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XXXII CYCLE

SHAPING ACADEMIC SPIN-OFFS'
PERFORMANCE THROUGH GENDER
DIVERSITY AND VENTURE CAPITAL:
SOME EVIDENCE FROM EUROPE

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“The science of today is the technology of tomorrow”

Edward Teller

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Chapter 1

1.1 Introduction

University-Industry collaboration nowadays is considered a relevant economic driver in fostering regional competitiveness through technological innovation. The University role of teaching and generating knowledge has been recently complemented by the University entrepreneurial activity so-called University ‘third mission’ (Etzkowitz, Webster, Gebhardt, & Terra, 2000), involving the transfer of the research generated inside academia to industry. The introduction of the Bayh-Dole Act in 1980 in the United States, have contributed to enhancing the universities patent creation, allowing university researchers to obtain economic value of their work through federal funding (D. C. Mowery, Nelson, Sampat, & Ziedonis, 2001). Moreover, with the establishment of the patent court and a patent-friendly legal environment (Arora, Fosfuri, & Gambardella, 1995), universities promoted patents creation and exploitation with the establishment of Technology Transfer Offices (TTO) that encouraged Academic Spin-Off (ASO) formation in order to commercialize their university-based research. As a consequence, the number of patents in U.S. universities have grown rapidly, doubling during the period between 1979 and 1984 and increasing with a share of 3.6 percent in 1995 starting from 1 percent in 1975 (D. Mowery, Nelson, Sampat, Policy, & 1999, n.d.). The university entrepreneurship culture through patent creation and exploitation that firstly originated in U.S., progressively moved to UK, reaching the other European countries. According to the ASTP-Proton, (2015) Survey Report, the vast majority of Technology Transfer Offices in Europe (92%) can count no less than one patent granted or a patent application in their portfolio with a licensing rate of 21% on average. Collecting data from over 400 European Organizations, the Report also examined the spin-off creation showing a regular activity in the European community, reporting 640 new spin-offs formed in 2015. In defining academic spin-off Shane (2004), refers to ‘high-tech companies whose core business is based on the commercial valorisation of results of a scientific and technological research’ while Wright, Clarysse, Mustar, & Lockett (2007) as ‘start-ups by faculty based in universities which do not involve formal assignment of the institution’s Intellectual Property (IP) but which may draw on the individual’s own IP or knowledge’. Accordingly, Colombo, Adda, & Piva (2010) define Academic Spin-Offs

(ASO) as companies with some ‘‘genetic’’ characteristics that facilitate detection, absorption, and exploitation of academic knowledge’. These definitions suggest that Academic Spin-Off companies in order to be more attractive and to represent an important technology transfer channel, need to protect their technologies and innovative ideas through intellectual property rights (IPR) protection and so the patent activity. There has been a range of important papers that analysed the Academic Spin-Off topic. Prior literature have investigated how universities facilitate the process of spin-off venture formation based on academic research using a capability perspective (Rasmussen & Borch, 2010). In their study, Zahra, Van de Velde, & Larrañeta (2007) used the ‘‘knowledge conversion capability’’ (KCC) in order to analyse the success of spin-offs in commercializing new technologies, particularly comparing Corporate spin-offs (CSOs) and University spin-offs (USOs). Some researchers have developed a spin-off typology and linked the spin-off phenomenon to regional development in a dynamic perspective (Bathelt, Kogler, & Munro, 2010), while others considered the influence of university characteristics on the growth of local ASO assessing the resource and competence-based perspective (Colombo, Adda, & Piva, 2010). Furthermore, several studies focused the attention academic spin-offs investigating performance factors. Some used patents in order to explain creativity (Dahlstrand, 1997) and to justify innovation transfer capabilities of ASOs (Kroll & Liefner, 2008), others proposed the capacity to attract venture capital financing and the experiencing of Initial Public Offerings (IPO) as performance measures (Shane & Stuart, 2002). In addition, Shane (2004) proposed to measure the number of job opportunity created, to determine the performance of a spin-off company. Furthermore, some studies evaluated the impact of legislative changes and of universities’ mechanisms on spinoffs’ creation (Baldini, 2010; Colombo, Adda, & Piva, 2010; Fini, Grimaldi, Marzocchi, & Sobrero, 2008; Lockett, Siegel, Wright, & Ensley, 2005; Nosella & Grimaldi, 2009; Moray & Clarysse, 2005).

According to these considerations, the main goal of the thesis is to investigate the University-Industry relationship focusing on Academic Spin-off companies looking at post entry performance factors. Numerous studies analysed antecedents of Academic Spin Offs, but post-entry performance has not drawn a significant scholarly attention.

1.2 Motivations and objectives of the research

Academic Spin-Off companies creation represents a valuable technology transfer channel through patent creation and commercialization and is considered to be one of the main tools for the exploitation of university research results. In this thesis, ASO Acquisition and Sales strategies have been considered as positive and significant post-entry performance, examining on one side how the governance gender structure impacts the ASO post-entry performance, on the other how Venture Capital influence ASOs growth strategy and facilitate firms' acquisition. Much of the research available in the literature have focused on USA's spin-offs, while this topic has not received sufficient attention for the European countries. Despite the well-recognized value of studying the Academic Spin-Offs phenomenon, empirical studies on this topic are continuously constrained by the limited availability of data (Shane, 2004). Therefore, a comprehensive and organic database providing data from different national and EU level ASO records is not currently available. Only few country level data are available. For this reason, I collected data from different sources and I built a new macro-level academic spin-offs database, based on information of European spin-off companies. Hence, this study is unique because it draws on a macro-level database, based on three different European countries over a 10 years period and data have been collected in several stages. The final comprehensive dataset includes time-variant information from 2009 to 2018 of almost 2.000 spin-off companies at European, national and regional level.

1.3 Structure of the thesis

The thesis has its roots on an in-depth analysis of the received literature related to the academic spin-offs phenomenon and performance factors. The thesis is composed by four chapters.

The first chapter is the present, providing general overview of the study, explaining the aim of the work, the context in which is conducted and the main contributions.

The second chapter is a literature review where I set the theoretical framework of the thesis, by delving more deeply into the literature on 'Academic Spin-Off companies'. I analysed the publications issued using the keywords "*Academic Spin-Off*" or "*University*

Spin-Off” or “*ASO*”, by performing text mining and chronological analyses and exploring the new directions of the related studies.

In the third chapter I examined the impact of gender diversity in the Academic Spin-Offs board of directors on the performance of these firms. The purpose of the study is to contribute to the large debate on gender diversity, given the growing institutional framework for the promotion of diversity in a vast number of regions.

The fourth chapter evaluates one of the instruments used to finance innovative firms and how it impacts ASO acquisition probability as a positive post-entry performance indicator. In particular, it examines to what extent VC investments contribute to the likelihood of Academic Spinoff companies of being acquired.

1.4 Abstracts

Here following the abstracts of the papers:

- **Paper 1** (chapter 2): Over the last decades, the literature on Academic Spin-Offs has grown significantly. In this study, 498 documents published on the topic from 2000 to 2020 have been selected, with the aim of observing the phenomenon evolution over the last 20 years. In order to examine the document results, the present study uses different analyses. The text mining analysis performed by an accurate selection of the most common words in the titles and abstracts of the publications and the chronological analysis for the publications progression over time. All of the analyses have been conducted through constructing and visualizing bibliometric networks using the *VOSviewer* software. This has allowed to identify four clusters that represent the principal areas of the scientific discussion: Technology Transfer, Science Commercialization, Venture Capital and Investment and University Spin-Off or Academic Spin-Off Team. The review suggests a conversion from more general topics to a more strategic debate showing a changing trend of the studies passing from qualitative to quantitative analyses, from American to European case study, underlining the characteristics of the founding team such as the board of directors’ dynamics. According to these findings, scholars are moving to further scenarios with new strategies and

linkages, underlying some useful research areas where the future research can be addressed.

- **Paper 2** (chapter 3): In the last decade, the awareness of the women role in society has received an increasing attention both from scholars and policy makers. Diversity and gender equality inside companies has become a key aspect of corporate governance, sustainability and growth (Farag & Mallin, 2016). Drawing on agency theory, resource dependence theory and human capital theory, this study analyse how women on the board of directors affect Academic Spin-Offs (ASO) financial performance. The sample of the analysis comprises the population of European ASO companies using an own-built database, based on information of almost 2.000 ASO firms. A large body of literature suggests that gender diversity on board improves company performance, while this study shows a different picture, suggesting that the relationship between gender diversity and ASO companies financial performance do not have a positive impact. Despite institutional framework, together with the influence of media and stakeholders, impose more pressure on business organisations to promote more diverse boards, if this improves firm performance remains ambiguous. Accordingly, some previous works already found counterintuitive conclusions, hence this relationship needs to be more explored.
- **Paper 3** (chapter 4): Venture capital is an important form of financing for innovative companies in the high-tech sector. As stated by Bottazzi et al. (2002) the US Venture Capital industry is fundamental for the commercialization of technological innovation. Accordingly, the European institutional framework reveals on one side how the policy can contribute to the growth of an active venture capital industry in Europe, on the other industry reports analyse the supply of funding and the creation of positive conditions for entrepreneurship. This study provides an empirical analysis using a unique panel dataset comprising time-series cross-sectional data derived from the entire population of academic spin-off companies in three different European countries. In particular, the work has been conducted considering not only the national and regional level in order to examine the country and the singular regional effects, but also the strategic aspects and dynamics of the firms over a 10 years period (2009-2018). The results

of the analysis show that VC investments in Europe significantly contribute to the probability of ASO acquisition revealing that Venture Capital stands a positive signal to the market. While prior studies documented the potential benefits associated with the managerial aspects of VC for firm success in terms of survival and growth providing start-ups additional expertise and support to attract funding given the existing entrepreneurs lack of business experience (Bottazzi & Da Rin, 2002b; Gorman & Sahlman, 1989), this paper examine the impact of venture capital investments on ASO firms acquisition in terms of post-entry performance.

1.5 Overall Contributions

1.5.1 Contributions of the thesis

The study offers several incremental contributions to the research on Academic Spin-Offs. First, it explores the relationship between female representation on the board of directors of ASO and the financial performance of this type of firms which has not been done before. Diversity and gender equality inside companies has become a key aspect of corporate governance, sustainability and growth (Farag & Mallin, 2016) and studying the composition of the board of directors helps to analyse whether certain gender characteristic can shape the company outcome. Therefore, this study contributes also to the literature on women on boards, board composition and to the extensive literature on corporate governance. Second, adding to an emerging body of research on venture capital and the instruments used to finance innovative firms, it delivers a relevant contribution towards understanding the significant role played by several actors that provide important resources at different level in the growth of ASOs (Fernández-Alles, Camelo-Ordaz, & Franco-Leal, 2014). Lastly, while previous studies on Academic Spin-Offs have mostly focused on USA's companies, the research has been conducted focusing on European companies. Prior research examined the phenomenon using a qualitative approach, collecting information through surveys or interviews, while this research has been performed with empirical analyses employing a new database built on information of European Academic Spin-Offs. However, this study has several limitations. The indirect measures used in this work, do not provide strategic interpretations because are

not accompanied by primary data. Furthermore, the study compares the population of ASO companies of three European countries, would be interesting to extend the sample of the investigation with additional countries and additional analyses to evaluate the robustness of the results.

1.5.2 Contributions during the Ph.D.

Publications:

- Cinici, M.C., Schifilliti, V., Cesaroni F. (2019). Understanding the dynamics of entrepreneurial ecosystems: evidence from a longitudinal case study. *Handbook of Research on Techno-Entrepreneurship, Third Edition*, pp.350-376
- Mansani, F., Schifilliti, V., Langley, P., (2019). UK Start-up Ecosystem. *ITA-Italian Trade Commission, Trade Promotion Section of the Italian Embassy. Report 2019, London.*

Conference presentations:

- Schifilliti, V., Cinici, M. C., Cesaroni, F., Baglieri, D. (2019). The Impact of the IPR Regulation on Academic Spin-offs' Acquisitions. *R&D Management Conference, Paris. Conference proceedings.*
- Schifilliti, V., Cinici, M. C., Cesaroni, F., Baglieri, D. (2019). Can Patent Legislation Make a Difference on Academic Spin-offs Acquisition? Some European Evidence. *SMS 39th Annual Conference, Minneapolis. Conference proceedings.*
- Crupi, A., Cesaroni, F., Cinici, M.C., Schifilliti, V. (2017). Technology based growth: does R&D boost employment in China? *Forthcoming in IASOS Congress – Usak University conference proceedings.*

Chapter 2: Academic Spin-Off Companies Literature: insights from a content analysis

2.1 Introduction

Academic Spin-Off companies (ASO) represent a valuable technology transfer channel through patent creation and commercialization and is considered to be one of the main tools for the exploitation of university research results. The university entrepreneurship culture through patent creation and exploitation that firstly originated in U.S. with the establishment of Technology Transfer Offices, progressively moved to UK, reaching the other European countries.

