1173	146.6
Technovation	951	43.2
Management Science	903	180.6
Journal of Business Venturing	587	73.4
Academy of Management Review	498	249.0
Journal of Marketing	398	66.3
R & D Management	335	22.3
Industrial Marketing Management	257	17.1
Journal of Operations Management	234	46.8
Journal of Business Research	211	17.6
Long Range Planning	208	23.1
Academyof Management Perspectives	203	101.5
International Journal of Technology Management	184	8.4
Organization Science	173	28.8
Journal of Management	140	46.7
Journal of Engineering And Technology Management	134	14.9
International Journal of Project Management	133	44.3
IEEE Transactions on Engineering Management	118	19.7
Strategic Entrepreneurship Journal	113	37.7
Journal of Supply Chain Management	91	30.3
British Journal of Management	82	20.5
Asia Pacific Journal of Management	79	19.8
Industrial And Corporate Change	77	12.8
Journal of International Marketing	67	22.3
Technology Analysis & Strategic Management	66	5.5
Management Decision	63	12.6

Notes: *(a) Average of Total Citation.*

The co-citation is the most common method used to examine the relationships between two prior articles cited together in a sample of documents (Di Stefano *et al.,* 2010). Co-citation analysis is conducted to map the interrelationships in the intellectual structure of strategic alliances and product innovation studies. *Table 1.5* show the results of a co-citation matrix constructed by pairing every article with each other article, using BibExcel to count the number of times every pair of bibliographic documents had been

cited together or co-cited frequently. As a results, co-citations range from 1 to 69. The *Appendix A* shows those whose frequency is ≥30. In addition, by using the social networks VOSviewer software automatically labeled the clusters of the co-cited pairs. Four groups of papers have been produced by the cluster analysis mapping in VOSviewer showing closely linked documents (see *Appendix B*, tables from 6 to 9 for the complete list of every cluster). The clusters derived from mapping are characterized depending on the references contained. Hence, the clusters produced are the following:

- Cluster 1: Strategic network (red color);
- Cluster 2: Technological change and organizational capabilities (green color);
- Cluster 3: Competitive and coordination (blue color);
- Cluster 4: Collaboration and innovation (yellow color).

The relationships among these groups constitute the intellectual structure of a field (Leydesdorff and Vaughan, 2006). Articles in a specific group share the same co-citation profile. Basically, those articles treated similar broad research question without any obligation to have same results. Clusters of references near to the boundaries of the map are globally related to fewer neighbors (Van Eck and Waltman, 2016). The frequency with which a reference is cited is not the concern if the main focus of the study is co-citation. Hence, the frequency of citation does not necessarily indicate the weight of contribution to a knowledge group.

The co-citation networks and its density illustrated in the figure 1.2 and 1.3 respectively, show the structure of strategic alliances and product innovation research in the period analyzed. Concerning the results obtained and in order to clarify different perspectives related to the four clusters identified and to better understand how they are closely linked to each other, we will start our analysis using the papers that play an axial role in each group.

The first cluster has by far the greatest number of works comprised thirty-eight articles associated with research on the social networks analysis related to learning alliances and innovation. Powel, Koput, and Smith-Doen (1996), investigated samples of dedicated biotechnology firms during the period of 1990-1994 to explain that the complexity, extensiveness, and diverse sources for knowledge bases in an industry, the area of innovation can be achieved through collaborative learning networks that provide entry in the field rather than trying to enter as individual firms with more limited knowledge. For their part, Rothaermel and Deeds (2004) investigate the causal relationship between exploration-exploitation firm alliances and its product development. Moreover, they verified the moderating effect of firm size on new product development. The authors' survey 325 biotechnology firms engaged in 2565 alliances over a 25 year period, finding strong support leading from exploration alliances for an integrated product development system to products on the market. Furthermore, they also found that the product development path is moderated negatively by firm size and the firms possessing a higher patenting propensity tend to enter in more exploitation alliances and have a broad number of products on the market. Hagedoorn (1993), contributes to this debate by clarifying the motives that lead firms to engage in partnerships in their efforts to innovate as an alternative to both markets and hierarchies. Based on a large model of alliances the author found that market and technology-related are two basic categories that dominate the firm's motivations for interfirm cooperation. Nevertheless, Deeds and Hill (1996) carried out an empirical study of entrepreneurial biotechnology firms based on data from 132 companies in this area focused on the firm level, giving answer to the key question regarding the relationship between the number of strategic alliances the firm enters and the rate of new product development. They found generalizable results beyond the biotechnology industry. Their study provides

strong evidence to support the U-shaped relationship between the number of strategic alliances and the rate of new product development. Overall, firms that have an increasing number of partnerships see fewer benefits in the area of new products development with low-level firms. In contrast, at high level the additional strategic alliances costs outweigh the benefits. Finally, Baum, Calabrese and Silverman (2000) investigated the early performance effect of variation in a startup's alliance network composition by linking theory and research on alliance networks and on the firms. The analysis of 142 Canadian startup biotechnology firms during a six year period from 1991 to 1996, showed that early differential performance of biotech startups produced variances in the alliance networks at their foundation. Moreover, the firm's size and age affects the performance of new biotechnology firms.

The second cluster with a total of thirty articles is concentrated on technological change and organizational capabilities. Overall, the common theme of this group is analysis of the motivation to form strategic alliances as a sign of the company's innovativeness. In particular terms, Cohen and Levinthal (1990) focused on the factors that influence absorptive capacity at individual and organizational level. They argue that the development of absorptive capacity and innovative performance is path-dependent defined as the ability of a firm to recognize the value of new external information, assimilate it, and apply it to commercial end. The Authors suggest that innovative capability, a firm's absorptive capacity is largely a function of the firm's level prior related knowledge. They show a model of firm's R&D investment which suggests that absorptive capacity appears to be part of a firm's decision in allocating resources for innovative activity. Kogut and Zander (1992), put forth the theory of the knowledge of the firm that neglects the problem of individual motivation by focusing on organizing principles as the primary unit of analysis for understanding the variation in firm

performance and growth. They suggest that firms learn new skills by recombining their current capabilities. Moreover, the cumulative knowledge of the firm provides options to expand in new but uncertain markets in the future. March (1991) introduces the organizational learning into this debate, focusing on the exploitation of old certainties and the exploration of new possibilities. He surveys some complications in allocating resources between two general situations involving the development and use of knowledge in organizations. His main conclusion is that adaptive processes sustaining exploration are likely to be effective in the short run but self-destructive over the long run, and that the development of knowledge may depend on maintaining an influx of the naïve and ignorant, and that competitive victory does not reliably go to the properly educated. Lane and Lubatkin (1998), contribute to the inter-organizational learning research by reconceptualising the firm-level construct as a relative absorptive capacity. In their study, the authors used a sample from the population of R&D alliances among pharmaceutical and biotechnology companies. Their findings suggest that as competition becomes more knowledge-based, a firm must develop a thorough understanding of its own knowledge, the processes by which it converts knowledge to capabilities, and the capacity of those capabilities to meet the demands of its environment. The results of technological level change are treated as an adaptation of existing technologies developed by others. Finally, Hamel (1991) surveyed nine international alliances, producing an understanding of the determinants of inter-partner learning. Collaboration among the firms might provide opportunities for them to internalize the skills and abilities of each other, so that they develop their states in both circumstances, with and without the alliances. The author suggests that asymmetries in learning change, the partners' bargaining power, longevity and stability can be

incompatible with their allies' success. The partners may have become competitive which is more useful than structure in determination of learning outcomes.

The third cluster contains 28 articles which are focused on coordination and the competitive advantages of strategic alliances identified in the literature. The central contribution on this theme is offered by Dyer and Singh (1998) who emphasize that the relationships between firms constitute an increasingly important unit of analysis to explain the creation of competitive advantages. The authors examine the prospective sources of inter-organizational rent-generating process and the instrument that serve to preserve relational rents. Their analysis suggests that even the importance of the competitive advantage inside firms and industries, a singular focus of this analysis may limit the explanatory power to explain firm level profitability. Building relational capital, Kale *et al.* (2000) discuss the reasons that drive firms to engage in alliances and the protection of their own core proprietary assets. Providing empirical evidence using large sample survey data to highlight the significance of alliance management practices, the finding shows that managing conflicts integrative held among the alliances partners, and building relational capital help firms simultaneously to achieve alliance objectives and also leads to the success of alliances. The extension of classic statements of embeddedness and understanding of organization networks are offered by Uzzi (1997) who has drawn on ethnographic work at 23 entrepreneurial companies focused on fleshing out the concept of structural embeddedness of relationships which shapes organizational and economic results. His findings suggest that embedded actors' acknowledgement of differences between arm's-length and embedded ties help to specify an actor's capacity to access the opportunities of a contact or network strategically depending on the excellence of the relationship that link them as well as its management. Nahapiet and Ghoshal (1998) focus on the identification of the

interrelationship between social and intellectual capital in the context of exploring and explaining the source of organizational advantage. They suggest that the importance on the co-evolution of the two forms of capital gives a dynamic perspective on the development of organizational advantage. The authors show that the lines of intellectual capital are intensely embedded in social relations and in the structure of these relations. Lastly, they find that knowledge and knowledge process are major foundations of organizational advantage. Finally, to examine the factors that elucidate the choice of governance structure in inter-firm alliances Gulati (1995) use a singular emphasis on transactional costs, economics and sociological theory based on a multi-industry data (biopharmaceutical, new materials, and automotive economic sectors) by American, European, and Japanese firms on alliances formed between 1970 and 1989. His study shows that alliances, defined as "any independently initiated interfirm link that involves exchange, sharing, or co-development", that cover shared R&D are likely to be equity based than non R&D alliances. There is also strong support for the idea that frequent alliances among two partners are less likely to be formed than other alliances using equity. Finally, the results show that international alliances are more likely to be equity-based than domestic alliances.

The last of these clusters, cluster four, is comprised of only six articles: Faems et al(2005), Nietro (2007), Ahuja (2001), Das (2000), Belderbos (2004), and Tether (2002), all of these articles focus on the involvement of the collaboration within the context of the innovation process. Empirical evidence on innovation and inter-organizational collaboration for the innovative performance of firms is examined by Faems, Looy, and Debackere (2005). They examine the suggestion that inter-organizational collaboration supports the effectiveness of innovation strategies. The analysis is based on data from 221 Belgian manufacturing companies gathered from the

community innovation survey. The study finds a positive relationship between inter-organizational collaboration and innovative performance. In other words, collaboration between different types of partners coincides with diverse types of innovation. The conclusion is that the more firms engage in a variety of inter-organizational collaboration, the more likely they are to create new improved products that are commercially successful. Along these same lines, based on the concept of product innovation Nietro and Santamaria (2006) show how collaboration and the composition of networks can explain or facilitate product innovation achievements as well as increase their degree of novelty. The theoretical and empirical analyses are based on a longitudinal study of Spanish manufacturing sector in the period from 1998 to 2002 finding that: (1) firms enhance their knowledge base by looking for adapted partners to collaborate with. Technological collaborative networks are fundamental to realizing a higher degree of novelty in product innovation. (2) the continuity of collaboration and the composition of the collaborative network are highly significant dimensions. (3) collaboration with suppliers, clients and research organizations impact positively the novelty of innovation, though collaboration with rivals has a negative impact. Empirical evidence from the chemicals industry supports the model of Ahuja and Lampert (2001) who explain how established firms create breakthrough inventions. The authors argue that by experimenting with novel, emerging, and pioneering technologies firms can overcome these traps and create breakthrough invention. Their study finding firms varied in their use of entrepreneurial strategies and that utilizing these entrepreneurial strategies led to superior invention performance. Das and Teng (2000) discuss the role of four essential components of resource-based view theory of strategic alliances: rationale, formation, structural preferences, and performance. They suggest that imperfect mobility, imitability and substitutability promise accentuated value-creation

and thus facilitate alliance formation. Moreover the authors proposed a new typology of partner resource alignment based on two dimensions of resource similarity and resource utilization, yielding four types of alignment: supplementary, surplus, complementary, and wasteful. Moreover, they show that the collaborative inter-firm avoids the problems of conflicts in alliances as the technological locations and creation of market transaction, which in turn allow partners to pool resources and exploit complementarities that contribute to alliance performance. Finally, Belderbos, Carree, and Lokshin (2004) investigate the impact of research and development cooperation and knowledge spillover on productivity performance for the period of 1996-1998 of Dutch innovating firms. They distinguish between different types of R&D partners with competitors, suppliers, customers, and universities and research institutes in first part and two performance measures: labour productivity and productivity in innovative sales on the other part. Their result was to find major heterogeneity in the rationales and goals of R&D cooperation with different partners.

