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Re-thinking university spin-off: a critical literature review and a research agenda

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Abstract In recent years, universities have focused more on the creation of spin-off companies as a means of transferring the knowledge generated by their research activities. At the same time, this has generated an increase in academic research on this business structure in order to identify the best strategies for their management and the most efficient university policies, amongst other things. In this study, we have identified and evaluated the literature on university spin-offs published in journals included in the Social Sciences Citation Index of the Web of Science in order to identify what, by whom, where and how it has been researched. The number of studies was marginal until 2000 but has grown exponentially since 2010. Our systematic review classifies research findings into three levels—individual, firm, and institutional context—each with respect to characteristics, antecedents, and outcomes of entrepreneurial activities. Reviewing the content of these articles allows some gaps in the research to be identified and conclusions to be reached about possible future research in this field to supplement, update and extend the results obtained to date.

Keywords Higher education institution · Spin-off · Academic entrepreneurship · USO · Literature review

JEL Classification I230 · O310 · O320

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1 Introduction

Since the late twentieth century there has been a stream of critical opinion and reviews of the role that the university should take as a relevant agent in the R&D system. The third mission of the university has become rapidly popular. This concept seeks to identify how to apply science through the transfer of knowledge to the productive sector and society in general. Entrepreneurial universities are institutions which are characterized by "greater involvement in economic and social development, more intense commercialization of research results, patent and licensing activities, the institutionalization of spin-off activities, and managerial and attitudinal changes among academics with respect to collaborative projects with industry" (Van Looy et al. 2011, p. 554). In this context, "universities are being required to operate in a more business-wise fashion, commercializing the outcomes of their research, and spinning out new, knowledge-based, enterprises" (Kirby 2006, p. 600).

One of the methods to generate this knowledge transfer is university spin-offs. In the business field, the term spin-off refers to the process by which a company is created from another pre-existing entity. The resulting new company is also known as a spin-off. The term serves both to define the process itself and the result of that process. At the university level, we talk about an academic or university spin-off (USO) when the company was established within a higher education institution, putting into practice the knowledge generated in these centres through the R&D activity of academics.

These USOs are characterized by their activity being based on the exploitation of new processes, products, or services arising from the knowledge gained and the results obtained in the university itself. The basic premise behind academic entrepreneurship is that a wide range of scientific research takes place within universities, and some of the research results may have commercial applications capable of generating revenue for those universities (Wood 2011). Constructing an entrepreneurial university therefore requires the existence of individuals willing to take on entrepreneurial behaviours from within the university.

In the last 3 decades, we have significantly assisted in the generation of USO at a global level, probably due to the generalization of interest in the most efficient and effective use of scientific knowledge, especially that generated through research financed with public funds. Currently, USOs are considered as an important instrument due to their contribution to the generation of businesses, the creation of jobs, their contribution to maintaining the balance of the economic system, as well as their positive influence on innovative processes (Miranda et al. 2017).

The initial hypothesis is that both the methodologies used in the studies and the topics addressed have evolved significantly in recent years. In addition, the importance of this review of the literature also lies in the fact that its results may be useful for researchers from two different areas of research: (1) those who study the R&D policies and the role of universities in science and technology systems, and (2) those who study entrepreneurship, specialising in the phenomenon of corporate entrepreneurship or intrapreneurship.

The aim of this work is to identify the way in which research on the USO has developed internationally, with a view to identifying the main lines of work followed and determining a research agenda in this field. In other words, we have tried to analyse what has been researched (topics), when (evolution over time), by whom (principal authors and journals) and how (research types and methodologies).

In the following sections, we will analyse the existing reviews of the USO literature before moving on to present the methodology used in our analysis and the results. We conclude our paper with a proposal for future lines of research and the conclusions.