According to the ASTP-Proton FY2015 Survey Report (ASTP-Proton, 2015), the vast majority of Knowledge Transfer Offices in Europe (92%) can count no less than one patent granted or a patent application in their portfolio with a licensing rate of 21% on average. According to these numbers, European Knowledge Transfer Offices (or Technology Transfer Offices) are valuable structures for the Intellectual Property management, using successful measure to attract business interests for their IP. ‘The difference between the number of reported new patent applications and the total number of patent families managed by the KTOs indicates an active management of such patent portfolio that spans multiple years.’

Table 1. Intellectual Property activities in European KTOs (ASTP-Proton, 2015)

INTELLECTUAL PROPERTY ACTIVITIES	
Invention Disclosures	11,301
New Patent Applications	2,802
Patents Granted	1,079
Active Patent Families in 2014	18,762

Additionally, taking into account the number of active patent families, more than 200 patent families have been registered from around 12 percent of the Knowledge Transfer Offices, while 8 percent of the organizations declared just 0 active patent families

(ASTP-Proton, 2015). Collecting data from over 400 European Organizations, the Report also examined the spin-off creation showing a regular activity in the European community, reporting 640 new spin-offs formed in 2015. However, the trend is not the same for every organization. In particular, 48 percent of institutions did not register any spin-off in 2015, 17 percent recorded only one spin-off created while 27 percent registered 2 to 5 spin-off companies formation, concluding with the 7 percent of KTOs creating more than 6 spin-offs in the whole year (ASTP-Proton, 2015). These results can be explained considering that some Knowledge or Technology Transfer Offices have been established for a longer time in some countries, while are a quite new in others. ASTP-Proton report underlines the increasing interest on innovation inside Universities and the patent creation and commercialization through Technology Transfer Offices and Academic Spin-Off companies. The extant literature has proposed several definition of spin-off companies. As stated by (Rogers, Takegami, & Yin, 2001), spin-off companies are those based on the parent R&D organizations, namely, the government R&D laboratory, the University, the University research centre and private R&D organizations. According to Colombo, Adda, & Piva (2010) these companies have some “‘genetic’ characteristics that facilitate detection, absorption, and exploitation of academic knowledge’. In defining academic spin-off Shane (2004), refers to ‘high-tech companies whose core business is based on the commercial valorisation of results of a scientific and technological research’. While Wright, Clarysse, Mustar, & Lockett (2007) on the one hand define ASO as ‘new ventures that are dependent upon licensing or assignment of an institution’s Intellectual Property (IP) for initiation’, on the other ‘start-ups by faculty based in universities which do not involve formal assignment of the institution’s IP but which may draw on the individual’s own IP or knowledge’.

This study provides a review of the current literature on Academic Spin-Off companies by offering a systematic overview that serves to better understand previous aspects that have been examined in this field. In the first section, the methodology used for the review has been described, with a detailed explanation of the selection criteria and research procedure. The second section defines the results of the analysis and the cluster identification procedure. The third section briefly underlines the identified subject areas and the last session discusses the main findings and draws conclusions.

2.2 Methodology

2.2.1 Selection Criteria

Publications on the Academic Spin-Off phenomenon varies overtime and the selection process has been conducted on the comprehensive database *Elsevier's Scopus*. The research has been conducted searching for the keywords “*Academic Spin-Off*” or “*University Spin-Off*” or “*ASO*” selecting the subject areas “Business, Management and Accounting” and “Economics, Econometrics and Finance”. Although the first publication on the topic was in 1992, in the following years only one document per year has been published until 1995 where no contributions have been registered. Starting from 1997 the theme seemed to definitively attract scholars’ interest with an increase of important papers published on the topic that achieved the maximum in recent years. For the clustering analysis the year range between 2000 and 2020 has been chosen in order to observe the phenomenon evolution over the last 20 years. The result is a set of 498 documents published.

2.2.2 Clustering Methods

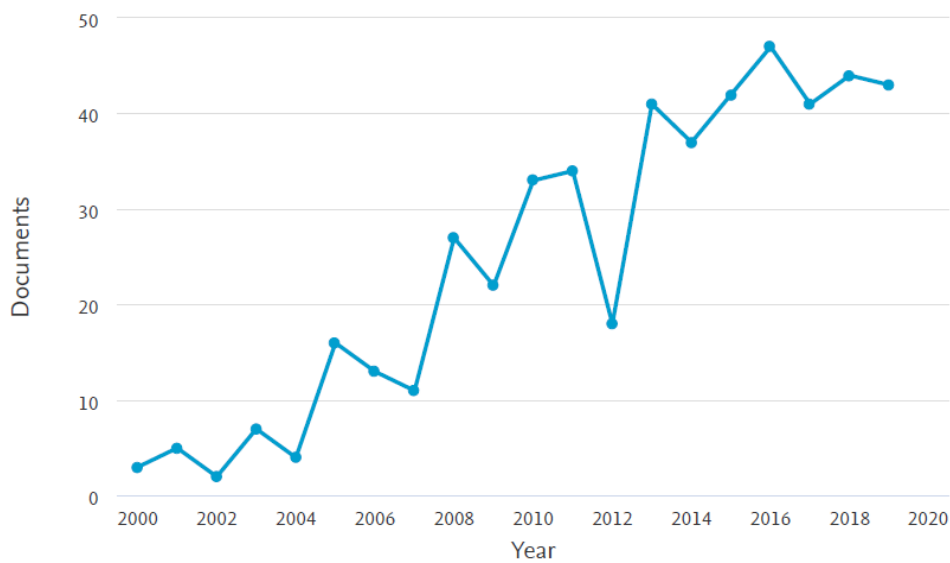
In order to examine the document results, the present study uses different analyses. For the bibliometric networks the mapping and clustering technique proposed by Waltman, Jan Van Eck, & Noyons (2010) has been applied. This approach is a support against the incongruities generated while building maps at different stages of detail, based on mapping and clustering systems created upon analogous measures. First, the text mining analysis has been run with an accurate selection of the most common words in the titles and abstracts of the publications. The aim was to identify the occurrence of the keywords or ‘items’ and the links between them. Using the network visualization, items have been grouped into clusters and represented by label and circle whose dimension depends on the weight of the item. Second, the chronological analysis for the phenomenon evolution over time has been run using the overlay visualization. Thus, all of these analyses have been conducted through constructing and visualizing bibliometric networks using the *VOSviewer* software. Lastly, the clustering results divided by thematic areas have been described.

2.3 Results

2.3.1 Description of the results

Over the last years, the interest of scholars on the topic covered several aspects related to the concept of Academic Spin-Off. As mentioned above, in section 2.2.1, the result is a set of 498 documents published, divided as 393 articles, 46 book chapter, 37 conference proceedings and 22 other documents (Figure 1).

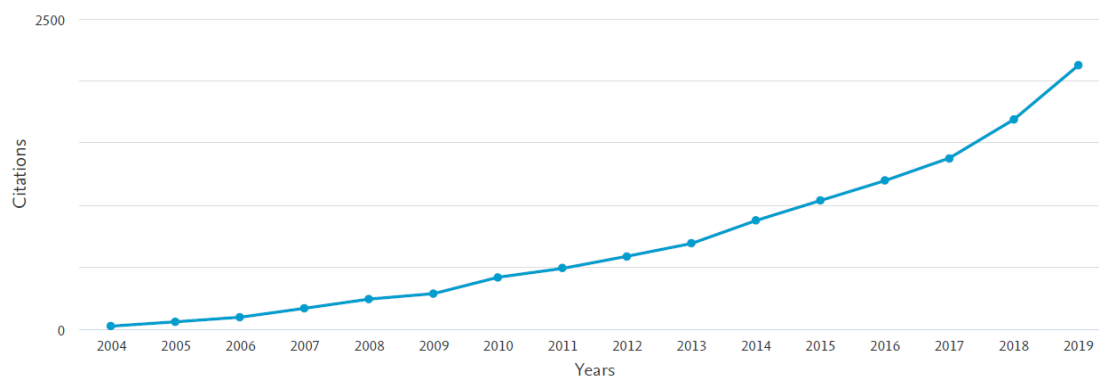
Figure 1: Total number of publications by year



Source: Elsevier's Scopus

The documents have been cited 5,762 times until 2020 with an h-index of 56 as shown by Figure 2 while Appendix 1 (pag 143) illustrates the list of all the documents with the total number of citations.

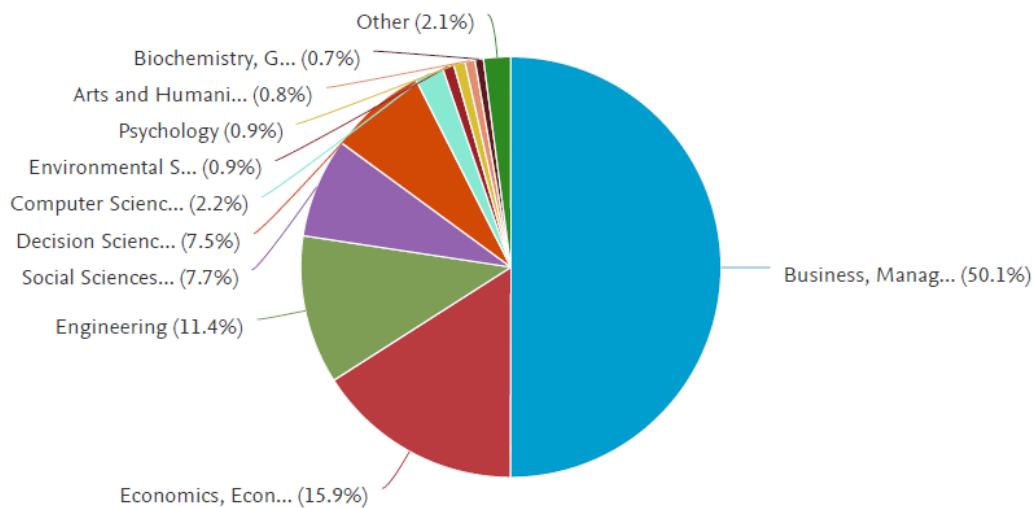
Figure 2: Total sum of cited publications by year



Source: Elsevier's Scopus

As displayed by Figure 3, the subject areas that delve more deeply into the topic are “Business, Management and Accounting” followed by “Economics, Econometrics and Finance” and “Engineering”.

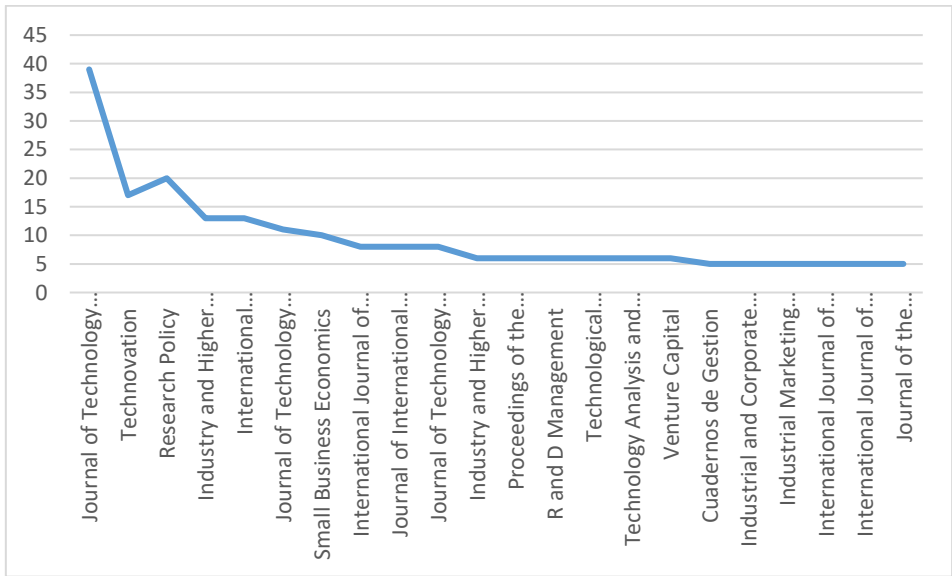
Figure 3: Documents by subject areas



Source: Elsevier's Scopus

Regarding the journals in which these articles have been published as it can be observed by Figure 4, Journal of Technology Transfer, Research Policy and Technovation are emerging with the highest contributions published on the topic.