In the same vein, the last author in this group, Tether (2002) survey UK data on innovative firms to investigate the patterns of co-operation between innovating firms and external partners. The analysis finds that R&D cooperation is frequently results in firms engaging in superior level innovative activities instead of incremental innovation.

Lastly, a visualization of the intellectual structure of research on strategic alliances and product innovation achieved by VOSviewer as identified in the co-citation network *Figure 1.2*, show us that the clusters are connected by some articles that are recognized by the analysis as playing the role of bridges.

Figure 1.2. Co-citation network of Strategic alliances and Product innovation. Using VOSviewer map and cluster techniques

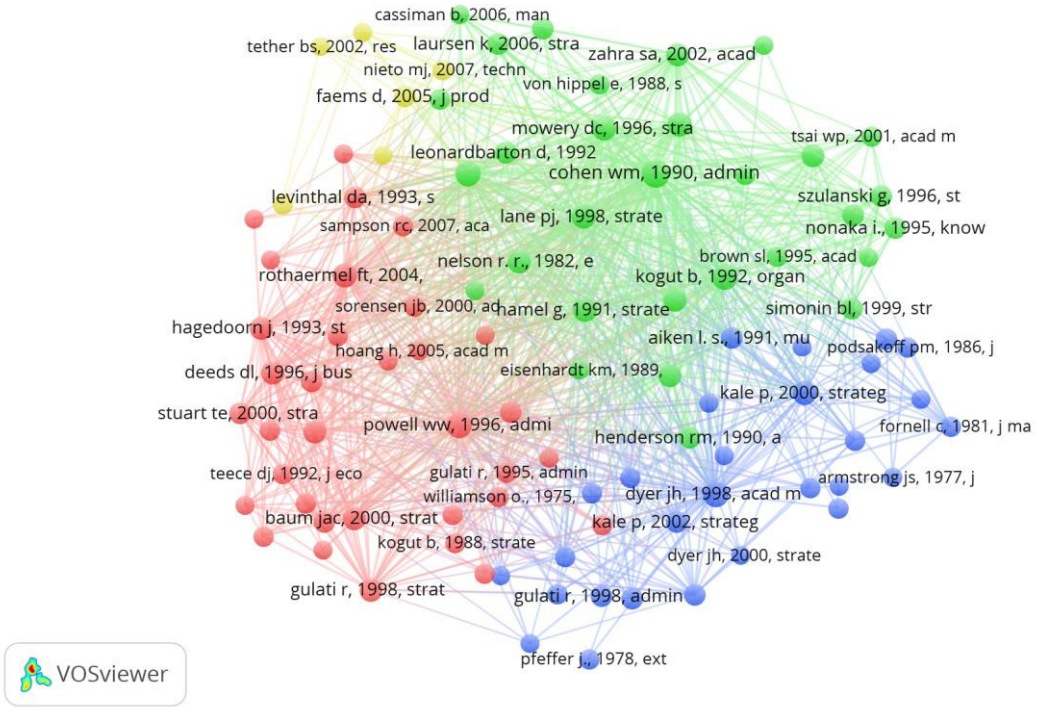
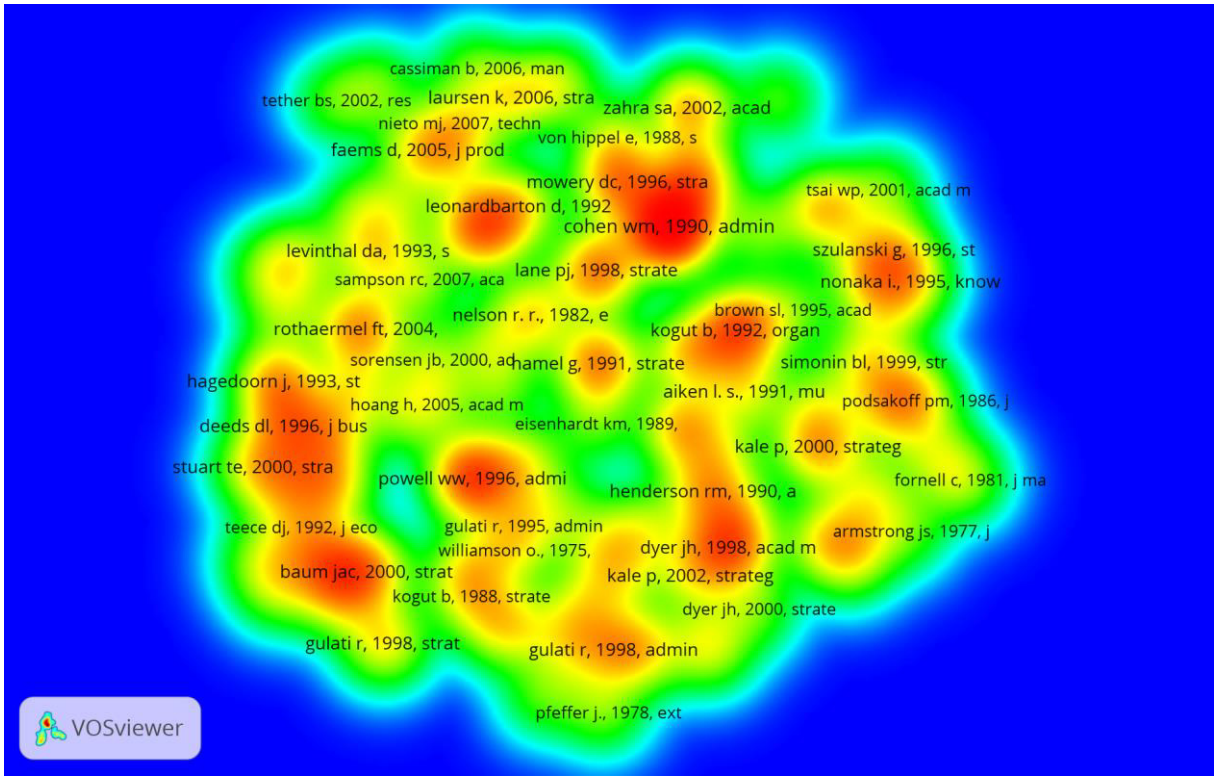


Figure 1.3. Density visualization of Co-citation network of Strategic alliances and Product innovation



Also we have observed that strategic networks, technological change and organizational capabilities have been the dominant subjects of the research conducted. In the visualization, each article is represented by a label and a circle. The bigger size circle of a document explains its greater importance among the others in the same group and its correlate circle will have a greater volume. Small size circle represent articles which are cited fewer times. In general the closer two documents are located to each other in the visualization, the more strongly they are related based on number of co-citation. The colors indicate clusters of articles that are relatively strongly related to each other.

Generally, while the software VOSviewer can be used to create and visualize the bibliometric maps from any type of co-occurrence data, the utilization of that software is limited and does not authorize the creation of networks. Also, this application has no processing capabilities, for that reason it was necessary to use other software like BibExcel to prepare the data for the analysis and network visualization. In addition, more insights can be achieved by density visualization of clusters based on the paper proximity analysis. Hence, *Figure 1.3* illustrate the density visualization of the co-cited references of the intellectual core: in this figure the article densities are translated into colors using a color scheme, the red stains represent areas of highest article density, and the blue color corresponds with lowest article density. Font size relates to the frequency of specific articles and the position of articles in relation to one another represents the degree of relatedness of terms. Therefore, *Figure 1.3* offers insights into the frequency of terms and their association to substantial research activity, as well as the relationship various important items have to each other. According to Van Eck and Waltman (2016) the Item density of each point in the map has a color depending on the proximity of the items and the weights of neighboring items. The larger the number of items in a point

neighborhood and the smaller the distances between them and the interest point, the higher the item density. In addition, the higher the weights of neighboring items, the higher the item density. On the whole, colors show the sum of attention that the researchers give to a specific topic in various fields of a concept map (Van Eck and Waltman (2010).

5. DISCUSSION AND CONCLUSION

Drawing from various theoretical backgrounds of document citation and co-citation analyses applied to the bibliographic references cited on 399 articles published in different academic journals during the period of 1997-2016, this study attempts to shed light on the most significant works that examined the intellectual structure underlying strategic alliances and product innovation literature during twenty years of research.

Bibliometric study provides a quantitative analysis of the previous research on a given discipline or subject, and is a good complement to other types of literature review. By using the data and results of studies based on bibliometric techniques, we are better able to understand the scope of the field, its seminal works, developments, theories, and dominant paradigms. Hence, we adopted this approach to aggregate the results of our cluster analysis resulting in the four themes that formed the basis of our interpretation. The key contribution of this study is reflected in the fact that it is among the first studies to review product innovation combined with strategic alliances. The use of quantitative analysis, particularly citation and co-citation analysis, permitted us to provide an appropriate instrument for researchers to identify the intellectual structure of the literature and new opportunities for future research as well as to set their work in the

field under investigation. In the same line this study has a strong support for the results obtained in other contents studies. In addition, it provides qualitative and quantitative researches in present literature concerning the strategic alliances. For instance, the bibliometric study of (Di Guardo and Harrigan, 2012) classified the research topics into four approaches as follow: network approach, industrial organization approach, economics of strategy approach, and learning and transfer approach. It furthermore supports Ferreira, Storopoli, and Serra (2014) whose analysis revealed similar study themes. Notwithstanding they categorized the theoretical streams into transaction costs, Knowledge-based and learning arguments, and social networks.

This study contributes to the literature and to quantitative research in existing academic studies on strategic alliances, specifically combined with product innovation Our analysis suggests that there are four different research streams that constitute the strategic alliances and product innovation literature: -cluster 1- Strategic networks (in red color) focusing on various aspects explaining the knowledge transfer in an alliances as well as the relationship between learning alliances and innovation associated with social network analysis. Articles in this group are frequently cited and bear the strong imprint of the literature field as shows on the map. These suggest that the authors' research has an immense impact and represents core strength within the context of strategic alliances and product innovation field. -cluster 2- Technological change and organizational capabilities (in green color) not far than the last cluster, this one takes an important position in the innovation and alliances literature. We observe that this cluster focus on the motivations' analyzes of strategic alliances as a carriage of the company's innovation. This result suggests that mutual internal and external organization capabilities can improve the technological innovation. -cluster 3- Competition and coordination (in blue color) focusing on coordination and the competitive advantages of

strategic alliances identified in the literature. Results constitute using the transaction costs economics and sociological theory to analyse the creation of competitive advantages, -cluster 4- Collaboration and innovation (in yellow color) focusing on the impact of the collaboration within the context of innovation process. The articles in this last group are generally more recent and fewer than the other groups. All the six articles were published between 2000 and 2007. The results from our cluster analysis indicate that strategic alliances and product innovation literature still fragmented albeit, but there are a growing number of citations on this topic over the previous two decades.

After looking at the intellectual structure of strategic alliances and innovation in detail, I identified firms expanding the range of their strategic partnerships to improve their performance. As noted by Yamakawa, Yang and Lin (2011) firms' performance are related to strategic alliances. Based on the outcomes of this study, looking at the firms performance is predictive of future success, and revealed there is indeed modest empirical evidence on the performance consequences for firms engaging into strategic alliances.

Particularly, little is known about the effect of individual and portfolios' strategic alliances which in particular types affect the firm's performance in an intensive industry. Therefore, future research should look at the formation of particular types of strategic alliances and their relationship with a firm's performance by providing empirical evidence on strategic alliances and firm's performance.

In particular, it has be considered that the older articles tend to accumulate a greater number of citation, the older articles were cited more often and only a handful of more recent papers are among of the most cited.

Appendix A

Table 1.5. *The list of publications containing Authors pairs co-cited more than 30 times*

Co-Citations frequency	Article 1	Article 2
69	COHEN WM, 1990	Lane PJ, 1998
69	COHEN WM, 1990	Powell WW, 1996
68	COHEN WM, 1990	KOGUT B, 1992
67	COHEN WM, 1990	March JG, 1991
64	COHEN WM, 1990	Zahra SA, 2002
59	COHEN WM, 1990	Mowery DC, 1996
54	COHEN WM, 1990	HAMEL G, 1991
53	COHEN WM, 1990	Grant RM, 2004
53	COHEN WM, 1990	Grant RM, 1996
49	COHEN WM, 1990	Dyer JH, 1998
48	COHEN WM, 1990	Rothaermel FT, 2004
47	March JG, 1991	Rothaermel FT, 2004
46	Powell WW, 1996	Rothaermel FT, 2004
46	Grant RM, 1996	KOGUT B, 1992
45	March JG, 1991	Powell WW, 1996
44	Ahuja G, 2000	Powell WW, 1996
44	Baum JAC, 2000	Powell WW, 1996
44	KOGUT B, 1992	Mowery DC, 1996
43	KOGUT B, 1992	Lane PJ, 1998
43	KOGUT B, 1992	Powell WW, 1996
43	Lane PJ, 1998	Powell WW, 1996
42	Ahuja G, 2000	COHEN WM, 1990
41	COHEN WM, 1990	Kale P, 2000
41	Dyer JH, 1998	Gulati R, 1998
41	LEVINTHAL DA, 1993	March JG, 1991
40	KOGUT B, 1992	March JG, 1991
40	March JG, 1991	Mowery DC, 1996
39	HAMEL G, 1991	Lane PJ, 1998
39	Dyer JH, 1998	Powell WW, 1996
39	Dyer JH, 1998	KOGUT B, 1992
39	Gulati R, 1998	Powell WW, 1996
38	Grant RM, 2004	March JG, 1991
38	Lane PJ, 1998	Zahra SA, 2002
38	Mowery DC, 1996	Powell WW, 1996
37	COHEN WM, 1990	Nelson R. R., 1982
36	Gulati R, 1995	Powell WW, 1996
35	COHEN WM, 1990	HAGEDOORN J, 1993
35	Lane PJ, 1998	Mowery DC, 1996
35	Grant RM, 1996	Zahra SA, 2002
35	HAMEL G, 1991	KOGUT B, 1992
35	BARNEY J, 1991	COHEN WM, 1990
34	COHEN WM, 1990	Teece DJ, 1997
34	COHEN WM, 1990	GULATI R, 1995
34	Lane PJ, 1998	March JG, 1991
34	HAMEL G, 1991	Powell WW, 1996

Co-Citation frequency	Article 1	Article 2
34	COHEN WM, 1990	Zollo M, 2002
34	March JG, 1991	Zahra SA, 2002
34	COHEN WM, 1990	NONAKA I, 1994
33	Grant RM, 2004	KOGUT B, 1992
33	COHEN WM, 1990	Laursen K, 2006
33	Dyer JH, 1998	Lane PJ, 1998
33	Powell WW, 1996	SHAN WJ, 1994
32	Baum JAC, 2000	COHEN WM, 1990
32	Chesbrough H. W., 2003	COHEN WM, 1990
32	Ahuja G, 2001	COHEN WM, 1990
32	Dyer JH, 1998	Kale P, 2000
32	COHEN WM, 1990	Szulanski G, 1996
32	COHEN WM, 1990	Gulati R, 1998
32	Grant RM, 1996	March JG, 1991
32	Grant RM, 2004	Lane PJ, 1998
31	Dyer JH, 1998	March JG, 1991
31	Grant RM, 1996	Lane PJ, 1998
31	Grant RM, 2004	Grant RM, 1996
31	COHEN WM, 1990	LEVINTHAL DA, 1993
31	COHEN WM, 1990	Nonaka I., 1995
31	Dyer JH, 1998	Rothaermel FT, 2004
31	Dyer JH, 1998	Gulati R, 1995
31	Ahuja G, 2000	Baum JAC, 2000
31	Rothaermel FT, 2004	Rothaermel FT, 2001
30	Grant RM, 2004	Powell WW, 1996
30	Lane PJ, 1998	Rothaermel FT, 2004
30	Baum JAC, 2000	SHAN WJ, 1994
30	KOGUT B, 1992	Nelson R. R., 1982
30	COHEN WM, 1990	Katila R, 2002
30	Kale P, 2000	KOGUT B, 1992
30	COHEN WM, 1990	Hagedoorn J, 2002

Appendix B

Cluster 1 defined 34 articles (in red)

Id	Cited Reference	Co-citation links
11139	powell ww, 1996, admin sci quart, v41, p116	1744
11749	rothaermelft, 2004, strategic manage j, v25, p201	1317
5785	hagedoorn j, 1993, strategic manage j, v14, p371	991
1184	baumjac, 2000, strategic manage j, v21, p267	939
3602	deeds dl, 1996, j bus venturing, v11, p41	884
8370	levinthal da, 1993, strategic manage j, v14, p95	841
12305	shanwj, 1994, strategic manage j, v15, p387	804
5683	gulati r, 1998, strategic manage j, v19, p293	801
13260	teecedj, 1986, res policy, v15, p285	783
13021	stuart te, 2000, strategic manage j, v21, p791	727
310	ahuja g, 2000, admin sci quart, v45, p425,	687
10994	pisano gp, 1990, admin sci quart, v35, p153	620
7786	kozamp, 1998, organsci, v9, p255	610
11746	rothaermelft, 2001, strategic manage j, v22, p687	581
311	ahuja g, 2000, strategic manage j, v21, p317,	555
7681	kogut b, 1988, strategic manage j, v9, p319	555
5681	gulati r, 1995, admin sci quart, v40, p619	540
11939	sampsonrc, 2007, acad manage j, v50, p364	529
7750	kotabe m, 1995, strategic manage j, v16, p621	520
12736	sorensenjb, 2000, admin sci quart, v45, p81	515
5686	gulati r, 1999, strategic manage j, v20, p397	498
13264	teecedj, 1992, j econ behav organ, v18, p1	492
13020	stuart te, 1999, admin sci quart, v44, p315	489
6451	hoang h, 2005, acad manage j, v48, p332	482
8088	lavie d, 2006, acad manage j, v49, p797	479
11702	rosenkopf l, 2001, strategic manage j, v22, p287	464
14328	williamsono.e., 1985, eci capitalism	431
14322	williamson o., 1975, marketshierarchies	415
3296	cyert r. m., 1963, behav theory firm	403
5797	hagedoorn j, 2002, res policy, v31, p477	399
6257	henderson r, 1994, strategic manage j, v15, p63	370
5786	hagedoorn j, 1994, strategic manage j, v15, p291	369
5920	hamel g, 1989, harvard bus rev, v67, p133	364
4176	eisenhardt km, 1989, acad manage rev, v14, p532	256

Cluster 2 defined 30 articles (in green)

Id	*Cited Reference*	*Co-citation links*
2932	cohenwm, 1990, admin sci quart, v35, p128	2369
7689	kogut b, 1992, organ sci, v3, p383	1619
9095	march jg, 1991, organ sci, v2, p71	1595
8000	lanepj, 1998, strategic manage j, v19, p461	1445
5923	hamel g, 1991, strategic manage j, v12, p83	1264
9927	mowery dc, 1996, strategic manage j, v17, p77	1243
5479	grant rm, 2004, j manage stud, v41, p61	1135
14708	zahra sa, 2002, acad manage rev, v27, p185	1071
5476	grant rm, 1996, strategic manage j, v17, p109	972
10125	nelson r. r., 1982, evolutionary theory	929
1067	barney j, 1991, j manage, v17, p99	908
13267	teece dj, 1997, strategic manage j, v18, p509	803
8298	leonardbarton d, 1992, strategic manage j, v13, p111	683
10262	nonaka i, 1994, organ sci, v5, p14	681
13135	szulanski g, 1996, strategic manage j, v17, p27	656
8078	laursen k, 2006, strategic manage j, v27, p131	651
6263	hendersonrm, 1990, admin sci quart, v35, p9	621
10271	nonakai., 1995, knowledge creating c	619
12506	simoninbl, 1999, strategic manage j, v20, p595	607
7324	katila r, 2002, acad manage j, v45, p1183	595
2617	chesbrough h. w., 2003, open innovation new	559
4189	eisenhardt km, 2000, strategic manage j, v21, p1105	517
13500	tsaiwp, 2001, acad manage j, v44, p996	494
3757	dierickx i, 1989, manage sci, v35, p1504	490
13921	von hippel e, 1988, sources innovation	477
2365	cassiman b, 2006, manage sci, v52, p68	464
14736	zander u, 1995, organ sci, v6, p76	452
8003	lane pj, 2006, acad manage rev, v31, p833	447
1936	brown sl, 1995, acad manage rev, v20, p343	321
4176	eisenhardt km, 1989, acad manage rev, v14, p532	256

Cluster 3 defined 28 articles (in blue)