Figure 4: Journal per number of records

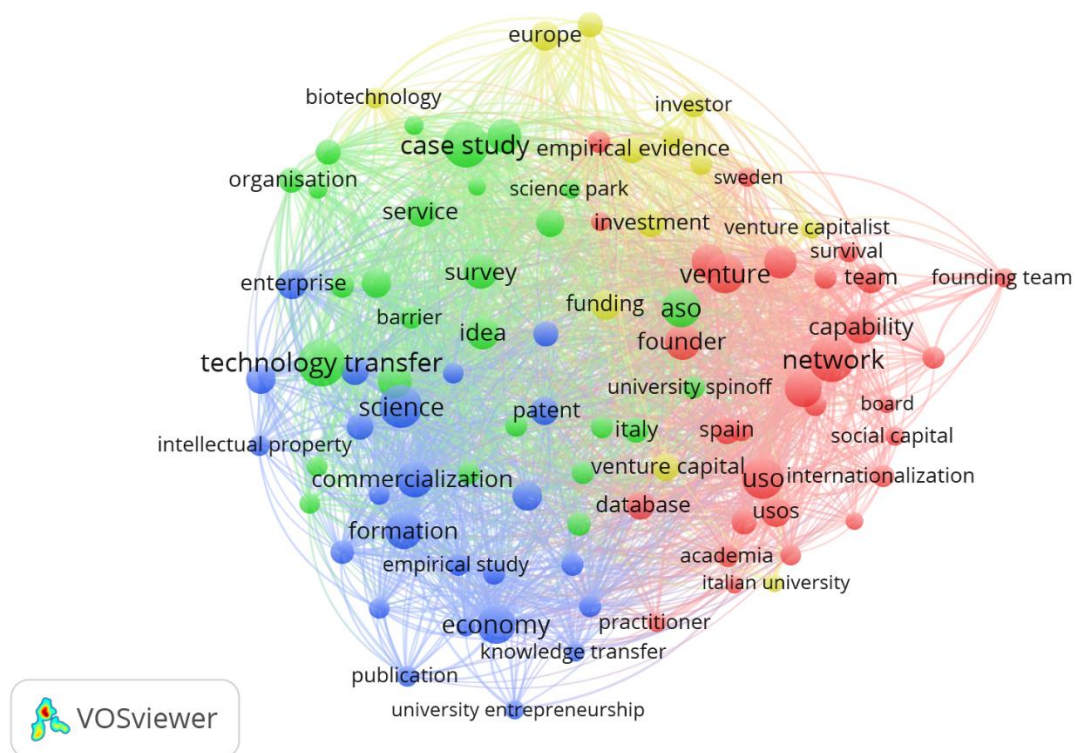


Source: Elsevier's Scopus

2.3.2 Cluster analysis results

Figure 4 displays the results of the text mining analysis with an accurate selection of the most common words in the titles and abstracts of the publications. The figure shows the main words, that appeared a minimum of 10 times in the publications and the links between them, without considering general terms such as ‘extent’ or ‘field’. In the network visualization, the terms have been grouped into clusters divided by colours and the dimension of the circle depends on the frequencies of the used words. As it can be seen in Figure 4, despite the convergence between clusters, there is a clear representation of the clusters coloured in blue, red, green and yellow that have been named for the analysis ‘Science commercialization’ (blue), ‘University Spin-Off team’ (red), ‘Technology Transfer’ (green), ‘Venture Capital and Investment’ (yellow).

Figure 4: Network visualization of text mining analysis



The result of the chronological analysis for the phenomenon evolution over time is displayed by Figure 5. The overlay visualization map shows the publications progression from 2000 to 2020 passing from blue (early publications) to red (latest publications). It

2.4.1 Technology Transfer and Science Commercialization

It is worth noting that the University role of teaching and generating knowledge has been recently complemented by the University entrepreneurial activity so-called University ‘third mission’ (Etzkowitz et al., 2000), involving the transfer of the research generated inside academia to industry. Previous studies underlined the importance of the third mission, demonstrating that universities are willing to meet external needs and to contribute, through patent disclosure, to the innovative development of the society (Loi & Di Guardo, 2015). Technology transfer and research commercialization has attracted attention both at academic and policy level. Extant literature underlined several ways of commercializing the new technology created inside University such as patenting, licensing and academic spin-off creation (B. Clarysse, Wright, & Van de Velde, 2011; Markman, Siegel, & Wright, 2008; Mustar et al., 2006; O’Shea, Chugh, & Allen, 2008; Phan & Siegel, 2006). Technology transfer can occur via formal or informal processes. Informal processes can involve collaborations between academia and external organizations such as informal contacts with industry experts (Craig Boardman & Ponomariov, 2009) or academic engagement (Perkmann et al., 2013). Formal processes involve contract research, consulting, patenting and licensing contracts (Cesaroni & Piccaluga, 2005; P. D’Este & Patel, 2007; Perkmann & Walsh, 2008; Thursby & Thursby, 2003). The patenting and licensing activity of the university inventions can be defined as one of the most common way of technology commercialization (Powers & McDougall, 2005). Therefore, Universities created several facilities like Technology Transfer Offices (TTOs), Science Parks or Incubators in order to spur commercialization (Bart Clarysse, Wright, Lockett, Van de Velde, & Vohora, 2005; Siegel, Waldman, & Link, 2003). Several studies analysed the role played by TTOs examining TTOs productivity in terms of ‘outputs’ and ‘inputs’ (Siegel et al., 2003; Thursby & Thursby, 2002) and performance while others analysed TTOs business models and the role of agents involved in commercialization (Baglieri, Baldi, & Tucci, 2015; Bercovitz, Feldman, Feller, & Burton, 2001; B. Clarysse, Wright, Lockett, Mustar, & Knockaert, 2007). TTOs promote the transfer of knowledge by identifying opportunities and commercial networks due to the business skills of their managers. However, Chapple, Lockett, Siegel, & Wright (2005) found that the TTOs growth is not always related with an increase of managers’ business competences, suggesting smaller TTOs dimension and

upgrading personnel competences. Another form of technology commercialization is represented by Academic Spin-Offs (ASO) (or University Spin-Off), companies founded by scientists created upon a technology developed inside University. In recent years, the spin-off phenomenon received growing interest since ASO companies are considered to be one of the main tools for the exploitation of the university research results. Hence, technology transfer occurs through company creation with the specific aim of exploiting the patented research or a series of unpatented know-how (Shane, 2004). To this respect, some studies highlighted the impact of the royalty mechanisms on ASO creation (Di Gregorio & Shane, 2003; O'Shea, Allen, Chevalier, & Roche, 2005) and how ASO formation increase the probability of financial returns compared to licensing (Macho-Stadler, Pérez-Castrillo, & Veugelers, 2008). Lockett & Wright (2005) found a positive relationship between ASO creation and university investments in IP protection and business competences of TTOs. In addition, the quality of the research inside University has a positive effect on ASO formation (Di Gregorio & Shane, 2003) as well as previous succeeding ASO cases that increase the probability of ASO formation from the same University (O'Shea et al., 2005). In conclusion, as an important part of national innovation system, universities are expected to continuously educate high-level talents, actively collaborate with industries and encourage spin-offs companies creation (Su, Zhou, Liu, & Kong, 2015).

2.4.2 Venture Capital and Investment

Extant literature has recognised several aspects related to the resources needed for technology commercialization such as funding, venture capital and supporting facilities like incubators. Many University programmes have been established to provide funding support for the academic spin-off development and to finance Intellectual Property protection of the invented technology. In several countries, governments have addressed specific public funds to the support of new innovative companies and to commercialize the IP generated inside University (Wright, Lockett, Clarysse, & Binks, 2006). Other policy approaches to stimulate innovation without directly providing pre-seed or seed funding are fiscal reduction for those who invest in new high-tech companies and ad hoc structures like business Incubators that provide management support to new companies that are connected to Universities or public research organizations. An important form of

financing for innovative companies in the high-tech sector is Venture Capital. As stated by Bottazzi & Da Rin (2002) the US Venture Capital industry is fundamental for the commercialization of technological innovation and several studies documented the role of American venture capitalist in supporting high tech companies (T. F. Hellmann & Puri, 2000). Previous studies on the relationship between innovations and venture capital have investigated the interest of VCs on innovative companies (Baum & Silverman, 2004; Engel & Keilbach, 2007; Hirukawa & Ueda, 2011) and demonstrated the positive effects between the innovative activity and VCs presence (Arqué-Castells, 2012; Bertoni, Colombo, & Croce, 2010; Kortum & Lerner, 2000; Popov, Roosenboom, & W., 2012). Some studies analysed the differences between backed and not-backed venture capital academic spin-off (Shane & Stuart, 2002) while others the importance of the relationship with University and TTOs networks to increase the probability of venture financing (Lockett, Wright, & Franklin, 2003b) concluding that ASO companies have a higher probability of the entering the venture capital network than start-ups (Heirman & Clarysse, 2004). In their research Bottazzi & Da Rin (2002) found that VC provide financial resources that are fundamental for the establishment and growth of European innovative companies.

2.4.3 University Spin-Off (USO) or Academic Spin-Off (ASO) Team

Several studies examined the role of researchers and entrepreneurs in academic spin-off companies. On one hand the works underlined the human capital characteristics of the scientists becoming entrepreneurs, on the other the composition of ASO team. According to Lockett, Wright, & Franklin (2003) research inventors may be a member of the board or may participate to the firm activity with an advisory role. Inventors from university devote too much attention to new technology development without being able to identify business opportunities because of the lack of entrepreneurial skills, network or resources as demonstrated by Golish, Besterfield-Sacre, & Shuman (2007) comparing inventors from academia and industry and their different attitude toward the commercialization process. Some studies analysed researchers background finding that inventors from scientific departments such as engineering, economics, medicine have a positive attitude of being engaged in technology transfer rather than mathematics or physics (Arvanitis, Kubli, & Woerter, 2008), while others found that researchers are motivated not only by

financial returns, but mostly by the research success and their academic reputation (Colyvas et al., 2002; Pablo D'Este & Perkmann, 2011). At team level, several studies analysed the size, heterogeneity and backgrounds of ASO members. Some studies examined the structure of founding team suggesting that ASO member with different industrial practices have a positive effect on ASO growth while others examined the team turnover showing that some members that take an active role in the initial stage of the spin-off, are replaced by new members with business experience (Eesley, Hsu, & Roberts, 2014; Vanaelst et al., 2006). Initial members often prefer to focus on their research while working inside University as well as participating to the firm with only technological advices. ASO team composition is also one of the main characteristics that venture capitalist consider while deciding to invest inside the company and previous body of literature analysed the relationship between venture success and team composition suggesting that teams heterogeneity is viewed as a good strategic choice that increase firms performance (Colombo & Grilli, 2005; Forbes, Borchert, Zellmer-Bruhn, & Sapienza, 2006; Stuart Bunderson & Sutcliffe, 2002; Vanaelst et al., 2006; Wright, Clarysse, Mustar, & Lockett, 2007b; Wright et al., 2006).

2.5 Discussion and Conclusion

This study intends to give a comprehensive overview of the Academic Spin-Off phenomenon. The analysis of the literature considers the year range between 2000 and 2020 in order to observe the evolution of the studies over the last 20 years. During this period, it has been observed an increase of important papers published on the topic that achieved the maximum in recent years, with only a slightly decrease in 2012. As resulted by the publications analysis, the journals that delivered more attention to the topic are Journal of Technology Transfer, Research Policy and Technovation with the highest rate of paper published. The study has been conducted using the text mining analysis performed by an accurate selection of the most common words in the titles and abstracts of the publications and the chronological analysis for the publications progression over time. This has allowed to identify four clusters that represent the principal areas of the scientific discussion: Technology Transfer, Science Commercialization, Venture Capital and Investment and University Spin-Off or Academic Spin-Off Team. The growing

attention of this body of literature considers not only the role of innovation inside universities in general, but also the increasing role played by Academic Spin-off companies. Over the last years, universities have coped with several policy changes that influenced their objectives, funding and procedures, due to important legislation such as the Bayh–Dole Act regulation in US or the ‘professor’s privilege’ reconsideration in several European countries (Baldini, Grimaldi, & Sobrero, 2006; R. Fini, Grimaldi, Santoni, & Sobrero, 2011; Geuna, 2001; Lissoni, Llerena, McKelvey, & Sanditov, 2008; McKelvey & Holmén, 2010; D. C. Mowery et al., 2001). However, the chronological analysis of the publications shows a conversion from more general topics to a more strategic debate. Nowadays, the interest of scholars focused more on the relationship between the research created inside Universities and the scientists entrepreneurial activity in terms of conceptual models, organization, performance and impact on local development. Moreover, the analysis shows a changing trend of the studies passing from qualitative to quantitative analyses, from American to European case study, underlining the characteristics of the founding team such as the board of directors’ dynamics. According to these findings, scholars are moving to further scenarios with new strategies and linkages, underlying some useful research areas where the future research can be addressed. Next to the traditional mission of teaching and researching, universities are assuming a strategic role with the creation and dissemination of new knowledge and technology (Olcay & Bulu, 2017) since they are now considered as an important part of national innovation system, expected to continuously educate high-level talents and actively collaborate with industries and encouraging spin-offs companies creation (Su et al., 2015).