Id	*Cited Reference*	*Co-citation links*
4059	dyer jh, 1998, acad manage rev, v23, p660	1386
7238	kale p, 2000, strategic manage j, v21, p217	1065
13664	uzzi b, 1997, admin sci quart, v42, p35	711
10038	nahapiet j, 1998, acad manage rev, v23, p242	621
5680	gulati r, 1995, acad manage j, v38, p85	617
5682	gulati r, 1998, admin sci quart, v43, p781	610
7469	khanna t, 1998, strategic manage j, v19, p193	601
324	aiken l. s., 1991, multiple regression	582
2086	burt r. s., 1992, structural holes soc	560
5980	hansen mt, 1999, admin sci quart, v44, p82	556
7239	kale p, 2002, strategic manage j, v23, p747	533
4659	fornell c, 1981, j marketing res, v18, p39	518
509	anandbn, 2000, strategic manage j, v21, p295	495
11040	podsakoff pm, 2003, j applpsychol, v88, p879	477
11788	rowley t, 2000, strategic manage j, v21, p369	470
14846	zollo m, 2002, organ sci, v13, p701	466
11039	podsakoff pm, 1986, j manage, v12, p531	455
4064	dyer jh, 2000, strategic manage j, v21, p345	446
13498	tsaiwp, 1998, acad manage j, v41, p464	422
3921	dozyl, 1996, strategic manage j, v17, p55	407
11518	rindfleisch a, 2001, j marketing, v65, p1	395
5688	gulati r, 2000, strategic manage j, v21, p203	394
704	armstrongjs, 1977, j marketing res, v14, p396	377
561	andersonjc, 1988, psychol bull, v103, p411	374
10896	pfeffer j., 1978, external control org	362
10561	oxley je, 2004, strategic manage j, v25, p723	360
4183	eisenhardt km, 1995, admin sci quart, v40, p84	342
12562	sivadas e, 2000, j marketing, v64, p31	282

Cluster 4 defined 6 articles (in yellow)

Id	*Cited Reference*	*Co-citation links*
4388	faems d, 2005, j prod innovatmanag, v22, p238	677
10213	nietomj, 2007, technovation, v27, p367	453
313	ahuja g, 2001, strategic manage j, v22, p521	452
3413	das tk, 2000, j manage, v26, p31	426
1268	belderbos r, 2004, res policy, v33, p1477	410
13322	tether bs, 2002, res policy, v31, p947	346

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Chapter II

Drivers of strategic alliances: the influence of technological diversification and operational efficiency

Abstract

This paper analyses empirically the influence of internal factors on strategic partnership. We argue that the alliances are driven by the increase of technological diversity and efficiency of firms. We test our hypotheses using a longitudinal study of 186 strategic alliances in the bio-pharmaceutical industry in three major industrialized regions (U.S, Europe, and Asia) during the period from 2003 to 2013. The research findings conclude that technological diversity is a negative driver of bio-pharmaceutical firms engaging in strategic alliances. We also find the last operational efficiency has a positive effect on the number of strategic alliances in the bio-pharmaceutical industry.

***Keywords**: Strategic alliances; Technological diversification; operational efficiency; bio-pharmaceutical.*

1. INTRODUCTION

The Last two decades have seen an extraordinary increase in strategic alliances between various firms (Dyer, Kale, and Singh; 2001), particularly in intensive industries (Hagedoorn, 1993; Mowery et al., 1996), which are becoming increasingly more effective in bio-pharmaceutical companies and more relevant for businesses of all sizes (Doz and Hamel, 1998). The concept of strategic alliances especially in this industry can be traced back to the period of 1960s (Bellussi and Osri, 2015). According to Gulati (1998, p. 293), strategic alliance is defined as "[…] voluntary arrangements between firms involving exchange, sharing, or co-development of products, technologies, or services. They can occur as a result of a wide range of motives and goals, takes a variety of forms, and occur across vertical and horizontal boundaries."

Various authors point out a multitude of reasons to explain firms' motivations to seek strategic alliances (Hegedoorn, 1993). These motivations include enhancing a firm's efficiency (Ahuja, 2000), entering new markets (Garcia-Canal *et al*., 2002), been able to quickly diffuse new technologies (Kale *et al.,* 2000), filling out product lines and portfolios, and reducing the costs, risks, and time required to develop new products and process technologies, (Elmuti and Kathawala, 2001). Therefore, the reason to seek partnership between two or more parties is commonly the result of a set of firm's internal motives.

The context for this research is the bio-pharmaceutical industry in the high-technology sector. It looks at pharmaceutical and biotechnology companies of different sizes and from various geographical regions. This industry sample has been chosen

because the development of new drugs or the improvement of existing products are the main activities in the extremely innovative pharmaceutical sector (Rothaermel, 2001). Also, there are a larger number of strategic alliances among these firms, in contrast to other high technology sectors (Hagedoorn, 1993; Rothaermel and Deeds, 2006; Marhold, Kim, and Kang, 2017) who enable the transfer of technology and best practices (Koka and Prescott, 2008).

In recent years the intensity of technological diversification has attracted the attention of researchers (Patel and Pavitt, 1994, 1997; Granstrand et al., 1997; Giuri, Hegdoorn, and Mariani, 2004; Garcia-Vega, 2006; Quintana-Garcia and Banavides Velasco, 2008; Corradini, Demirel, and Battisti, 2016). It is consistently identified as a crucial management decision of companies in their innovation activities. They are always looking to expand their technological capabilities to wider technological fields rather than beign limited to one technology. These act in a complementary fashion to the firm's core business (Cohen, 1995; Gambardella and Torrisi, 1998; Leten et al., 2007; Quintana-Garcia and Banavides Velasco, 2008; Chen, Jang, and Wen, 2010). In the same vein, according to previous studies, technological diversification is an indicator of firm performance (Granstrand, 2000; Quintana-Garcia and Banavides Velasco, 2008; Huang and Chen, 2010), and technological performance (Leten *et al.*, 2007) through significant economies complementing each other (Fai and Cantwell, 1999). Therefore, firms have to be able to handle a large number of technologies in order to develop and produce products and services.

Consistent with several previous studies to measure technological diversification (Garcia-Vega, 2006; Leten et al., 2007; Chen, Jang, and Wen, 2010; Corradini, Demirel, and Battisti; 2016), we used Herfindahl-Hirschman Index (HHI), which has already been employed in other empirical studies, in order to measure industry concentration.

The main objective of this study is to give the reader a profound understanding of the driving role of internal diversified technology and operational efficiency of firms plays in forming alliances across companies in that market arena. The existing empirical studies on strategic alliances consist of two broad strands. On one hand there is a broad body of empirical literature that investigates the drivers of strategic alliances and technological diversification of companies (Garcia-Vega, 2006; Leten et al., 2007; Quintana-Garcià and Benavides velasco, 2008; Franco and Haase, 2015) but they do not provide empirical evidence about the influence of internal diversified technology on strategic partnership portfolios. On the other hand, while previous studies investigated the impact of different aspects of the alliances, to our knowledge no prior empirical research within strategic literature has focused on the inverse impact of operational efficiency driving partnership alliances in the bio-pharmaceutical industry.

This study tries to fill these gaps in the existing literature. So as to achieve these objectives, we constructed a sample of 72 bio-pharmaceutical companies of different sizes in three major industrialized regions (U.S, Europe, and Asia) which engaged in 186 strategic alliances during the period of 2003-2013. We constructed a model of the longitudinal data, collected from several sources, such as Recap IQ, MedTrack, Osiris, Bloomberg's, and Qpat/Orbit databases. We find that internal technological diversification, which is measured by inverse Herfindahl index, has a negative relationship with a strategic alliance of the firms. Along the same line, an increased level of diversity has a positive but insignificant influence on strategic partnership. We also find that total asset turnover as a measure of operational efficiency is a positive driver of companies entering into strategic alliances.

The remainder of the paper is organized as follows. The following section outlines the theoretical framework with the hypotheses, and insights the drivers of

strategic alliances. The third section of this paper describes the research methodology, data and the variables used in the analysis. The fourth section will present the results. Finally, we conclude with discussion.

2. THEORETICAL FRAMEWORK AND HYPOTHESES

Over the last few decades, more and more companies and industries understand that they cannot survive alone due to the increase in global competition and the fast rate of technological change. The increases in the complexity of products and product processes over time have also caused them to recognize the pressing need for alliances (Rosenberg, 1976; Mohr and Spekman, 1994; Granstrand *et al.,* 1997; Doz and Hamel, 1998; Ireland *et al.*, 2002; Breshi *et al.,* 2003; Lo *et al.*, 2016). This is in turn proven by the evolution of the number of strategic partnerships, particularly in technology-intensive industries (Hagedoorn, 1993). Therefore, firms might expand their technological base by acquiring external sources of knowledge and maintain their competitive advantage and innovation across industries and countries (Granstrand 2003; Dahlander and Gann, 2010; Belderbos *et al.,* 2014).

Especially, in bio-pharmaceutical industries firms tend to be highly diversified in an environment characterized by fast changing technology, which mainly depends on the generation of new ideas or development of the existing products. For successful innovation, not just the amount of resources held by a firm, but also their diversity is important. More diverse internal resources improve the firms' ability to innovate through resource recombination.

Previous studies have conceptualized technological diversity as a surging tendency in industrialized states (Leten *et al.,* 2007). Other studies found that

technological diversity has a very similar profile among largest firms producing similar products (Patel and Pavitt, 1995; Giuri *et al.,* 2002) and is a good predictor for future product diversification (Pavitt, 1998). Moreover, firms have patents concentrated in the same technological classes in line with their goal in strategic alliances (Giuri, Hegdoorn, and Mariani, 2004).

With regards to our study interest, the influence of technological diversity and its increase over time on strategic alliances in biopharmaceutical firms, except the paper of Giuri *et al*., (2004) that analyzes the role of diversification on the tendency to engage in such agreements across various dimensions. This subject has not been sufficiently treated in the literature. In their study comparing firms' internal technological profile with their propensity to engage in external alliances, they find that there is a strong correlation between firms that are well-diversified technologically and their relationships or alliances. Furthermore the authors, with regards to industry particulars, suggest that there are cross sectoral differences in diversification level. The chemical and pharmaceutical industry firms tend to have patents concentrated in the same technological fields as the sample average in which they take part in alliances.

Overall, the use of various strategies to obtain the internal resources of the firms is an asset in gaining access to the external sources of knowledge and resources. Basically firms with lack diverse internal resources try to form relationships gaining them access to the complementary competencies and diverse external knowledge and technologies of other firms for innovation (Arora, Fusfuri, and Gambardella, 2001; Schildt, Maula, and Keil, 2005). In contrast to this, firms with large technology portfolios tend to rely heavily on external sources of knowledge trough acquisition, outsourcing, or collaboration, giving them the ability to exploit successfully this

relevant technological expertise that is beyond firm's core business (Lichtenthaler and Ernst, 2007; Cassiman and Veugelers, 2006).

Sapmson (2007) in his sample of 463 R&D alliances in the telecommunication equipment industry finds that technological diversity has a moderate impact on firm innovation, contrary to alliances which contribute far more to firm innovation. Koren and Tenreyro (2013) used the 1997 capital flow tables of the bureau of economic analysis for 180 good capital categories. Their study shows that technological diversification is significantly and positively correlated with the level of labor productivity and negatively, but significantly, associated with sectoral volatility.

According to Mindruta (2013), the degree of technological diversification of partners presumes particular relevance, since it may influence the establishment and the productivity of the collaboration itself, due to the scope of the complementary relationship that is generated between partners.

In addition Sarkis (2000), in his empirical study, focuses on 44 major US airports to evaluate their operational efficiencies. The results indicate that operations managers should evaluate and benchmark their performances with airports having similar characteristics. All the above leads us to the following hypotheses:

Hypothesis 1: technological diversification has a positive effect on strategic alliance.

Hypothesis 2: Greater diversity of technology impacts strategic alliance positively.

Hypothesis 3: Level of operational efficiency is positively associated with strategic partnership.

3. METHODOLOGY

3.1. Data and sample:

We conducted our study based on strategic partnerships data from 186 alliances formed by a limited sample of 72 firms, 48 U.S. companies (66,67%) and 24 Europe and Asian companies (33,33%). This covers the high-tech pharmaceuticals sector listed under the Standard Industrial Classification (SIC –code 283). Annual firm-level panel data was constructed in the period of 2003-2013. While our sample size appears to be small in contrast to pattern sizes among strategic alliances conducted at other sectors settings, it is in line with bio-pharmaceutical industries data set used in preceding studies (Marhold and Kang, 2017).

To construct our datasets, we used various types of sources: Medtrack archive, Recap IQ databases as a main source of the strategic alliance's data, and Qpat-Orbit database for patent data. It was necessary to use one patent database rather than various patenting systems in order to maintain a certain level of reliability, coherence and comparability (Ahuja and Kalita, 2001). In addition, Orbis and Bloomberg's databases were used to provide firm level data, such as financial data, firm size, age, region, and R&D expenditures for each company. Since the bio-pharmaceutical industry is composed of traditional pharmaceutical companies and dedicated biotechnology firms (Rothaermel, 2001), in the following step, we divided our sample depending on the firm sector's activity in two sub-sectors: Biotechnology and pharmaceuticals. We collected the required information regarding strategic alliances, technological diversification and operating efficiency after an enormous effort of correction and revision. A few companies had to be eliminated from our data, because we did not have sufficient information on some of the variables required for analysis such as total assets or sales,

or when the available alliance data were not adequate for the level of this study (Van de Vrande, 2013).

3.2. Variables:

3.2.1. Dependent variable

The number of alliances is used as a dependent variable of this study, a count variable of the total agreements a bio-pharmaceutical firm has entered into with one or more partners. In total, we analyzed 186 strategic partnering of firms in the observed years. This data is derived from the MedTrack and Recap IQ databases. MedTrack archive is the most comprehensive database of private and public biotech companies. The second database Recap IQ is a commercial database available from Thomson Reuters which can be used with private on-line access. This database provides the most important information about pharmaceutical industry alliances, including the functional activities performed by the alliance, partners, agreement date, descriptive information about the targeted technology, and the use of equity arrangements. These databases have been used in recent studies (Zidorn and Wagner, 2012; Liu, Pu, and Schramm, 2015). It was necessary to access more than one source in order to obtain complete data within the specified period of study.

3.2.2. Independent variables

Technological diversification: was computed using patent data drawn from Qpat-Orbit database, classified according to the International Patent Classification (IPC classes). All patents contain one or more technology field IPC codes representing the yearly number of all patents accumulated by a firm. Analysing the sample of 72 companies we observe that the firms had patents in at least 3 different fields, and the maximum value is 65 technology classes. In order to measure technological

diversification (DivTech), we use the inverse of Herfindahl-Hirschman Index (HHI) of concentration as one of the most popular indices consistent with several previous empirical studies (Gracia-Vega, 2006; Quintana-Garcià and Benavides-Velasco, 2008; Koren and Tenreyro, 2013).The HHI based on their 3-digit main patent classes is constructed as follows:

$$DivTech_{it} = 1 - \sum_{j=1}^{K} \left(\frac{N_{ijt}}{N_{it}}\right)^2$$

Let N_{ijt} denote the total number of patents held by the *i*th company in category *j* at time *t*, while *j* represents the IPC category where the company patented and K is the number of technological classes where the company was active.

Operational efficiency: there are several ways to measure operating efficiency through similar turnover ratios including fixed asset turnover (FAT) ratio, working capital ratio, and total assets turnover (TAT) ratio. In our study we choose using TAT for which we have available data. Moreover, it is often used as a financial ratio that measures the company's ability to use its assets in generating sales income to the company. We argue with previous literature that a firm's profitability is seen by looking at the recent past (Huang, Wang, and Lee, 2015). Thus, one year time lag was used to calculate the efficiency of the company's assets. Our primary source of past TAT was Orbis database. Further, we controlled and augmented these data with Bloomberg's database and annual reports of firms.

Diversity increase: is an alternative variable of technological diversification, measured by a dummy variable in order to control for the similar factors changing over time. It takes (1) when the inverse HHI has increased in the earlier year, (0) otherwise.

3.2.3. Control variables

In this study, we included control variables accounting for the age of the firm (**FirmAge**) measured as years since incorporation date and for the size of the firm (**Size**) defined as the total number of employees. Further, we controlled for the status of the firms (**ownership**) using a dummy variable 1 if the firm is public, 0 otherwise (Messeni Petruzzelly et al, 2015). (**R&D expenditures)** research and development expense measured annually for each firm. All this data is gathered from Orbis database provided from (BvD) Bureau Van Dijk, and through Bloomberg's as an additional database.

3.3. Estimation model:

Among the 72 firms that have involved in 186 strategic alliances during the period studied, we have a total number of 792 firm-year observations, with an average more than 11 observations per firms, in a strongly balanced data.

The approach this study follows is to estimate the panel data model as follows:

$$Y_{i,t} = \alpha + \beta_1 X_{1i,t} + \beta_2 X_{2i,t} + ... + \beta_n X_{ni,t} + \varepsilon_{i,t} ....(1)$$

Where $Y_{i,t}$ is the dependent variable for a firm i at the time t, α is a constant coefficient and β_n represents the regression coefficient for the regressor X_n and $\varepsilon_{i,t}$ is an error term which captures all others omitted factors with $E[\varepsilon_{i,t} \mid X_{i,t}] = 0$ for all i and t.

Hence, our final regression model by selecting the control and independent variable will be as follows:

$$SA_{i,t} = \alpha + \beta_1 DivTech_{i,t} + \beta_2 TAT_{i,t-1} + \beta_3 DI_{i,t} + \beta_4 FA_{i,t} + \beta_5 SIZE_{i,t} + \beta_6 ownership_{i,t} + \beta_7 \text{Re}\, gion_{i,t} + \beta_8 R\&D_{i,t} + \varepsilon_{i,t} \ldots (2)$$

Where, $SA_{i,t}$ is a total number of strategic alliance for firm i at time t, α is a constant coefficient, $DivTech_{i,t}$ is a technological diversification of firm i at time t, $TAT_{i,t}$ is total asset turnover of firm i at time $t-1$, $DI_{i,t}$ is the diversity increase of firm i at time t, $FA_{i,t}$ is firm age of firm i at time t, $SIZE_{i,t}$ is number of employees of firm i at time t, $ownership_{i,t}$ is Dummy variable of ownership of firm i at time t, $\text{Re}\, gion_{i,t}$ is Dummy variable of region of firm i at time t, $R\&D_{i,t}$ is research and development expenses firm i at time t, $\varepsilon_{i,t}$ is an error term which captures all others omitted factors with $E[\varepsilon_{i,t} \mid X_{i,t}] = 0$ for all i and t.

3.4. Estimation Technique:

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4. RESULTS

Table 2.1 presents a summary of the descriptive statistics including correlations among the variables used in this study. The correlation matrix shows a high level of correlation between the variables used in our model. To check for possible presence of any multicollinearity issues, we analysed the variance inflation factors (VIF) for all variables in the models. The results of this test are shown in *table 2.2*, that the variables

range from 1.02 to 5.62 and are bellow the cut-off point of 10 (Kleinbaum *et al*, 1998). This indicates no multicollinearity issues in our data.

Table 2.3 presents the results of our regression analysis using ordinary least squared (OLS) regression model. Model 1, is a baseline, it incorporates only the control variables used in our study. In all the models "SIZE" shows positive and statistically significant. It indicates that largest firms in the biopharmaceutical industry tend to engage and/or influence the strategic alliance. The other control variable "Ownership" shows negative and statistically significant coefficient in all the models. Ownership is a dummy variable with 1 if it is a public company and 0 if it is owned privately. Hence, the result indicates publicly owned companies do not tend to engage in strategic alliances as opposed to privately owned companies. However, none of the other set of control variables, in all the models, appear to demonstrate statistically significant results.

Model 2 tests hypothesis 1, which posits that internal technological diversification has a positive influence on strategic alliance. As can be seen in the model the coefficient for Technological diversification (*DivTech*) is negative and strongly significant (β = - 0.079, p< 0.01) at 1% significance level also in the full model 5. Hence, this result does not support our hypothesis. Model 3 tests hypothesis 2, which predicts the increase of diversity has a positive impact on strategic alliance. The coefficient for the increase of diversification (DI) has a negative insignificant influence on strategic alliance (β = - 0.007, p> 0.1) in that model and full model 5. Hence, hypothesis 2 is not supported. Model 4 tests our hypothesis 3, which proposed that past operational efficiency, is positively associated with strategic alliance. As depicted in this table the coefficient for last operational efficiency (used past TAT_{t-1} as a proxy) is positive and significant (β = 0.082, p< 0.1) at 10% significance level. In contrast, in the

full model 5 the coefficient of this variable is positive and insignificant. Therefore, our hypothesis 3 is supported when model 3 is used, but does not get support when the model is changed.

5. DISCUSSION AND CONCLUSION

Despite the growing attention devoted to the impact of strategic alliances on innovative and financial performance, study of the inverse effects is still in its infancy.

The main aim of this study is to investigate the influence of technological diversification and operational efficiency for the previous year of firms with strategic alliances. Our empirical study focused on the biopharmaceutical industry in the high-tech sector, where the number of strategic alliances is higher than other areas within the same sector. Our hypotheses were tested on a sample of 72 biopharmaceutical companies engaging into over 186 strategic alliances within the period of 2003-2013. This study contributes to the research on strategic alliances especially in the biopharmaceutical industry in the high-tech sector.

Our empirical results indicate negative correlation between technological diversification on the number of strategic alliances. More broadly, companies that have less diversity in technological domains are more likely to engage in strategic partnership with other parties. This result contradicts the finding of previous authors in the strategic literature, which finds that the diversity of technology platforms encourages the use of alliances as a preferred mechanism for exploration or exploitation alliances (Gottinger and Umali, 2008; Hoang and Rothaermel, 2010; Yamakawa *et al*., 2011). While, this result it is in line with Kang and Marhold (2017), their study finds that increasing internal technological diversity of the technological resources in a firm has a negative

effect on the diversity of its portfolio. This is consistent with Sampson, (2007) who suggests that when firms are entering alliances for the sake of new technological development, they should search for partners with non-similar technological capabilities.

However, we also hypothesized that operational efficiency of firms is positively associated with its number of strategic alliances. The result shows that a company with higher efficiency, measured by its last total asset turnover, gives investors an idea that the company is using its assets more efficiently and most likely will have good management and will use its assets to produce products. Hence, it is more likely to enter into many partnerships. This result is consistent with Giuri *et al.,* (2004), and the finding in their paper. Companies with lower asset efficiency did demonstrate insignificant impact on their partnerships strategies.

Table 2.1: Descriptive statistics and Correlation matrix

	Variables	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9
1	SA	0.23	0.47	1.0000								
2	DivTech	0.67	1.35	-0.3069	1.0000							
3	DI	0.56	0.50	0.0339	0.0594	1.0000						
4	TAT_{t-1}	0.40	0.39	0.1351	-0.1672	0.0227	1.0000					
5	SIZE	13650.85	29501.69	0.3282	-0.4081	0.0816	0.2234	1.0000				
6	FA	36.81	38.81	0.12	-0.0659	0.0512	0.2505	0.4730	1.0000			
7	Ownership (public=1)	0.79	0.41	-0.0555	0.0517	-0.0145	-0.055	0.076	0.1165	1.0000		
8	REGION (US=1)	0.67	0.47	-0.1235	0.2502	-0.0766	-0.237	-0.3343	-0.2019	0	1.0000	
9	R&D	661190.20	1439135.00	0.3107	-0.4188	0.072	0.1918	0.8973	0.4322	0.1009	-0.2819	1.0000

Table 2.2: VIF Test Results.