Chapter 3: Gender Diversity and Board Composition in Academic Spinoffs: implications for performance

3.1 Introduction

In the last decade, the awareness of the women role in society has received an increasing attention both from scholars and policy makers. Diversity and gender equality inside companies has become a key aspect of corporate governance, sustainability and growth (Farag & Mallin, 2016). In the last decade government regulations, together with the influence of the media and stakeholders, impose more pressure on business organisations to promote more diverse boards. Consequently, a series of measures to promote gender diversity on the board of directors has been appointed.

At European level, the European Commission in 2012 proposed a Directive with the purpose of improving the gender balance on corporate boards. The Commission proposal sets a *'quantitative objective of a 40 % presence of the under-represented sex among non-executive directors of companies listed on stock exchanges by 2020'*. For those companies who will not respect this share, the European Commission will require an appointment on the basis of *'a comparative analysis of the qualification of candidates by applying clear, gender-neutral and unambiguous criteria'* (European Commission, 2016).

In the end of 2013, the European Parliament voted in favour of the proposed Directive and the legislation was adopted with a broad support.

European Commission, 2016 report, considering the period from October 2010 to April 2016, shows an increasing rate of women on boards in 23 out of 28 Member States. Change in the board gender diversity is significant in Italy with a +25.5 percentage point increase, followed by France (+24.8 pp), Belgium (+16.1 pp), Germany (+14.6 pp), Slovenia (+14.1 pp), the United Kingdom (+13.7 pp) and the Netherlands (+13.2 pp). However, an interesting result is that the increasing share of women on board is registered in countries where a strong emphasis has been given on this topic.

Despite the institutional framework is promoting a more diverse board, with an increase of the presence of women on boards inside companies, if this can improve firms

performance is unclear. Several scholars analysed the gender composition of the board of directors which, as decision-making authority, plays a central role for the company's policy, objectives and direction. Although a large body of literature examined the relationship between female board representation and firm performance, the results are mixed. Numerous works on the topic suggest that gender diversity while increasing the company advantage, also influence the quality of firm's performance (Campbell & Mínguez-Vera, 2008; Cox & Blake, 1991; Elsbach, 2003; Smith, Smith, & Verner, 2006; Westphal & Zajac, 2013). Some studies appoint that a board with more female representation tend to increase returns on assets as well as generating economic gains (Campbell & Mínguez-Vera, 2008; Singh, Vinnicombe, & Johnson, 2001). On a contrary, other studies suggest that a board with more female representation does not impact positively firms performance showing decreasing accounting returns (Darmadi, 2011; Mínguez-Vera & Martin, 2011)

The objective of this work is to examine the impact of gender diversity in the board of directors on the performance of Academic Spin-Off companies. The study offers several incremental contributions to the research on women on boards, board composition and to the extensive literature on corporate governance and academic spin off.

First, this study is unique because it explores the relationship between female representation on the board of directors of Academic Spin-Offs and the financial performance of this type of firms which has not been done before. Second, while previous studies on Academic Spin-Off have focused exclusively on USA's companies, this empirical analysis used a new database built on information of European Academic Spin-Off. Lastly, this study makes a timely contribution given the growing institutional framework on gender diversity in a vast number of regions.

The paper is organised as follows. The next section discusses the theories applied and is followed by the literature review and hypothesis development based on the relationship between board diversity and firm financial performance. In the second section, the research design and the results of the empirical analysis have been presented. Finally, in the last section of the paper discussion of the main findings have been provided, together with conclusions and practical implications.

3.2 Board Diversity and Company's Performance: Theoretical Perspectives

Despite previous theories such as social identity theory (Ashforth & Mael, 1989), social role theory (Eagly & Karau, 2002), token theory (Kanter, 1977), upper echelon theory (Hambrick, 2007) have been used to examine the relationship between female on board and firm performance (Chattopadhyay, George, & Shulman, 2008; Chen, Crossland, & Huang, 2015; Glass & Cook, 2018; Post & Byron, 2013), agency theory, resource dependence theory and human capital theory offer a better theoretical basis for explaining the relationship between board diversity and firm performance.

According to agency theory, the monitoring and controlling function of the board inside companies is a fundamental aspect since agents behave in the best interests of shareholders (Jensen & Meckling, 1979). The theory considers the impact of board composition and corporate governance on company performance. As stated by Carter, Simkins, & Simpson, (2003) to a greater diversity inside the board corresponds a better monitoring activity of managers since it increases board independence and decreases agency costs (van der Walt & Ingley, 2003). However, using agency theory, they do not give a clear explanation of the relationship between board diversity and financial performance. Agency theory suggests on one side that a better monitoring activity of management include the combination of different backgrounds, experience and qualifications (Hillman & Dalziel, 2003), on the other that the ownership structure have a significant impact on the monitoring role of the board of directors (Ben-Amar, Francoeur, Hafsi, & Labelle, 2013; Morck, Shleifer, & Vishny, 1988). As stated by Anderson, Reeb, Upadhyay, & Zhao, (2011) diversity on board brings to different point of view and, consequently, to a better monitoring for shareholders and managers. Some studies found that gender diversity conveys to a better public and private disclosure (Gul, Srinidhi, & Ng, 2011), while others that women on board perform not only a stronger monitoring but also the more heterogeneity on board the less agency problems (Farrell & Hersch, 2005; Peterson & Philpot, 2007).

Resource dependence theory considers the board of directors as a strategic resource for the firm, and diversity inside the board imply an easier engagement of qualified and well-connected directors (Carter, D'Souza, Simkins, & Simpson, 2010; van der Walt &

Ingley, 2003). Therefore, different board members offer more diverse experience and a more effective use of their unique knowledge and firms resources (Hillman, Cannella, & Paetzold, 2000; JENSEN, 1993). In their study on resource dependence role, Hillman et al., (2000) found that board composition is an important link to the external environment, providing valuable resources as well as generating positive financial performance for the firm thanks to the different perspectives and backgrounds of the board members.

According to Carter et al., (2010) resource dependence theory is better explained with human capital theory. Human capital theory considers how a person's background in terms of education, competence and experience can be beneficial for the company (Becker, 1964). Additionally, as stated by Terjesen, Sealy, & Singh, (2009) gender diversity inside the board leads to a better company performance thanks to the unique human capital of the directors. They also found that women human capital cannot be said to be less than men in terms of education and other significant aspects but, compared to women directors, men are better involved as business experts (Hillman & Dalziel, 2003; Peterson, Philpot, & O'Shaughnessy, 2007; Terjesen et al., 2009). Therefore, the relationship between board diversity and firm performance is affected by the unique human capital of directors, however the link with financial performance may be positive or negative (Carter et al., 2010). Post & Byron, (2013) found that this relationship is effective for market performance but with accounting returns does not have the same impact, proposing that diverse human capital may affect investors' perceptions on the future income of companies with more female representation on board. Lastly, Hillman & Dalziel, (2003) found that board dynamics and board human capital may rely upon directors motivation in monitoring and being involved in the strategy of the company.

3.2.1 Literature review and hypothesis development

The general perception of the board of directors is moving from an unvarying group with no significant differences in education, background and work experience to a more recent idea of board diversity resulting into a better decision making process (Carpenter & Westphal, 2001). Van der Walt & Ingley, (2003) in their study on board of directors' dynamics, defined the diversity of the board composition as a various combination of several attributes, characteristics and skills detected by the board members which leads to board process and decision-making. Considering the comprehensive interest on the

topic, several studies explored the diversity phenomenon and recent literature analysed diversity in terms of different characteristics like age, education, gender in the boardroom.

In the review of gender composition in corporate boards, including 310 articles over the period 1981 – 2016, Kirsch (2018) identified four streams of research: differences between women and men directors, factors that influence the composition of the board, institutional rules that impact board gender composition and organizational outcomes affected by the composition of the board. This study, drawing on the forth stream of research, explores the relationship between gender diversity of the board and firm financial performance.

Current research offers several findings on financial outcome and gender equality outcome. Campbell & Mínguez-Vera, 2008 found that the gender composition of the board has a relevant effect on the quality of the monitoring activity. They consider this activity as an important corporate governance control instrument that brings to a consequently growth of the firm financial performance. Arguing that the more the diversity the higher the penetration and understanding of the marketplace, they also assume that board diversity vary across sectors according to the customers and employees demographic configuration. This statement has been proved by Brammer, Millington, & Pavelin, 2007 finding an important cross-sector variation with a higher presence of women directors in business to consumer sectors like Retail, Utilities, Media and Banking. Furthermore, firm's performance is influenced by the firm's governance activity that is a key element of board effectiveness (Bhagat & Bolton, 2008).

However, a relevant aspect of the firm's competitive advantage is the company image therefore how stakeholders evaluate board gender composition and how it positively affects the consumers' behaviour improving the company performance (Elsbach, 2003; Smith et al., 2006; Westphal & Zajac, 2013). Glass & Cook, 2018 in their study on women CEOs and board members looked at organizational outcomes and found that gender diverse leadership teams reveal more robust business and equity results than teams with men only. Terjesen et al., (2009) found that a more diverse board have a positive impact both on corporate governance and corporate social responsibility. In their analysis on the composition of the executive board and the bank risk taking, Berger,

Kick, & Schaeck, 2014 found that the characteristics of the team in terms of age, gender, educational composition of executive teams have an effect on the portfolio risk of financial institution. By taking a broader view, several scholars found that diverse gender composition impacts positively team performance confirming that mixed teams perform better, particularly in sales and profit than male dominated (Apesteguia, Azmat, & Iriberry, 2012; Hoogendoorn, Oosterbeek, & Van Praag, 2013).

However, despite it has been argued that gender diversity on the board improves company performance, other studies suggest that companies do not perform better when they have women on the board.

Post & Byron, 2013 in their meta-analysis on female on board and market performance using 100 studies of firms in 35 countries and five continents suggest that the relationship between board gender diversity and company performance is either not or very weakly positive. Some authors found that female representation on board cannot be considered a valuable strategy (Farrell & Hersch, 2005) others that there is a not significant relationship between the gender or ethnic diversity of the board, and financial performance for US corporation (Carter et al., 2010). Furthermore, Chen, Crossland, & Huang, 2015 demonstrated that greater female board representation is not positively associated with the firm's acquisition and the target acquisition size. A further supporting thesis on gender diversity and lower firm performance considers the higher risk aversion of the women in financial decision and the company costs of women resulting by the higher turnover and absenteeism (Cox & Blake, 1991; Jianakoplos & Bernasek, 1998).

Despite research on this topic is increasing over the last few years and a large strand of studies analysed the link between diversity of corporate board and firm's financial performance, as resulting by a detailed research on Scopus Elsevier database, no articles have been found on the relationship between Academic Spin Off (ASO) performance and board gender diversity. Therefore, the aim of this study is to fill in this gap of the literature by examining the impact of board structure on the performance of this high-tech companies in Europe. Academic Spin-Off companies (ASO) are characterized by their unique technology representing a valuable technology transfer channel through patent creation and commercialization and they are considered to be one of the main tools for the exploitation of university research results.

Several studies investigated ASO performance factors in terms of patents (Dahlstrand, 1997; Kroll & Liefner, 2008) or analysing the ability to attract venture capital investments or issuing initial public offerings (Shane & Stuart, 2002). Furthermore, some researchers in order to determine ASO performance, have evaluated the number of job opportunity created (Shane, 2004) or the impact of legislative changes and of universities' mechanisms on spinoffs' creation (Baldini, 2010; Colombo, Adda, & Piva, 2010; Fini, Grimaldi, Marzocchi, & Sobrero, 2008; Lockett, Siegel, Wright, & Ensley, 2005; Nosella & Grimaldi, 2009; Moray & Clarysse, 2005).