Variable	VIF
SIZE	5.62
R&D	5.29
FA	1.39
DivTech	1.32
REGION	1.19
TAT	1.13
Ownership	1.04
DDI	1.02
Average VIF	2.25

Table 2.3: Regression Results.

Dependent Variable	**Model 1**		**Model 2**		**Model 3**		**Model 4**		**Model 5**	
Strategic alliances	**Coefficient**	**S.E**	**Coefficient**	**S.E**	**Coefficient**	**S.E**	**Coefficient**	**S.E**	**Coefficient**	**S.E**
DivTech			-0.079***	(0.013)					-0.073***	(0.015)
DDI					-0.007	(0.032)			0.022	(0.034)
L.TAT							0.082*	(0.045)	0.046	(0.046)
Numberofemployees	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)	0.000***	(0.000)
AGE	-0.001	(0.000)	-0.000	(0.000)	-0.001	(0.000)	-0.001	(0.001)	-0.000	(0.001)
OwnershipPr	-0.083**	(0.039)	-0.064*	(0.039)	-0.084**	(0.039)	-0.088**	(0.042)	-0.079*	(0.042)
REGION_US	-0.007	(0.036)	0.026	(0.035)	-0.008	(0.036)	-0.006	(0.038)	0.019	(0.039)
RDExp	0.000	(0.000)	-0.000	(0.000)	0.000	(0.000)	0.000	(0.000)	0.000	(0.000)
_cons	0.244***	(0.045)	0.264***	(0.044)	0.248***		0.228***	(0.052)	0.261***	(0.056)
Adjusted R2	0.123		0.160		0.121		0.114		0.141	

t-statistics are in parentheses: : .01 - ***; .05 - **; .1 - *;

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Chapter III

Strategic Alliances and Financial Performance: Some Empirical Evidence of Bio-Pharmaceutical Industry

Abstract

Over the last decades, strategic alliance have played an important role among high tech firms, including biotech and pharmaceutical companies, showing an impact on financial performance. This study focuses on this topic and analyses how strategic alliances portfolios and types of the partnerships affect bio-pharmaceutical companies' financial performances. Drawing upon a panel data set of 158 alliances during the period of 2003-2013, empirical findings highlight that the number of alliances has a negative relationship with financial performance, whereas partnership types such as licensing and co-development have a positive relationship with the financial performance of biotech and pharmaceutical companies.

Keywords: *Strategic alliances, financial performance, licensing, Co-development partnership, biotechnology -pharmaceutical industries.*

1. INTRODUCTION

The strategy to allying with other firms have received wide attention by practitioners and scholars (Gulati, 1998, 2007; Faems *et al.,* 2010; Gottinger and Umali, 2008), as well as has the analysis of its effect on firm performance (George, Zahra, Wheatley and Khan, 2001; Jiang et al., 2010; Anand and Khanna, 2000; Lavie, 2007; Martynov, 2017) in view of the dramatic growth of this practice over the last two decades particularly in high technology industries (Hagedoorn, 1993; Booz and Hamilton, 1997). Many companies found that it is difficult to go it alone (Doz and Hamel, 1998) without any relationships with other firms that share similar goals and with which they aspire for mutual benefits (Mohr and Spekman, 1994; Ireland *et al.,* 2002).

According to previous studies, strategic alliances are defined as voluntary agreement, starting from simple deals occurring between one or more individuals or independent firms to comprehensive agreements that enable companies to achieve common goals involving exchange, sharing or co-development of products, technology or services (Gulati, 1998; Elmuti and Kathawala, 2001; Deeds and Rothaermel, 2003; Faems *et al.,* 2005). It is well known that firms are motivated entering into specific alliances in an effort to share new technologies, and to increase voluntary knowledge transfers (Mowery, Oxley and Silverman, 1996; Gulati, Nohria and Zaheer, 2000; Rothaermel and Boeker, 2008; Parmigiani and Rivera-Santos, 2011) commercialize innovations (Gulati, 1998; Deeds and Rothaermel, 2003), contribute to the performance of business allies, in order to gain competitive advantage (Elmuti and Kathawala, 2001; Tan and Thai, 2014), and to attain financial support to develop new drugs (Hopkins *et al.,* 2013; Liu *et al.,* 2015). Therefore, the diversity of research and development, and technology platforms encourages the use of alliances as a

preferred mechanism for exploration or exploitation (Gottinger and Umali, 2008; Yamakawa *et al.,* 2011; Rothaermel and Deeds, 2004; Hoang &Rothaermel, 2010).

Although strategic alliances are more attractive than other strategy types like mergers and acquisition (M&A), its outcome is not always satisfactory. In fact, prior studies showed that alliances effect on firm performance has a positive direct effect (Colombo *et al.,* 2009; Lavie and Miller, 2008; Lin *et al.,* 2012; Pangarkar and Wu, 2013). Other studies found that firms were disappointed to have no benefit on their performances from strategic alliances (Stuart, 2000; Jang, Tao, and Santoro, 2010; Kim and Choi, 2014). Yet other researchers have found that the impact of strategic alliances depended on other factors (Baum, Calabrese and Silverman, 2000; Koka and Prescott, 2008; Lahiri and Narayanan, 2013). Therefore, in addition to the firm's internal outlines, competences and capabilities (Gottinger and Umali, 2008), companies are seeking for other external factors enabling them to improve their performance. For this reason, biotech and pharmaceutical companies have expanded the range of their strategic alliances (Niosi, 2003; Gulati, 1998) carrying different types of agreements with varying costs and benefits.

This specific industry is selected mainly because in the last two decades there has been a significant increase in the number of strategic alliances among firms within the industry. Furthermore, it is one of the most profitable in the high technology business sector throughout the globe. The study period we selected (2003-2016) coincided in the period in which the sector saw a tremendous increase in the number of strategic alliances among firms. Therefore, it is worth studying the impact of these strategic alliances on the financial performance of firms.

In order to analyze the impact of strategic alliances on firm's financial performance, we first identify the type of agreements included in the alliances of biotech and pharmaceutical companies. And then we divide the different types of alliances in to two

categories: co-development and licensing. This is because many authors emphasized the importance of studying alliance portfolios instead of single type of alliances (Duyters and Lokshin, 2011; Faems *et al.,* 2010; Martynov, 2017).

There are different types of strategic alliances, this study, however, will be limited to an examination of two particular cases of partnership that involve agreements of licensing and co-development among biotech and pharmaceutical companies. An investor, on one hand, is interested in securing value and reducing risk by his portfolio companies' entering license agreements enabling the transfer of technology and best practices (Koka and Prescott, 2008), but on the other hand, he wants a substantial upside potential for his investment. In contrast, a co-development agreement included in many alliances allows to the licensor many advantages. He reduces his capital needs in which they agree to develop a compound or technology jointly, stipulating the participation in a product's advanced clinical development and commercialization of the resulting product. The alliance may also include co-promotion or co-marketing agreements. However, despite their increasing importance, strategic alliances have often encountered problems with unsatisfactory performance (Geringer, 1986)

This study focuses on analysis the impact of company's alliances on financial performance, with a particular emphasis to the two types of alliances: co-development and licensing. Despite the fact that biotech and pharmaceutical industry is the most important sector as a strategic asset in the world economy, few researchers have attempted to analyze that sector from this perspective.

The analysis of financial performance is frequently a matter for debate by decision makers such as managers, planners, economists and others since the last decade (Boldeanu and Pugna, 2014). According to Tailab (2014), financial performance plays a key role in measuring the overall financial health of companies over the short and long term and can also be used to compare similar firms across the same industry. Consistent with previous studies

on financial performance (Mirza and Javed, 2013; Martynov, 2017; Tailab, 2014) there are many different measures of financial performance and these include return on assets (ROA), return on equity (ROE) and returns on sales (ROS). We selected financial performance measured by return on assets (ROA) ratio as an outcome by following the earlier studies (Dupont, 1919), and recent researchers (Mishra et al, 2009; Tailab, 2014; Martynov, 2017). It is a traditional indicator used to show how efficiently the resources of the company are used to generate income.

This study has the following specific objectives: (1) to establish the influence of two types of strategic alliances (licensing and co-development agreements) on the return on asset (ROA) of biotech pharmaceutical companies (2) to investigate the impact of the alliance portfolios on the financial performance in this sector. In order to achieve these objectives we constructed a sample of top large, medium and small U.S, Europe and Asian biotech pharmaceutical companies, by using data collected from multiple sources, including Recap IQ, MedTrack, and Osiris database, we found that the number of strategic alliances has a negative relationship with a financial performance of the companies, measured by the return on assets. Furthermore, we found that strategic alliance types such as licensing and co-development have a positive relationship with a firm's financial performance. Firms with only one alliance have weaker financial performances as compared to firms which have more than one alliance.

The remainder of the paper is structured as follows. The following section introduces the conceptual and theoretical framework with the hypotheses. The third section of this paper presents the research methodology, data and data sources and the variables used in the analysis. The fourth section will present empirical analyses and results. Finally, we conclude with a discussion.

2. CONCEPTUAL FRAMEWORK AND HYPOTHESES

The main focus of this study is to set up the influence of strategic alliances on the financial performance of biotech and pharmaceutical companies. We hypothesized that licensing, co-development agreements and the portfolios of strategic alliances can be related to the company's financial performance as shown in the model of conceptual framework developed in Fig.3.1.

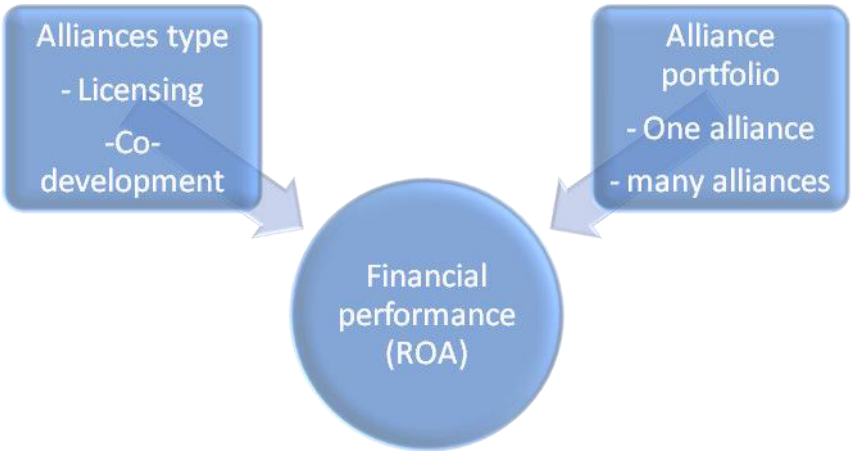

Fig.3.1 Conceptual framework

Relationship between License Agreement and Financial Performance

The effect of a contract depends on the types of provisions included and differentiates between the consequences of control and coordination provisions (Schilke and Lumineau, 2016). It is necessary to determine the cooperation and its corresponding output of alliances. Hence, the partners should be sufficiently differentiated based on each one's needs or gaps in order to provide missing elements or new/complementary capabilities (Osborn and Hagedoorn, 1997). Firms search for alliance partners with resources that they can leverage and integrate to create synergy (Lin, Yang, and Demirkan, 2007).

The alliance management capability has a huge impact on financial performance (Niesten and Jolink, 2015). The capability of alliances (Wang *et al.,* 2015) means their capabilities in terms of their effects on value creation and value capture. Specifically, they are five key parameters which can be used to improve organizational performance based on alliance partners (Albers *et al.,* 2013). These are the structural interface between partners, the structural "interface" within partners, and the specialization, formalization, and centralization of the alliance organization.

H_1: Companies with a licensing agreement(s) achieve higher financial performance than similar firms without such alliance(s).

Interaction between co-development agreement and financial performance

Alliances are assuming a role in the performance of leading players in an industry that is showing signs of a slowdown and increased competitiveness, which is the case of the Brazilian shopping center industry (Gomes *et al.,* 2017).Co-development alliances are formed to create new capabilities (technologies, products, services, processes, etc.) that partner organizations need in order to reach their goals (Bidault, 2012). Thus, success of a co-development (Feng *et al.,* 2010) alliance depends on the close cooperation between partners. Therefore partner selection for co-development is based on the individual and collaborative utilities.

Due to co-development alliances, the effect of new product failures is reduced (Hu, *et al.,* 2017). Massive growth are also considered, such as characterized with SC-industries of emerging markets in the last decade, as reported by Cushman & Wakefield (2014), the Brazilian SC-industry, that doubled in size during this period (ABRASCE, 2015), is presently suffering from an increase in vacancies (IBOPE, 2014) and a decrease in sales growth (IBGE, 2015).

H_2: Companies with co-development agreements are likely to see influence on their financial performance

Impact of financial performance by number of alliances

Alliance portfolio size is an important antecedent of competitive action frequency (Andrevski *et al.,* 2016) it is used to analyze the role of inter-organizational alliances in creating legitimacy for a sustainable technology (Kishna *et al.,* 2017). Firm boundaries could change based on the impact of alliance portfolio size on innovation and financial performance (Lahiri and Narayanan, 2013). Hence, maintaining the alliance portfolio (Hoffmann, W. H., 2007) is an important thing.

The concept of alliances portfolio and firm performance provides the detailed explanation of multifaceted contribution of alliance portfolios to firms' market performance (Lavie, 2007). Certain characteristics of alliances (Reuer *et al.,* 2002) also improve the performance of firms. When the number of alliances is smaller, the consider activity is also limited (Dussauge, 2006). To increase the firm's performance, there is a need to create a dedicated alliance function and develop company-wide standards (Dussauge and Wassmer, 2006) and customized tools for multi-alliance management. Organizations might have the knowledge about strategic alliances when expanding their alliance portfolio (Hashai, 2015), and that can help to enhance their portfolio performance. Additional alliances may give access to advanced knowledge, innovate technologies, new markets, or resources and improvement in the firm's performance. We could argue that the companies that have more than one alliance in their strategic portfolio should show the best performance.

H_3: As the number of company's alliances increases, the financial performance increases.

H_4: Having only one alliance does not play a significant role in company's financial performance.

3. METHODOLOGY

3.1. Data and Sample:

This study focuses on biotech and pharmaceutical companies. A total of 233 biotech and pharmaceutical companies [Standard Industrial Classification (2834; 2835; 2836)] and 472 alliances were found during the period 2003 to 2013. In order to test our hypotheses, we exclude companies that are created before 2003. Because of missing values on the constructed variables, we were obliged to exclude many companies and agreements, and hence the sample size was reduced to 66 biotech and pharmaceutical companies that have had 158 alliances in the period of 2003 – 2013. The availability of data is the sole reason for the final sample size. All agreements were codified based on their alliance sub-categories in order to classify the type of agreement following the prior research (Lavie and Rosenkopf, 2006; Rothaermel, 2001). We coded strategic alliances in the two types of alliances as either licensing and co-development alliances. We studied the impact of these two types of alliances on the firm's financial performance for the period 2003 to 2016. Secondary data was collected from multiple sources, including Recap IQ, MedTrack, and Osiris database, for a sample of top largest, medium and small U.S, Europe and Asia biotech and pharmaceutical companies.

The empirical analysis is done on panel data by following previous studies in this area. The use of data as a panel helps us to get less collinearity and to account for heterogeneity. In order to get the regression results, we used the STATA statistical program.

3.2. Variables

3.2.1. Dependent variable:

Financial performance: is the annual financial performance of a firm for the period 2003-2016, is measured by Return on Assets (ROA). The choice to measure financial performance of the biotech-pharmaceutical companies by ROA instead of various financial ratios used in many previous articles in the related literature, including return on equity (ROE) (Boldeau and Pugna, 2014), return on investment (ROI) (Narware, 2010), and net profit margin (NPM) (Oswald *et al.,* 1991), it because this indicator of profitability shows how well the company can use its resources to develop its income. Moreover, it has been widely used as the best indicator of financial performance in earlier and recent research (Burns *et al.,* 2008; Martynov, 2017). We collected ROA from OSIRIS database for the period of 2003 to 2016, commercially provided by Bureau Van Dijk, which contains information on listed and unlisted companies throughout the world with very detailed financial reports.

3.2.2. Independent variables:

Alliance portfolios: it is defined as the total number of all alliances entered by companies in the period from 2003 to 2013. Earlier studies (Lavie and Miller, 2008; Duysters and Lokshin, 2011; Martynov 2017) used alliance portfolios as a standard measure of strategic alliances' contribution to the company's financial performance. Companies usually tried to increase their alliance portfolios by entering into several alliances in order to gain external knowledge and enhance their profitable capabilities and competitiveness in the market.

We obtained the alliance portfolio data for pharmaceutical and biotech companies from two sources. Recap IQ database and MedTrack database. Recap IQ database is a commercial database available from Thomson Reuters. This database provides detailed, relevant information of pharmaceutical industry alliances, including the functional activities

performed by the alliance, partners, agreement date, descriptive information about the targeted technology, and the use of equity arrangements. MedTrack archive is the most comprehensive database of private and public biotech companies. The data for alliance portfolio ranges from 2003 to 2013. Since we are hypothesizing that the impact of alliance portfolios on firm's performance that would come after four years after the agreement, we used lagged alliances of portfolios variable by four years in the regression $t-4$.

Total Alliance (1ally): was captured by a dummy variable in which 1 indicates companies that have one agreement and 0 for the companies that have allied many times.

Alliance types: In order to test the impact of the different types of alliances on firm's financial performance, we categorized the alliances into two types of alliances: license agreements that enables the transfer of technology and best practices-*Licensing* (Koka and Pescott, 2008) and Co-development agreements included in many alliances that allow the partners to share the resources in products' advanced clinical development-*Co-development* (Fang, Lee, and Yang, 2014). The number of agreements was obtained from Recap IQ. The data on the type of agreements was codified into 12 categories by using MedTrack for detailed information concern subcategories of alliances. We do not include joint venture in this study.

Licensing: represent the total number of license agreement's the company has. In this independent variable, we used lagged licensing variable by four years in the regression $t-4$.

Co-development: is the total number of co-development agreements the company is engaged in.

3.2.3. Control variables:

We incorporated control variables which previous literature on the alliances and performance found to be important and influential on financial performance. We controlled for; (a): *Firm age* in order to capture the firm's experience in the industry measured by its age

since foundation. It is controlled because age difference will greatly change the ultimate result of the alliance (Baum *et al.,* 2000); (b): *R&D intensity*; is used to control for the increase in R&D expense that often accompanies the firm growth indicated. We calculated R&D intensity by dividing total R&D expenses by total sales. We also controlled for (c): *sales growth;* as sales growth could impact the financial performance of companies directly. In the most strategic alliances, the licensee is biotech companies, while the pharmaceutical company is the technology licensor. Hence, we included two dummy variables: licensor (1/0); licensee (1/0).

3.3. Estimation model:

The approach this study follows is to estimate the panel data model as follows:

$$Y_{i,t} = \alpha + \beta_1 X_{1i,t} + \beta_2 X_{2i,t} + ... + \beta_n X_{ni,t} + \varepsilon_{i,t} ....(1)$$

Where $Y_{i,t}$ is the dependent variable for firm i at time t, α is a constant coefficient and β_n represents the regression coefficient for the regressor X_n and $\varepsilon_{i,t}$ is an error term which captures all others omitted factors with $E[\varepsilon_{i,t} \mid X_{i,t}] = 0$ for all i and t.

Hence, our final regression model by selecting control and independent variable will be as follows:

$$ROA_{i,t} = \alpha + \beta_1 NAP_{i,t-4} + \beta_2 ll_{i,t-4} + \beta_3 CD_{i,t} + \beta_4 1ALLY_{i,t} + \beta_5 FA_{i,t} + \beta_6 R\&D_{i,t} + \beta_7 GS_{i,t}$$
$$+ \beta_8 LICE_{i,t} + \beta_9 LICER_{i,t} + \varepsilon_{i,t} ..... (2)$$

Where, $ROA_{i,t}$ is return on assets for firm i at time t, α is a constant coefficient, $NAP_{i,t-4}$ is number of alliances (Alliance portfolios) of firm i at time $t-4$, $ll_{i,t-4}$ is the number of licensing of firm i at time $t-4$, $CD_{i,t}$ is the number of co-development of firm i at time t, $1ALLY_{i,t}$ is Dummy variable of total alliances i at time t, $FA_{i,t}$ is firm age of firm i at time t,

$R\&D_{i,t}$ is research and development intensity firm i at time t , $GS_{i,t}$ is the growth of sales of firm i at time t, $LICE_{i,t}$ is a dummy variable with 1 if the firm is licensee and 0 otherwise, $LICER_{i,t}$ is a dummy variable with 1 if the firm is licensor and 0 otherwise, $\varepsilon_{i,t}$ is an error term which captures all others omitted factors with $E[\varepsilon_{i,t} \mid X_{i,t}] = 0$ for all i and t.

3.4. Estimation Technique:

In order to achieve the aims of this study, the random effects generalized least squares (GLS) was carried out to perform the results of every hypothesis. Random-effects GLS is considered more efficient and appropriate than fixed effects (Jiang *et al.,* 2010). Because we have dummy variables, it is not possible for us to use fixed effect estimator and compare the results. We used robust standard errors estimation clustered at the firm level in order to control for heteroskedasticity and autocorrelation of our panel dataset. The analysis is done using STATA software version 13.

4. RESULTS

Table 3.1, below, presents the summary statistics of the variables used for the analysis. The mean, standard deviation minimum and maximum of the variables used in the study are presented.

Table 3.2, presents the correlation matrix of the variables used in the analysis. As can be seen in the table, most of the regressors are correlated with ROA. Furthermore, the signs of the correlations are consistent with the theoretical hypotheses we formulated in the former section. The other control variables included from the literature appear to have the same expected sign in the correlation matrix as well.

Table 3.3, present the test of multicollinearity controlled by using the VIF (Variance Inflation Factor). The result shows that there is no multicollinearity among all independent variables in the model because all the VIF values are less than 10 (Gujarati, 2003).