Hence this research, linking gender-based observations and ASO financial performance, is a unique study in ASO literature.

Female directors, given their different perspectives and their cautious aptitudes, may increase the quality of decision making inside the board and the firm financial performance (Loyd, Wang, Phillips, & Lount, 2013; van Ginkel & van Knippenberg, 2008). As stated by Post & Byron, (2013) female representation on board may have a positive effect with the financial performance of the company in contexts where shareholders protection is higher. As stated by Anderson, Reeb, Upadhyay, & Zhao, (2011) diversity on board brings to different point of view and, consequently, to a better monitoring for shareholders and managers. Thus, women on board perform not only a stronger monitoring but also the more heterogeneity on board the less agency problems (Farrell & Hersch, 2005; Peterson & Philpot, 2007). Furthermore, female representation may increase communication inside the board, considering that women are more obliging and open minded compared to man (Gul et al., 2011) Therefore, the first hypothesis has been built considering that female representation is positively related to Academic Spin-offs financial performance.

Hypothesis 1: The presence of women in the board of directors has a positive impact on ASO financial performance

According to resource dependence theory, different board members offer more diverse experience and a more effective use of their unique knowledge and firms resources (Hillman et al., 2000; JENSEN, 1993). In addition, board composition is an important link to the external environment, providing valuable resources as well as generating positive financial performance for the firm thanks to the different perspectives and

backgrounds of the board members. However, because women have different human capital and links with the external environment, gender diversity inside the board leads to a better company performance thanks to the directors unique human capital (Terjesen et al., 2009). Furthermore, it has to be considered that companies are interested to attract institutional investors and in order to give a good image, they engage more female directors as a positive signal of board diversity (Farrell & Hersch, 2005). Hence, based on the above discussion, it has been proposed:

Hypothesis 2: The greater the presence of women in the board of directors, the higher ASO financial performance

3.4 Research Design

3.4.1 Sample and Data

The sample of the analysis comprises the population of European Academic Spin Off (ASO) using an own-built macro-level database based on Italian, Belgium and UK ASO data collected in several stages. First, for Italy, data on Universities Third Mission have been chosen from the ANVUR website on SUA catalogue (Scheda Unica Annuale), while for UK, the Spinout UK website has been considered and for Belgium, data on Flemish spin-off companies have been provided by the Flemish Government, in particular by the Department of Economy, Science and Innovation. Second, data on firm level were collected from Orbis, a Bureau van Dijk (BVD) database that provides company information as well as data on directors and other corporate governance variables.

The final comprehensive dataset includes information of almost 2.000 Spin-Off companies at European, national and regional level: 160 from Flemish, 920 from Italy and 1048 from UK. The goal of this research is to analyse the relationship between female board representation and firm financial performance. Therefore, in order to test the hypotheses, the dependent variable *Sales* has been used to measure the company financial performance. The variable has been built computing the natural logarithm (LN) of the average of ASO sales from 2009 to 2018. By definition, Academic Spin Offs are new companies established on the Intellectual Property of an institution (Wright,

Clarysse, Mustar, & Lockett 2007) therefore, for this type of companies, sales has been considered as a better performance indicator for young firms.

As predictor variable, *Female board representation* has been used as dummy variable with value 1 when gender diversity occurs, 0 otherwise. Female board representation considers the presence of women on board of directors without exploring the difference between independent or executive women directors. In line with several previous studies, this analysis focuses on female directors in general (Carter et al., 2010; Post & Byron, 2013).

The other predictor variable is *Board gender composition* measured by the percentage of women sitting in the board of directors. In large companies there is a higher probability of having a diverse boards, where stakeholders assume to see less inequality and more diversity (Farag & Mallin, 2016) but, considering the small dimension of ASO companies, this probability may not be the same. However, gender diversity represents a positive corporate governance signal derived by ethical aspects of the organizations and a measure of social responsibility (Nekhili & Gatfaoui, 2013; van der Walt & Ingley, 2003).

As corporate governance control variables have been used: *Board size* calculated taking to account the total number of board members and *Board average age* is measured considering the average age of board directors. Since ASO companies are characterized by their innovative technology based on the research from academia, the last control variable is *R&D capabilities* has been built including the number of patents and trademarks.

3.4.2 Econometric Model

The dataset has been built using spin-off companies data, clustered within three countries and the dependent variable has been built with continuous observations. Therefore, since the dependent variable is a continuous variable, a linear regression model (OLS) has been used to test both of the hypotheses.

The model tested for the ordinary least squares equation is:

$$Sales = \alpha + \beta_1 FemBoardRep + \beta_2 BoardGenComp + \beta_3 BoardSize + \beta_4 BoardAvAge + \beta_5 R\&DCap + \varepsilon$$

Where:

Sales: dependent variable;

α : intercept;

$\beta_1 FemBoardRep$: predictor variable (dummy variable), *Female board representation* in the board of directors of UK, Italian and Belgium ASO companies;

$\beta_2 BoardGenComp$: predictor variable, *Board gender composition* measured as percentage of women sitting in the board of directors of UK, Italian and Belgium ASO companies;

$\beta_3 BoardSize$: control variable, *Board size* calculated using the total number of board members of UK, Italian and Belgium ASO companies;

$\beta_4 BoardAvAge$: control variable, *Board average age* measured considering the average age of board directors of UK, Italian and Belgium ASO companies;

$\beta_5 R\&DCap$: control variable, *R&D capabilities* built including the number of patents and trademarks of UK, Italian and Belgium ASO companies;

ε : error term

3.5 Results

Table 1 illustrates the descriptive statistics of the variables used in the empirical analysis and Table 2 presents the correlation matrix of all the variables included in the model. It is clear that correlation among the variables is weak or null, only one variable shows correlation above 0.50 that is not causing estimation problems.

Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Dependent variable and main predictors</i>					
Sales	928	3939192	2153417	-2225624	9963736
Female board representation	1,632	.2843137	.4512252	0	1
Board gender composition	1,632	.138116	.2755064	0	1
<i>Control variables</i>					
Board size	1,63	4.320.859	3.732.063	1	21
Board average age	653	5.003.132	925.743	26	80
Number of patents	2,141	3.703.877	2.182.642	0	646
Number of trademarks	2,141	.6655768	3.101.293	0	83

Table 2 Correlation Matrix

	Sales	Female board representation	Board gender composition	Board size	Board average age	Number of patents	Number of trademarks
Sales	1.000						
Female board representation	-0.0418	1.000					
Board gender composition	-0.0822*	0.7956*	1.000				
Board size	0.1505*	0.2474*	-0.0505*	1.000			
Board average age	0.0483	-0.0277	-0.0454	0.0388	1.000		
Number of patents	0.0065	0.0239	-0.0166	0.1498*	0.1017*	1.000	
Number of trademarks	0.1424*	0.0722*	-0.0106	0.1819*	0.0832*	0.2943*	1.000

*= correlations are significant at 5%

The testing has been performed in stages. Model 1 includes only the control variables while in Model 2 and Model 3 the predictor variables Female board representation and Board gender composition have been introduced. Model 4 shows the main effects of both predictors on the dependent variable Sales. The results presented in Table 3 demonstrate that the influence of gender diversity on the board and ASO financial performance is significant. However, as it can be seen in Model 2 when gender diversity occurs the effect on ASO performance is negatively significant (-405089.1, $p < 0.05$). Accordingly, Model 3 shows significant negative results suggesting a negative impact of the percentage of female directors on company performance (-460454.0, $p < 0.05$). These results imply that gender diversity in ASO companies is not a determinant factor that influence ASO financial performance.

Table 3 Gender Diversity, Board of Directors on ASO performance

	Model 1	Model 2	Model 3	Model 4
Female board representation		-405089.1** (202548.6)		-264899.7 (629441.6)
Board gender composition			-460454.0** (233847.4)	-170942.7 (726633.1)
Board size	-10225.2 (68333.4)	16000.9 (69416.2)	-8385.7 (68179.5)	7607.8 (78095.7)
Board average age	10261.8 (8901.9)	9900.1 (8881.9)	9623.8 (8886.9)	9788.4 (8901.5)
Number of patents	-56974.5*** (15669.7)	-56721.5*** (15631.9)	-56990.4*** (15632.9)	-56815.0*** (15649.1)
Number of trademarks	591758.0*** (114148.2)	589430.2*** (113874.9)	592670.3*** (113881.3)	590574.5*** (114067.0)
_cons	3501751.6*** (460816.6)	3566282.9*** (460820.6)	3606714.2*** (462815.6)	3582917.7*** (466567.1)
N	616	616	616	616
R-sq	0.047	0.053	0.053	0.053
adj. R-sq	0.041	0.046	0.045	0.044

Standard errors in parentheses * p<0.10, ** p<0.05, *** p<0.01

3.6 Discussion and Conclusion

Given the recently international interest on the topic, the effects of gender diversity in the corporate boardroom has received an increasing scholarly and policy attention. Despite the institutional framework is promoting a more diverse board, encouraging the presence of women on the board inside companies, if this can improve firms performance remains unclear. Van der Walt & Ingley, (2003) in their study on board of directors' dynamics, defined the diverse board composition as a various combination of several attributes, characteristics and skills detected by the board members which leads to board process and decision-making. Drawing on agency theory, resource dependence theory and human capital theory, this study analyse how women on the board of directors affect Academic Spin-Offs (ASO) financial performance. The sample of the analysis comprises the population of European ASO companies using an own-built database, based on information of almost 2.000 ASO firms. A growing body of literature have investigated the impact of gender diversity on firm's financial performance (Campbell & Mínguez-Vera, 2008; Erhardt, Werbel, & Shrader, 2003; Lückerath-Rovers, 2013; Mahadeo, Soobaroyen, & Hanuman, 2012; Miller & del Carmen Triana, 2009; Pathan & Faff, 2013) and, to the best of my knowledge, there are no other studies analysing this relationship focusing on ASO companies. A large body of literature suggests that gender diversity on board improves company performance. Therefore, the first hypothesis has been built on agency theory considering that women on board perform not only a stronger monitoring but also the more heterogeneity on board the less agency problems (Farrell & Hersch, 2005; Peterson & Philpot, 2007). Consequently, female representation on board is positively related to Academic Spin-offs financial performance. The second hypothesis has been developed on resource dependence theory and human capital theory that can give a better support for the analysis, suggesting that women directors, with their different point of view, experience and background may increase the financial performance of the firm. Thus, the more the women sitting in the board of directors of ASO companies, the better the financial performance. The results of this study show a different picture compared to the vast majority of research, suggesting that the relationship between gender diversity and ASO companies financial performance do not have a positive impact. Accordingly, some previous works already found counterintuitive conclusions, revealing that the presence of women on board is not positively linked with

the performance of the firm (Carter et al., 2010; Chen et al., 2015; Cox & Blake, 1991; Jianakoplos & Bernasek, 1998). Despite institutional framework, together with the influence of media and stakeholders, impose more pressure on business organisations to promote more diverse boards, if this improves firm performance remains ambiguous. However, much remains to be investigated through additional analyses. Post & Byron, (2013) in their meta-analysis on female on board and market performance found a positive link with market performance but not with accounting returns, proposing that the different human capital between women and men impacts positively investors' perceptions of the future income of firms with more female directors. Furthermore, it has to be considered that companies are interested to attract institutional investors and in order to give a good image, they engage more female directors as a positive signal of board diversity (Farrell & Hersch, 2005). As stated by Agrawal & Knoeber (2001) the promotion of gender diversity in the boardroom is the consequence of social and ethical aspects instead of company returns. Therefore, the findings of this research need to be more explored with a further analysis through multiple case studies. Despite the study examined the financial performance of ASO companies, further research may investigate other factors that links the relationship between board diversity and firm performance such as additional dimensions of firm performance. In addition, future research could explore country level factors because of different laws, culture, history that can influence board diversity or industry aspects that can influence board dynamics.

3.7 Practical implications

The analysis of the relationship between gender diversity on corporate board and financial performance on European ASO companies has important implications not only at academic level but also for practitioners, managers, shareholders and policy makers, as it is the first study to investigate this topic at ASO level. The results of the work demonstrate that the presence of female board members does not impact positively ASO financial performance. This implies that the supposed advantage of a more diverse board on academic high-tech companies is a factor to be considered. By definition, Academic Spin Offs are new companies established on the Intellectual Property of an institution (Wright, Clarysse, Mustar, & Lockett 2007) and represent a valuable technology transfer

channel through patent creation and commercialization. ASO firms are considered to be one of the main tools for the exploitation of university research results and an important instrument for innovation. Hence, the evidence of this research suggests that the recent European policy measures to promote board diversity, based on the principle that diversity improves the quality of corporate governance, does not impact positively new born innovative companies. Several theories discussed above provide the general framework for the link between gender diversity and firm financial performance, but extant literature found mixed results. Moody's recent analysis on 540 companies in Europe shows that in companies with credit rating A, women occupy 34% of the seats on the board of directors and the European Union commissioner for equality is relaunching plans for mandatory quotas of women on company boards. At ASO level women sitting on the board of directors do not have a positive impact on company outcomes and, despite much remains to be examined about board composition, the results of this study help to explain this relationship. These results imply that gender diversity in ASO companies is not a determinant factor that influence ASO financial performance.

Chapter 4: Does Venture Capital really matter for Academic Spinoffs' Acquisition?

4.1 Introduction

Academic Spin-offs companies, through the commercialization of invention created inside universities, are important mechanism to foster the economic and innovative progress (Rodríguez-Gulías, Rodeiro-Pazos, Fernández-López, Corsi, & Prencipe, 2018). This type of start-ups founded inside academia, are usually innovative companies in the high-tech sector seeking for funding and Venture Capital has become an important form of financing resource for this companies (Zhang, 2009; Zucker, Darby, & Brewer, 1994).

The role of Venture capital (VC) has grown significantly in the United States, but in Europe has not greatly developed, doubling for the US start-up investors in 2019 but with a different trend for Asia and Europe as demonstrated by the Venture Capital Funding Report 2019. Therefore policy-makers are continuously promoting actions for this form of financial intermediation (Bottazzi & Da Rin, 2002a).

As stated by (Bottazzi & Da Rin, 2002b) the US Venture Capital industry is fundamental for the commercialization of technological innovation and several studies documented the role of American venture capitalist in supporting high tech companies (T. F. Hellmann & Puri, 2000).

At European level, the European institutional framework is reinforcing venture capital legislation and restoring the regulation of stock markets as a measure against economic deadness and unemployment (Bottazzi & Da Rin, 2002b). This can be seen in several official documents like the European Commission, 1998 report or Europe 2020 political agenda (European Commission, 2011). These documents reveal on one side how the policy can contribute to the growth of an active venture capital industry in Europe, on the other industry reports analyse the supply of funding and the creation of positive conditions for entrepreneurship.

According to the aggregate statistics published yearly by the European Private Equity and Venture Capital Association (EVCA), 2018 is the year with a peak level of total equity amount invested in European companies, improving by 7% to €80.6 billion. Similarly, the number of companies obtaining investment increased by 7% to over 7,800 (the highest level). Focusing on Venture Capital, 2018 investments increased by 13% compared to 2017 achieving €8.2 billion as shown in Table 1. As it can be seen, the number of backed companies increased as well by 12% achieving more than 4,400 units. In particular, Seed companies increased by 22% to 1,350, however investments declined by 7% to €721 million. Start-up investments is more than 29% to €4.9 billion, with a backed companies increase of 6% (2,475). Later-stage number of companies is more than 8% but with an investments reduction by 3% to € 2.6 billion. Additionally, statistics show higher investments in ICT sector with 47% of the total, followed by biotech and healthcare (28%) and consumer goods and services (9%).

Tab 1. Venture capital backed companies (seed, start-up and later stage)		
	EU Investments	EU companies
2014	3.8	3,742
2015	4.7	3,714
2016	5.0	3,552
2017	7.2	3,958
2018	8.2	4,437

Source: Invest Europe / EDC, European Private Equity Activity 2018

Table 2 reveals that the amount invested in venture capital as a percentage of GDP in Europe is not that significant. Europe is investing a small part of the GDP with a consistent variation of venture capital intensity among the European countries. In Italy, for example, VC intensity has a low dimension.

Tab 2. Venture capital investments as percentage of GDP – 2018	
Europe	0,048%
UK	0,077%
Italy	0,009%
Belgium	0,056%

Source: IMF, World Economic Outlook Database (GDP) / Invest Europe / EDC, European Private Equity Activity 2018

Research has shown that Venture Capital in Europe is growing fast influencing European firms significantly (Bertoni & Tykvová, 2015). Indeed, the financing of several dynamic start-ups has led to a consistent number of companies listed on Europe's 'new' stock markets. Thus, Venture capital is an important aspect of the policy agenda, both at EU and national levels since venture backed companies are principally dynamic and likely to create jobs and wealth (Bertoni & Tykvová, 2015). Despite the growth of venture capital industry in Europe, the investment intensity is less than US.

Previous studies analysed the relationship between of VC and Academic Spin-Off companies. In their study, Knockaert, Wright, Clarysse, & Lockett (2010) found that the probability of investing in academic spin-offs is positively correlated by the percentage of public funding in a VC fund and the presence of VC affect positively spin-offs' growth (Colombo, Cumming, & Vismara, 2016; Grilli & Murtinu, 2014a; Meglio, Mocciaro Li Destri, & Capasso, 2017; Rodríguez-Gulías et al., 2018). Therefore, the new spin-off ventures, to be created and succeed, are influenced by the VC investments.

As shown by Kortum & Lerner (2000), venture capital backed companies are important sources of innovation, considering that venture capital backed start-ups can produce a significant number of inventions per investment dollar compared to established firms in related industries. Indeed, investments in an internal knowledge base may have more than one effects, influencing the acquirers aptitude to exclusively consider the value of entrepreneurial discoveries and reducing markets competition to acquire start-ups (Benson & Ziedonis, 2010).

This study examine how Venture Capital affects the Academic Spin-Off performance. In particular, to what extent VC investments contribute to the likelihood of European Academic Spinoff companies (ASO) of being acquired. In doing so, the work relies on a unique panel dataset comprising data derived from the population of academic spin-off companies in three different European countries over a 10 years period (2009-2018). The study contributes to the current literature in several ways. First, adding to an emerging body of research on venture capital and the instruments used to finance innovative firms. Second, it provides concrete evidence that informs a broader evaluation of ASOs. Third, this study delivers a significant contribution to the empirical and theoretical research on academic entrepreneurship in the ASO field understanding the significant role played by several actors that provide important resources at different level in the growth of ASOs (Fernández-Alles et al., 2014). The most common dataset of ASO companies rely on single country analyses, but this study compares a greater number of companies in different European countries, increasing the information about the phenomenon (Rodríguez-Gulías et al., 2018).

The paper is organised as follows. The first section presents the theoretical framework and hypothesis development. The second section illustrates the sample, data and econometric model. The last section provides the results of the empirical analysis and the discussion of the main findings.

4.2 Theory and Development of Hypothesis

4.2.1 Venture Capital and firm performance

Venture capital plays an important role for the European investment ecosystem because of its contribution to the EU performance in terms of innovation, job creation and growth (Grilli & Murtinu, 2014; Kortum & Lerner, 2000; Puri & Zarutskie, 2012; Samila & Sorenson, 2011).

One widely shared belief is that VC plays a central role for high-tech companies' creation, mostly where capital markets are not encouraging new business formation.

Previous studies on the relationship between innovations and venture capital have investigated the interest of VCs on innovative companies (Baum & Silverman, 2004; Engel & Keilbach, 2007; Hirukawa & Ueda, 2011) and demonstrated the positive effects between the innovative activity and VCs presence (Arqué-Castells, 2012; Bertoni, Colombo, & Croce, 2010; Kortum & Lerner, 2000; Popov, Roosenboom, & W., 2012). In their research Bottazzi & Da Rin, 2002 found that VC provide financial resources that are fundamental for the establishment and growth of European innovative companies. The extant literature has recognised several aspects of VC contribution to the firm. Hellmann & Puri, 2000 analysed the role of VC in terms of market and commercialization strategies, Colombo, D'Adda, & Pirelli, 2016 in terms of innovation strategies such as partnerships and Hellmann & Puri, 2002 in terms of non-financial aspects providing companies not only money but also managerial skills and competencies. According to Bottazzi & Da Rin, 2002 VC can be seen has a characteristic of the quality of the firm to third parties and can bring several benefits from the business connections (Hochberg, Ljungqvist, & Lu, 2007).

Furthermore, VC has a positive effect on companies performance with respect to employment, sales, probability of fail (Bertoni, Colombo, & Grilli, 2011; Engel & Keilbach, 2007; Puri & Zarutskie, 2012) and on firms' patent activity (Arqué-Castells, 2012). Specifically, some studies reveal that the more the VC the higher the patenting rate showing that non-venture backed companies produce fewer and less valuable patents (Kortum & Lerner, 2000) while others that VC has positive effects on employment, patenting and companies creation in a region (Samila & Sorenson, 2011). Kelly & Kim, 2018 comparing VC backed and non-VC backed companies performance factors, found that VC accelerate the firm commercialization process through a faster product development investing more in R&D expenditures than non-VC backed companies. The study reveals a growth not only on firm innovation but also on the wages, indicating a higher employment value. Hence, VC investments influence significantly companies performance through higher wages resulting by the growth of innovation and commercialization performance.

Although theoretical attention has been given to the strategic nature of venture capital investments (Hellmann & Puri, 2002), empirical research on academic spin-off at

European level has not received enough attention. This study contributes to the existing literature estimating to what extent European Venture Capital investments contribute to the likelihood of innovative firms of being acquired. While previous research, however, mostly looked at companies dimension overall, this work focuses on Academic Spinoff companies.

4.2.2 Venture Capital and Academic Spin-Off

Academic Spin-offs (ASO) are companies characterised by the exploitation of the innovation developed inside university and the new technology generated is protected by the firm patenting activity that is granting them the competitive advantage in the market.

As stated by (Rogers et al., 2001), spin-off companies are those based on the parent R&D organizations, namely, the government R&D laboratory, the University, the University research centre and private R&D organizations.

In order to be more attractive and to represents an important technology transfer channel, ASO companies need to protect their technologies and innovative ideas through intellectual property rights (IPR) protection and so the patent activity.

Intellectual property (IP), codified or tacit knowledge and technology are basic aspects for spinoffs creation when they are transferred from universities or research centres to a new organization (Agarwal, Echambadi, Franco, & Sarkar, 2004; Bart Clarysse & Moray, 2004; Parhankangas & Arenius, 2003). Hence, on one hand academic spinoffs are key elements for university funding and technology development, on the other for the country economic health (Friedman & Silberman, 2003; Vincett, 2010). Moreover, studies demonstrated that the impact of the investments in technology development is more effective for smaller firms and start-ups rather than for larger companies (Arora et al., 1995). It is worth noting that Venture Capital prefer to invest in innovative start-ups for the high probability of their fast growth (Zhang, 2009).

Much of the research available in literature on ASO have focused on USA's spin-offs, while this topic has not received enough attention for the European countries.

The introduction of the Bayh-Dole Act in 1980 in the United States, have contributed to enhancing the universities patent creation, allowing the university researchers to obtain

economic value of their work through federal funding (D. C. Mowery et al., 2001). Moreover, with the establishment of the patent court and a patent-friendly legal environment (Arora et al., 1995), universities promoted patents creation and exploitation with the establishment of Technology Transfer Offices that encouraged academic spin-off formation in order to commercialize their university-based research.

As a consequence, the number of patents in U.S. universities have grown rapidly, doubling during the period between 1979 and 1984 and increasing with a share of 3.6 percent in 1995 starting from 1 percent in 1975 (D. Mowery et al., n.d.).

As previously discussed, ASO competitive advantage in the market is influenced by the cutting-edge technology protected by Intellectual Property rights, mostly in emerging technology domains (Wennberg, Wiklund, & Wright, 2011). The Cutting-edge IP can give the basis for technology standards for the emerging derived markets (Woolley, 2016).

Considering that Venture Capitalist are interested on firms with strong market opportunities and a reduced amount of risk, then new high tech companies using IP have a higher probability of obtaining VC funding (Munari & Toschi, 2011). In their study, Knockaert, Wright, Clarysse, & Lockett (2010) found that the probability of investing in academic spin-offs is positively correlated by the percentage of public funding in a VC fund. Therefore, the new spin-off ventures, to be created and succeed, are influenced by the VC investments.

As shown by Kortum & Lerner (2000), venture capital backed companies are important sources of innovation, considering that venture capital backed start-ups can produce a significant number of inventions per investment dollar compared to established firms in related industries.

Indeed, investments in an internal knowledge base may have more than one effects, influencing the acquirers aptitude to exclusively consider the value of entrepreneurial discoveries and reducing markets competition to acquire start-ups (Benson & Ziedonis, 2010).