Table 3.4 presents the regression results of random effect least squares (GLS) model used to test our hypotheses. In our first hypothesis, we expected licensing alliances to influence firm performance (we used ROA to proxy firms' financial performance) positively. As can be seen in the regression table below, the coefficient for licensing is positive and strongly significant (β=0.059, $p< .05$) at 5% significance level in all the models. Hence, from the result, we can say that our first hypothesis, H1, is strongly supported.

In hypothesis two, we expect co-development to impact financial performance positively. As depicted in table-3- below, in model one and two, the coefficient for co-development is positive and significant (β=0.042, β=0.037; $p< .05$), $p< .1$) at 5% and 10% respectively. This appears to give evidence that firms with higher numbers of co-development alliances perform better than firms who have a lower number of co-development alliances. Hence, our result appears to supports our hypothesis two (H2). Concerning model three and four, the results show that the co-development has a positive coefficient and insignificant relationship with ROA (β= 0.030; 0.027, $p> .01$) when we controlled by licensee. This result was rejected.

However, we found negative coefficient for the number of alliances. Furthermore, in all the models it is strongly significant (β= -0.261, $p< .05$) at 5% significance level. Hence, our result indicates that when the number of alliances increases the firm's financial performance with a proxy of ROA decreases. Our result is the opposite of what we hypothesized in H3. This bizarre relationship might be because of the real relationship between the number of alliance and firms' financial performance is non-monotonic. To wit,

the real relationship between the two variables might be U-shaped, inverted U-shaped, J-shaped or otherwise.

We also tried to compare the performance of companies which have only one alliance with the performance of others which have more. In our H4, we expected companies who have only one alliance would perform lower than other firms who have more than one alliance. In all the models, the coefficient for 1Ally (a dummy variable with 1 if the company has only one alliance and 0 otherwise) is negative and strongly significant ($\beta = -0.401$, $p < .01$) at 1% significance level. Hence, our finding has the evidence to support H4.

In all the models we run, as can be seen below in table-4-, we found the expected sign as well as significant coefficient at different significance levels.

5. DISCUSSION AND CONCLUSION

The biotech and pharmaceutical industry is one of the high technology industries which has historically been successful at the global level. The top and younger high technology firms enter into strategic alliances to find financial support and hence utilize each other's skills while aiming to reach their multiple goals.

We attempted to investigate the effect of strategic alliances on firms' financial performances. Our study focuses on biotech and pharmaceutical companies in which alliances between upstream and downstream companies are specifically prevalent (Wuyts, Dutta, and Stremersch, 2004). The sample consisted of 66 biotech and pharmaceutical companies that entered into over 158 strategic alliances in the period of 2003- 2013 combined with a financial data covering the period of 2003-2016.

Overall, we found a complex relationship between different alliance categories and firms' financial performance. The results we found are mixed.

Results show that there is a complex relationship between different alliance categories and firms' financial performance. The number of licensing agreement impacts financial performance. Likewise, other type of agreement, such as co-development, impacts financial performance positively.

However, our result indicates negative relationship between the number of alliances and firm's financial performance. This bizarre relationship might be because of the real relationship between the number of alliance and firms' financial performance is non-monotonic. To wit, the real relationship between the two variables might be U-shaped, inverted U-shaped, J-shaped or otherwise. For instance, Martynov, (2017), found an inverse U-shaped pattern in the effect of larger alliances on future firm performance. Likewise, Jiang *et al.,* (2010), found U-shaped relationship between firm performance and partner industry diversity. Testing this kind of relationship is beyond the scope of this paper. Yet Stuart (2000) found no positive impact of alliances on firm performance. It is not the number of alliances that are important, but rather the partner's characteristics.

Furthermore, our result indicates that firms with only one alliance appear to perform more poorly financially. This result supported the argument of Martynov (2017) who indicated that entering in alliance or not at all resulted in worse firm performance. As well Hagedoorn and Schakenraad (1994) stated that there is no effect of technology alliances on profitability.

The number of licensing agreement impacts financial performance positively. Likewise, other type of agreement such as co-development impact financial performance positively, whereas the results appear to indicate that the number of alliances impacts financial performance negatively. Similarly, firms with only one alliance appear to perform more weakly financially as compared to firms which have more than one alliance.

Table 3.1: Summary statistics

	Variables	Obs	Mean	Std. Dev.	Min	Max
1	ROA	924	-0.4344614	2.865577	-80.83621	6.954387
2	Alliance Portfolio	726	0.2176309	0.5005023	0	4
3	licensing	726	0.4752066	1.274175	0	11
4	co-development	726	0.2231405	0.6473833	0	5
5	R&D Intensity	922	13.02815	72.29609	-4.98053	1212.791
6	log firm age	924	3.16557	0.8853767	0	5.030438
7	Sales growth	924	0.1126856	0.8343037	-6.137142	5.441257
8	licensor	924	0.2997835	0.4584112	0	1
9	licensee	924	0.288961	0.4535253	0	1
10	1Ally	924	0.5454545	0.4981993	0	1

Table 3.2: Correlations Matrix

	Variables	1	2	3	4	5	6	7	8	9	10
1	ROA	1									
2	Alliance Portfolio	0.0474	1								
3	licensing	0.0428	0.8736	1							
4	Co-development	0.0367	0.7949	0.6922	1						
5	R&D Intensity	-0.0228	-0.0605	-0.0549	-0.0492	1					
6	log firm age	0.063	0.0563	0.0416	0.0286	-0.0237	1				
7	Sales growth	0.0627	0.041	0.0442	0.0258	-0.1901	0.0038	1			
8	licensor	0.0277	0.6526	0.5781	0.5288	-0.0476	0.0355	0.0778	1		
9	licensee	0.0403	0.6758	0.5355	0.5269	-0.0434	0.0391	-0.0081	0.0373	1	
10	1ally	-0.1116	-0.2768	-0.2301	-0.2019	0.1183	-0.1903	-0.0401	-0.1689	-0.2413	1

Table 3.3: Multicollinearity Test

Variable	VIF
Alliance Portfolio	4.43
Licensing	4.27
Licensee	1.7
1ALLY	1.28
Co-development	2.23
Licensor	1.59
Log firm age	1.05
R&D Intensity	1.07
Sales growth	1.05
Average VIF	2.07

Table 3.4: Determinants of ROA as Dependent variables estimates

	model1	model2	model3	model4
NumberofAlliances	-0.261**	-0.261**	-0.261**	-0.261**
	(0.113)	(0.113)	(0.113)	(0.113)
licensing	0.059**	0.059**	0.059**	0.059**
	(0.023)	(0.023)	(0.023)	(0.023)
codevelopment	0.042**	0.037*	0.030	0.027
	(0.019)	(0.021)	(0.022)	(0.023)
R&D Intensity	-0.001**	-0.001**	-0.001**	-0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
log firm age	0.175*	0.175*	0.175*	0.174*
	(0.097)	(0.096)	(0.097)	(0.096)
Sales growth	0.053	0.053	0.053	0.053
	(0.041)	(0.041)	(0.041)	(0.041)
licensor	-0.020		-0.008	
	(0.048)		(0.053)	
1ally	-0.401***	-0.400***	-0.398***	-0.397***
	(0.114)	(0.114)	(0.114)	(0.113)
licensee			0.040	0.044
			(0.063)	(0.058)
_cons	-0.593*	-0.594*	-0.597*	-0.596*
	(0.314)	(0.311)	(0.316)	(0.311)

t-statistics are in parentheses: *** p< .01, ** p< .05, * p< .1 .

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Conclusions

Strategic alliances are one of the most frequently adopted mechanisms to enlarge knowledge base and strategic options to companies. They are also more effective than direct acquisition for business since both parties have a mutual agreement, joint strategic plan, vision, as well as objectives in doing business together.

The aim of this dissertation is to provide some contributions to theory and practice in the bio-pharmaceutical industry. The dissertation is specially designed to address a number of issues rising about the knowledge structure, drivers and effects of strategic alliances. The overall purpose of this dissertation has been inspired from the following four fundamental questions:

RQ1: what is the intellectual structure of strategic alliances and product innovation in the past years?

RQ2: how can technological development lead companies to engage in different strategic alliances?

RQ3: Do alliances portfolio affect partners' financial performance?

RQ4: What kind of strategic alliances allow organizations to attain financial performance results in their partnership?

Three independent studies were employed to answer these questions using three different methodologies. In this dissertation we examined qualitatively and

quantitatively the strategic alliances on more than a few companies located in one of intensive industries.

We began the first study of the dissertation by providing insight on the major knowledge subfields among the academic literature, writing about the combination of strategic alliances and product innovation and attempting to delineate the best cited articles and determine their involvement in this field. We adopted quantitative methods to identify common ground in the knowledge subfield in this area. This analysis allowed us to identify four groups of papers constituting the intellectual structure of a field setting as follow: (1) strategic alliance, (2) technological change and organizational capabilities, (3) competitive and coordination, (4) collaboration and innovation. Then to better clarify various authors' perspectives, we investigated the most co-cited papers derived from each cluster.

Findings provide insights regarding the type of documents associated with higher cluster in alliance and innovation literature networks.

The first contribution of this study is the use of a quantitative methodology i.e. the citation and co-citation analysis, among combined research of product innovation and strategic alliances, which permitted us to provide an appropriate tool for researchers to identify the intellectual structure of the literature and new opportunities for future research as well as to set their work in the field under investigation

Given this, in the second and third study the empirical evidence was based on data from three major regions across biopharmaceutical industry. It provided longitudinal data from various databases. As the second question states, the influence of diversity technological and operational efficiency on the formation of strategic partnership, was particularly scrutinized.

The empirical results indicate the negative impact of technological diversification, measured as inverse Herfindahl-Hirschman Index (HHI), on the number of strategic partnerships. Fundamentally, our research has underscored that the low ratio of technological diversification motivate the selection to work in partnership in order to enhance their skills and technological knowledge. Thus, similar technological structure stimulates positively the choice to collaborate with others.

In contrast to previous evidence, we found that companies with higher efficiency measured by total asset turnover (TAT) are more likely to enter in many inter-organizational partnerships.

Considering the last questions, the third study provides insightful implications of two types of partnerships, particularly licensing and co-development alliances, and their impact on return on partners' assets. I specifically investigated portfolio alliances accumulated by firms and I found a complex relationship in results. On the one hand, the higher the number of inter-organizational partnerships, the lower their financial performance. This outcome might be because the real relationship among the number of alliances and firm's financial performance is non-monotonic. On the other hand, we found that the companies perform lower than others with one alliance in their portfolio.

Furthermore, in this study we discovered that firms' financial performance is influenced by the choice of licensing and co-development agreements. Concerning the control variables, the analysis shows that some of them have indeed a role in determining the positive relationship of co-development agreement. Specifically, the licensee partner is more inclined to form co-development partnership to improve its financial performance. As usual, this study has several limitations which may shape future research pathway.

- Limited number of types of strategic alliances as mentioned above. I focused on licensing and co-development agreements, although other agreements exist. Therefore, further study will need to expand the type of strategic alliances in order to be able to define the best alliances choice.
- This study is limited to the strategic alliances within the three most industrialized regions: the US, Europe, and Asia. The sample can be extended to examine bio-pharmaceutical companies located in the emergent countries.
- This study focuses on the bio-pharmaceutical industry. Therefore, findings are not easily generalized in other industries. This therefore brings us to make suggestions for further studies.