4.2.3 Venture Capital and Academic Spin-Off Acquisition

It is widely recognised that acquisition is a market selection process where the established and large firms acquire small, technology-based companies. As stated by Arora, Fosfuri, & Gambardella (1995) firms are driven by the need to acquire external technology, and through acquisition big companies encompass not only existing technology, but also the capabilities and competences to develop new technologies.

For some European countries where the venture capital sector is not really strong, acquisition may act as an important tool for fostering the economic dynamics and innovative activities (Xiao, 2015). Therefore, within the acquisition process small technology-based firms will transfer resources, new knowledge, management capabilities to acquired firms.

As mentioned before, VC have a positive effect on companies performance also with respect to the firms' patent activity. Hence, in this study we consider the impacts of Venture Capital on Academic Spinoff acquisition focusing on how VC investments influence the firm commercialization process. In particular, the objective is to examine the impact of venture capital investments on ASO companies acquisition probability as a positive post-entry performance indicator.

Previous literature examined several factors that affects positively companies transactions such as the start-up environment with the technology protection (Gans, Hsu, & Stern, 2000) or the role of VC. On one side VC added value to the companies in which they invest has a positive correlation between management support and company performance, given by the experience of the investment managers (Bart Clarysse, Bobelyn, & del Aguirre, 2013; Sapienza & Timmons, 1989), on the other VC backed firms have a higher acquisition probability while cooperating with potential acquirers since it reduces the information asymmetry and increases acquisition likelihood (Porrini, 2004). Hence, has been proposed:

H1: The more the Venture Capital investments, the higher the likelihood of ASO of being acquired.

4.3 Methodology

4.3.1 Sample and Data

The university entrepreneurship culture through patent creation and exploitation that firstly originated in U.S. with the establishment of Technology Transfer Offices, progressively moved to UK, reaching the other European countries.

Despite the well-recognized value of studying the ASO phenomenon, empirical studies on this topic are continuously constrained by the limited availability of data (Shane, 2004). Hence, a comprehensive and organic database providing data from different national and EU level ASO records is not currently available. Only few country level data are available. For this reason, I collected data from different sources and I built a new macro-level academic spin-offs database, based on information of European spin-off companies.

This study investigates European VC context, using as sample of the analysis, three countries with different Venture capital investments as percentage of GDP: Italy, Belgium and UK and their academic spin-off environment.

Hence, this study draws on a macro-level database, based on three different countries over a 10 years period and data have been collected in several stages. First, for Italy, data on Universities Third Mission have been selected on the ANVUR website from SUA (“Scheda Unica Annuale della Ricerca Dipartimentale (SUA-RD) – ANVUR – Agenzia Nazionale di Valutazione del Sistema Universitario e della Ricerca,” n.d.), while for UK, the Spinout UK website has been used (Spinoutsuk.co.uk). For Belgium, data on Flemish spin-off companies have been provided by the Flemish Government, in particular by the Department of Economy, Science and Innovation (“Departement EWI |,” n.d.).

Second, data on firm level were collected from the Orbis database while data on national and regional level have been selected from Eurostat, the statistical office of the European Union. Lastly, in order to investigate the spinoff acquisition phenomenon, the dataset was further complemented by records from the Zephyr database. Both Orbis and Zephyr are Bureau van Dijk (BVD) databases that provide company information, corporate structures and M&A deals.

The final comprehensive dataset includes time-variant information from 2009 to 2018 of almost 2.000 spin-off companies at European, national and regional level: 160 from Flemish, 920 from Italy and 1048 from UK.

Nevertheless, not all the above data on firms' deals have been considered in this research, but only the 100 percent Acquisition typology. Consequently, the final dataset with almost 2,000 academic spin-off records, contains 115 companies that performed a 100 percent Acquisition, which can be distinguished in 15 Italian, 13 Flemish and 87 UK companies.

In order to test the hypothesis, the dependent variable *Acquisition* has been created as dummy variable with value 1 when the ASO acquisition occurs, while 0 otherwise.

As Predictor variable, *Venture Capital investments* from 2009 to 2015 on seed, start-up and later stage firms has been considered, collecting data from the Eurostat database calculated in million euro.

As Control variables at Country-Level, the following variables have been selected by the Eurostat Statistics Database from 2009 and 2018:

IPR Legislation Changes: to analyse the effect of the changes in the institutional regulation, the number of IPR legislation changes of each year of the examined period (10 years) has been counted.

In order to examine the influence of formal institutions and to investigate the quality of policy formulation and implementation, the analysis included the World Bank's Worldwide Governance Indicators ("Worldwide Governance Indicators | DataBank," n.d.) that contain time-variant measure of Political Stability, Government Effectiveness, Voice and Accountability, Regulatory Quality, Rule of Law and Control of Corruption. For this study, Government Effectiveness has been considered:

Government Effectiveness: 'reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies' (Kaufmann, Kraay, & Mastruzzi, 2010).

Gross Domestic Product (GDP): The higher the GDP, the more the resources flowing into innovation and research and the higher the likelihood that entrepreneurship would occur (Riccardo Fini, Fu, Mathisen, Rasmussen, & Wright, 2017).

R&D expenses: the ASO acquisition can be influenced by the amount of the R&D investments in the country for each year.

As Control variables at Regional-Level, *Gross Domestic Product(GDP)* and *Total Intramural R&D expenses (GERD)* have been collected from the Eurostat Statistics Database at NUTS2 regional level from 2009 and 2018.

The study has been conducted considering not only the national and regional level in order to examine the country and the singular regional policies effects, but also the strategic aspects and dynamics of the firm.

As Control variables at Firm-Level, data between 2009 and 2018 on *ROE* (ratio of net income to shareholders' equity as a measure of the firm financial performance. An high ROE value indicates the company ability to generate profit using shareholders' capital) and *R&D expenses* (ASO companies are characterized by their innovative typology based on technological research from academia) have been used. The number of patents and number of trademarks have been included as measure of R&D expenses to capture the firm's innovation aptitude.

These data have been collected from the Bureau van Dijk (BVD) databases that provides company information, corporate structures and M&A deals.

4.3.2 Econometric Model

The data include the specific moment of the acquisition event of each company, therefore they allowed for a continuous-time event history analysis. In particular, the dataset has been built using spin-off companies data, clustered within three countries in a 10 years period and the dependent variable is a dummy variable that switches from 0 to 1 when the ASO acquisition occurs. Therefore, since the dependent variable is a dummy variable, the Logistic Panel Regression has been used to test the hypothesis according to the following regression model:

$$ACQ_{i,t} = \beta_0 + \beta_1 VCinvest_{i,t} + \beta_2 IPRLegChanges_{i,t} + \beta_3 GovEffect_{i,t} + \beta_4 GDPcountry_{i,t} + \beta_5 R\&Dcountry_{i,t} + \beta_6 GDPregion_{i,t} + \beta_7 R\&Dregion_{i,t} + \beta_8 ROE_{i,t} + \beta_9 R\&Dfirm_{i,t} + \varepsilon_{i,t}$$

Where:

$ACQ_{i,t}$: dependent variable (dummy), Acquisition;

β_0 : intercept;

$\beta_1 VCinvest_{i,t}$: predictor variable, VC investments in Europe;

$\beta_2 IPRLegChanges_{i,t}$: control variable, number of IPR Legislation Changes;

$\beta_3 GovEffect_{i,t}$: control variable Government Effectiveness, quality of policy formulation and implementation;

$\beta_4 GDPcountry_{i,t}$: control variable Gross Domestic Product (GDP) of the country;

$\beta_5 R\&Dcountry_{i,t}$: control variable R&D expenses of the country;

$\beta_6 GDPregion_{i,t}$: control variable Gross Domestic Product (GDP) of the region;

$\beta_7 R\&Dregion_{i,t}$: control variable R&D expenses of the region;

$\beta_8 ROE_{i,t}$: control variable ROE of the firm;

$\beta_9 R\&Dfirm_{i,t}$: control variable R&D expenses of the firm;

$\varepsilon_{i,t}$: error term.

4.4 Results

Table 1 illustrate the descriptive statistics of our sample, including the mean and standard deviation and Table 2 shows the correlation matrix of all the variables used in the model. Correlations are weak or moderate and only few variables show a higher correlation with some of the predictors, but not enough to cause estimation problems.

Table 1 Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Dependent variable and predictor</i>					
Acquisition	23,551	.0527791	.2235969	0	1
VC investments	15	4.039.766	3.597.408	32	875
<i>Country-level controls</i>					
IPR legislation	21,41	3.489.865	4.773.971	0	22
Government effectiveness	19	1.074.517	.5557458	.374144	1.744.032
GDP Country	19,269	1783299	514498.9	348781.1	2611924
R&D Country	17	1.545.124	.2902617	1.21	2.49
<i>Regional-level controls</i>					
GDP Region	16,992	104683.5	82767.22	10798	366541
R&D Region	14	1.617.858	.912696	.08	5.2
<i>Firm-level controls</i>					
ROE	7,179	-7.667.652	105.913	-997.617	634.611
Number of patents	24	3.703.877	2.182.179	0	646
Number of trademarks	23,551	.6655768	3.100.634	0	83

Table 2 Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11
1. Acquisition	1.000										
2. VC investments	0.1319*	1.000									
3. IPR legislation	0.0492*	0.3441*	1.000								
4. Government effectiveness	0.1410*	0.8644*	0.2990*	1.000							
5. GDP Country	0.0553*	0.6009*	0.1792*	0.3012*	1.000						
6. R&D Country	0.1024*	0.4497*	0.1122*	0.7822*	-0.2877*	1.000					
7. GDP Region	-0.0323*	-0.2601*	-0.1344*	-0.2970*	-0.0060	-0.2690*	1.000				
8. R&D Region	0.0730*	0.3715*	0.1766*	0.3609*	0.1994*	0.2454*	-0.0114	1.000			
9. ROE	-0.0417*	-0.1694*	-0.0751*	-0.1515*	-0.0502*	-0.0786*	0.0127	-0.0774*	1.000		
10. Number of patents	0.0947*	0.1316*	0.0511*	0.1276*	0.0748*	0.0765*	-0.0395*	0.1604*	-0.0768*	1.000	
11. Number of trademarks	0.1211*	0.1435*	0.0544*	0.1478*	0.0687*	0.1003*	-0.0203*	0.1121*	-0.0849*	0.2943*	1.000

*= correlations are significant at 5%

The testing has been performed in stages. Model 1 includes only the control variables at firm, regional and national level and shows that the variables Government effectiveness (4.311, $p < 0.01$), Number of Patents (0.0322, $p < 0.001$) and Number of Trademarks (0.0773, $p < 0.10$) seem to have a significant impact on acquisition probability. In Model 2 the predictor variable VC investment has been introduced.

In *Hypothesis 1*, has been stated that a higher level of VC investments will be positively related with the ASO acquisition impact. As it can be seen from Table 3, venture capital investments have a significant positive effect on the academic spin-off acquisition at 0.00730 with $p < 0.05$ significance level.

Table 3 Logistic Panel Regression

	Model 1	Model 2
VC investments		0.00730** (0.00295)
IPR legislation	0.0370 (0.0497)	0.130** (0.0568)
Government effectiveness	4.311*** -1.485	8.317*** -2.403
GDP Country	0.000000117 (0.000000910)	-0.00000115 (0.00000121)
R&D Country	-1.200 -2.319	3.506 -3.203
GDP Region	0.00000196 (0.00000311)	-0.00000717 (0.00000464)
R&D Region	0.0763 (0.471)	-0.0226 (0.429)
ROE	-0.000482 (0.00222)	-0.0000569 (0.00256)
Number of patents	0.0322*** (0.00778)	0.00707 (0.00709)
Number of trademarks	0.0773* (0.0397)	0.0609 (0.0461)
_cons	-17.14*** -3.720	-37.25*** -4.877
Insig2u	4.368*** (0.0914)	5.482*** (0.0853)
N	5676	5676
R-sq		
adj. R-sq		

Standard errors in parentheses

* p<0.10, ** p<0.05, *** p<0.01

4.5 Discussion and Conclusions

In this paper, we have evaluated to what extent VC investments contribute to the likelihood of Academic Spinoff companies (ASO) of being acquired. Although recent literature focused on the strategic nature of VC investments (T. Hellmann & Puri, 2002), the empirical research is mainly limited to case studies and managerial surveys (Benson & Ziedonis, 2010). Thus, this study provides an empirical analysis using a unique panel dataset comprising time-series cross-sectional data derived from the entire population of academic spin-off companies in three different European countries. In particular, the work has been conducted considering not only the national and regional level in order to examine the country and the singular regional effects, but also the strategic aspects and dynamics of the firms over a 10 years period (2009-2018). The results of the analysis show that Venture Capital investments in European academic spin-off firms significantly contribute to the probability of ASO acquisition revealing that Venture Capital stands a positive signal to the market. While prior studies documented the potential benefits associated with the managerial aspects of VC for firm success in terms of survival and growth providing start-ups additional expertise and support to attract funding given the existing entrepreneurs lack of business experience (Bottazzi & Da Rin, 2002b; Gorman & Sahlman, 1989), this paper examine the impact of venture capital investments on ASO firms acquisition in terms of post-entry performance. In their study, Knockaert, Wright, Clarysse, & Lockett (2010) found that the probability of investing in academic spin-offs is positively correlated by the percentage of public funding in a VC fund and the presence of VC affect positively spin-offs' growth (Colombo, Cumming, et al., 2016; Grilli & Murtinu, 2014a; Meglio et al., 2017; Rodríguez-Gulías et al., 2018). Therefore, the new spin-off ventures, to be created and succeed, are influenced by the VC investments. Kelly & Kim, 2018 comparing VC backed and non-VC backed companies performance factors, found that VC accelerate the firm commercialization process through a faster product development investing more in R&D expenditures than non-VC backed companies. As shown by Kortum & Lerner (2000), venture capital backed companies are important sources of innovation, considering that venture capital backed start-ups can produce a significant number of inventions per investment dollar compared to established firms in related industries. Indeed, investments in an internal knowledge base may have more than one effects, influencing the acquirers aptitude to exclusively

consider the value of entrepreneurial discoveries and reducing markets competition to acquire start-ups (Benson & Ziedonis, 2010).

This work contributes to several strands of literature. First, adding to an emerging body of research on venture capital and the instruments used to finance innovative firms. Second, it provides concrete evidence that informs a broader evaluation of ASOs. Third, this study deliver a significant contribution to the empirical and theoretical research on academic entrepreneurship in the ASO field understanding the significant role played by several actors that provide important resources at different level in the growth of ASOs (Fernández-Alles et al., 2014)

However, much remains to be investigated through additional and more detailed analyses. For instance, the indirect measures used in this work, do not provide strategic interpretations because are not accompanied by primary data. Therefore, further research may consider strategic aspects such as the investor's perspective and the synergies through previous involvement of the acquirers in ASO activity. Despite this study compares the population of ASO companies of three European countries, further research may extend the sample of the investigation with additional countries and additional analyses to evaluate the robustness of the results. Although the study examined Venture Capital investments on a broad perspective, a distinction among different types of VC such as Government VC, Individual VC and Corporate VC should be better addressed. In the end, the study was not limited to a specific sector therefore further research would investigate the impact on firms operating into other regions and industries.

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Appendix 1

TITLE	AUTHORS	SOURCE TITLE	YEA R	Total Citation s	Average Citations per year
The impact of network capabilities and entrepreneurial orientation on university spin-off performance	Walter, A., Auer, M., Ritter, T.	Journal of Business Venturing	2006	544	27,2
Entrepreneurial orientation, technology transfer and spinoff performance of U.S. universities	O'Shea, R.P., Allen, T.J., Chevalier, A., Roche, F.	Research Policy	2005	510	25,5
When Cymbals Become Symbols: Conflict over Organizational Identity Within a Symphony Orchestra	Glynn, M.A.	Organization Science	2000	398	19,9
Academic Entrepreneurship in Europe	Wright, M., Clarysse, B., Mustar, P., Lockett, A.	Academic Entrepreneurship in Europe	2007	306	15,3
A process study of entrepreneurial team formation: The case of a research-based spin-off	Clarysse, B., Moray, N.	Journal of Business Venturing	2004	288	14,4
The creation of spin-off firms at public research institutions: Managerial and policy implications	Lockett, A., Siegel, D., Wright, M., Ensley, M.D.	Research Policy	2005	271	13,55
Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries	Wright, M., Clarysse, B., Lockett, A., Knockaert, M	Research Policy	2008	233	11,65
Toward a Typology of University Spin-offs	Pirnay, F., Surlemont, B., Nlemvo, F.	Small Business Economics	2003	212	10,6
Creating value in ecosystems: Crossing the chasm between knowledge and business ecosystems	Clarysse, B., Wright, M., Bruneel, J., Mahajan, A.	Research Policy	2014	196	9,8
From the critics corner: Logic blending, discursive change and authenticity in a cultural production system	Glynn, M.A., Lounsbury, M.	Journal of Management Studies	2005	195	9,75
The Evolution of Entrepreneurial Competencies: A Longitudinal Study of University Spin-Off Venture Emergence	Rasmussen, E., Mosey, S., Wright, M.	Journal of Management Studies	2011	194	9,7

Determinants and consequences of university spinoff activity: A conceptual framework	O'Shea, R.P., Chugh, H., Allen, T.J.	Journal of Technology Transfer	2008	194	9,7
Exploitation and diffusion of public research: The case of academic spin-off companies in Italy	Chiesa, V., Piccaluga, A.	R and D Management	2000	181	9,05
Research and technology commercialization	Markman, G.D., Siegel, D.S., Wright, M.	Journal of Management Studies	2008	179	8,95
A stage model of academic spin-off creation	Ndonzuau, F.N., Pirnay, F., Surlemont, B.	Technovation	2002	178	8,9
Academic entrepreneurs or entrepreneurial academics? Research-based ventures and public support mechanisms	Meyer, M.	R and D Management	2003	154	7,7
The development of university spin-offs: Early dynamics of technology transfer and networking	Pérez, M.P., Sánchez, A.M.	Technovation,	2003	150	7,5
The effectiveness of university knowledge spillovers: Performance differences between university spinoffs and corporate spinoff	Wennberg, K., Wiklund, J., Wright, M.	Research Policy,	2011	146	7,3
Opening the ivory tower's door: An analysis of the determinants of the formation of U.S. university spin-off companies	Link, A.N., Scott, J.T.	Research Policy	2005	145	7,25
Why are some university researchers more likely to create spin-offs than others? Evidence from Canadian universities	Landry, R., Amara, N., Rherrad, I.	Research Policy	2006	144	7,2
University revenues from technology transfer: Licensing fees vs. equity positions	Bray, M.J., Lee, J.N.	Journal of Business Venturing	2000	144	7,2
Overcoming weak entrepreneurial infrastructures for academic spin-off ventures	Degroof, J.-J., Roberts, E.B.	Journal of Technology Transfer	2004	141	7,05
Complements or substitutes? the role of universities and local context in supporting the	Fini, R., Grimaldi, R., Santoni, S., Sobrero, M.	Research Policy,	2011	131	6,55

creation of academic spin-offs					
Entrepreneurial Origin, Technological Knowledge, and the Growth of Spin-Off Companies	Clarysse, B., Wright, M., Van de Velde, E.	Journal of Management Studies	2011	128	6,4
University capabilities in facilitating entrepreneurship: A longitudinal study of spin-off ventures at mid-range universities	Rasmussen, E., Borch, O.J.	Research Policy	2010	125	6,25
Academic spin-offs, formal technology transfer and capital raising	Clarysse, B., Wright, M., Lockett, A., Mustar, P., Knockaert, M.	Industrial and Corporate Change	2007	118	5,9
R&D networks and product innovation patterns - Academic and non-academic new technology-based firms on Science Parks	Löfsten, H., Lindelöf, P.	Technovation	2005	113	5,65
What drives scientists to start their own company? An empirical investigation of Max Planck Society scientists	Krabel, S., Mueller, P.	Research Policy,	2009	113	5,65
Knowledge conversion capability and the performance of corporate and university spin-offs	Zahra, S.A., Van de Velde, E., Larrañeta, B.	Industrial and Corporate Change	2007	111	5,55
Factors fostering academics to start up new ventures: An assessment of Italian founders' incentives	Fini, R., Grimaldi, R., Sobrero, M.	Journal of Technology Transfer,	2009	108	5,4
The influence of university departments on the evolution of entrepreneurial competencies in spinoff ventures	Rasmussen, E., Mosey, S., Wright, M.	Research Policy	2014	105	5,25
The performance of university spin-offs: An exploratory analysis using venture capital data	Zhang, J.	Journal of Technology Transfer	2009	102	5,1
Exploring the Networking Characteristics of New Venture Founding Teams	Grandi, A., Grimaldi, R.	Small Business Economics	2003	100	5

Conceptualizing academic-entrepreneurial intentions: An empirical test	Prodan, I., Drnovsek, M	Technovation	2010	97	4,85
Inventory control of perishables in supermarkets	van Donselaar, K., van Woensel, T., Broekmeulen, R., Fransoo, J.	International Journal of Production Economics	2006	95	4,75
The process of transformation of scientific and technological knowledge into economic value conducted by biotechnology spin-offs	Fontes, M.	Technovation,	2005	95	4,75
Academics' organizational characteristics and the generation of successful business ideas	Grandi, A., Grimaldi, R.	Journal of Business Venturing	2005	94	4,7
The relationship between knowledge transfer, top management team composition, and performance: The case of science-based entrepreneurial firms	Knockaert, M., Ucbasaran, D., Wright, M., Clarysse, B.	Entrepreneurship: Theory and Practice	2011	91	4,55
Creating university spin-offs: A science-based design perspective	Van Burg, E., Romme, A.G.L., Gilsing, V.A., Reymen, I.M.M.J.	Journal of Product Innovation Management	8	91	4,55
Founding team composition and early performance of university-based spin-off companies	Visintin, F., Pittino, D.	Technovation	2014	86	4,3
How scientists commercialise new knowledge via entrepreneurship	O'Gorman, C., Byrne, O., Pandya, D.	Journal of Technology Transfer	208	86	4,3
Spin-off enterprises as a means of technology commercialisation in a transforming economy- Evidence from three universities in China	Kroll, H., Liefner, I.	Technovation	2008	85	4,25
Convergence or path dependency in policies to foster the creation of university spin-off firms? a comparison of France and the United Kingdom	Mustar, P., Wright, M.	Journal of Technology Transfer	2010	84	4,2
A knowledge-based typology of university spin-offs in the context of	Bathelt, H., Kogler, D.F., Munro, A.K.	Technovation	2010	81	4,05

regional economic development					
Measuring the performance of Oxford University, Oxford Brookes University and the government laboratories' spin-off companies	Lawton Smith, H., Ho, K	Research Policy	2006	78	3,9
Academic spin-offs at different ages: A case study in search of key obstacles to growth	van Geenhuizen, M., Soetanto, D.P.	Technovation	2009	75	3,75
Technology transfer offices and academic spin-off creation: The case of Italy	Algieri, B., Aquino, A., Succurro, M.	Journal of Technology Transfer	2013	73	3,65
Does inventor ownership encourage university research-derived entrepreneurship? A six university comparison	Kenney, M., Patton, D.	Research Policy,	2011	70	3,5
The M&A dynamics of European science-based entrepreneurial firms	Bonardo, D., Paleari, S., Vismara, S	Journal of Technology Transfer	2010	70	3,5
Understanding academic entrepreneurship: Exploring the emergence of university spin-off ventures using process theories	Rasmussen, E.	International Small Business Journal	2011	68	3,4
How can universities facilitate academic spin-offs? An entrepreneurial competency perspective	Rasmussen, E., Wright, M.	Journal of Technology Transfer	2015	66	3,3
University technology transfer through entrepreneurship: faculty and students in spinoffs	Boh, W.F., De-Haan, U., Strom, R.	Journal of Technology Transfer	2016	57	2,85
Consumer responses to shelf out-of-stocks of perishable products	Van Woensel, T., Van Donselaar, K., Broekmeulen, R., Fransoo, J.	International Journal of Physical Distribution & Logistics Management,	2007	57	2,85
Assessment of proposals for new technology ventures in the UK: Characteristics of university spinoff companies	De Coster, R., Butler, C.	Technovation	2005	57	2,85

Constraining entrepreneurial development: A knowledge-based view of social networks among academic entrepreneurs	Hayter, C.S.	Research Policy	2016	56	2,8
Commercializing science: Is there a university "brain drain" from academic entrepreneurship?	Toole, A.A., Czarnitzki, D.	Management Science	2010	56	2,8
Success factors of university-spin-offs: Regional government support programs versus regional environment	Sternberg, R.	Technovation	2014	55	2,75
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The transformation of network ties to develop entrepreneurial competencies for university spinoffs	Rasmussen, E., Mosey, S., Wright, M.	Entrepreneurship and Regional Development	2015	48	2,4
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The role of equity, royalty, and fixed fees in technology licensing to university spin-offs	Savva, N., Taneri, N	Management Science	2015	15	0,75
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