2 Literature review

Parallel to the increase in USOs, academics have also been interested in studying and analysing them to identify aspects such as the most effective university policies when it comes to promoting them, the business process followed to create them and the characteristics of the academics who have taken the step of creating a company of this type, amongst other things. There are already several bibliographical reviews to be found in the literature on the subject (see Table 1): O'Shea et al. (2004), Mustar et al. (2006), Rothaermel et al. (2007), Djokovic and Souitaris (2008), Mars and Rios-Aguilar (2010) and Yusof and Jain (2010). Among these works we can highlight that of Rothaermel et al. (2007), who analyse 173 articles on university entrepreneurship classifying them into four main streams: (1) entrepreneurial research university, (2) productivity of technology transfer offices, (3) new firm creation, and (4) environmental context.

Mustar et al. (2006) review the literature on research-based spin-off typologies and develop a taxonomy identifying common themes in this regard: (1) spin-off creation and (2) spin-off development. Subsequently, Yusof and Jain (2010) analyse the literature identifying three categories, namely entrepreneurial university, academic entrepreneurship and university technology transfer.

The limitations of previous reviews (see Table 1), together with the significant increase in the number of publications in recent years, justifies the need for a new examination of the main works on USOs. The most updated review (Mars and Rios-Aguilar 2010) includes publications until 2008, and since then the number of publications has increased significantly (see Fig. 1). In the 1987–2008 period there were 71 works (accounting for 26.5% of those analysed), which represents an average of 3.2 papers/year. In contrast, in the 2009–2016 period there were 197 works (73.5%), which gives an average of 24.6 papers/year.

3 Methodology

To perform the literature review we have focused on publications in the main social sciences journals, using the Web of Science Core Collection database, specifically analysing the articles published in journals included in the Social Sciences Citation Index (SSCI) edition.

We follow a "systematic review process" (Tranfield et al. 2003) using a combination of different keywords for the search: "academic", "entrepreneurship", "entrepreneur", "university", "academic institution", "spin-off" and "spin-out". The search was conducted in March 2017, so the timescale for the analysis was limited to the period (1997–2016). Each author independently read the original collection of over 800 articles to identify which should be included and then compared notes to reach agreement, eliminating articles with only a marginal relationship to USO. Only those articles whose main study subject was USOs have been selected for analysis. Other studies mentioning USOs but whose analysis is focussed on other processes for transferring results, such as collaboration agreements with companies or patent licenses, have been excluded.

Unlike the review carried out by Rothaermel et al. (2007), the target for this work has only been articles where USOs are the main subject of the study. In this way, a final database of 268 items was obtained (see Appendix).

Table 1 Summary of the existing reviews of the literature

Authors	Time period analysed	Number of articles reviewed	Findings	Shortcomings
O'Shea et al. (2004)	1991–2002	44	They synthesise their analysis of the literature into a conceptual framework that describes the main determinants and consequences of the creation of a USO	– Literature review process not defined; the database of journals is not demarcated – Non-homogeneous classification categories
Mustar et al. (2006)	1990–2005	26	Their review allows for the differentiation between papers that analyse the process of creating a USO and those that analyse its development process. According to the authors, the latter are the ones that show greater potential in the future	– Literature review process not defined; the database of journals is not demarcated – Classification categories not well defined
Rothaermel et al. (2007)	1981–2005	173	The main gaps detected are the analysis of the capacities needed for academics to be successful in the process of creating and developing a USO and the study of the effect of support programmes for the creation of USOs run by the public administrations	– Literature review process not defined; the database of journals is not demarcated – Many articles do not refer exclusively to USOs but to other ways of transferring research results (patents, contracts, etc.)
Djokovic and Souitaris (2008)	1990–2002	63	While the early literature has been mainly theoretical and focused on describing the phenomenon, a core group of recent studies have been theory-driven	– Only 34 articles analyse USOs – It only uses two classification categories: macro and micro
Mars and Rios-Aguilar (2010)	1999–2008	44	Results suggest that there is a paucity of attention paid to the conceptual and theoretical underpinnings of entrepreneurship within higher education scholarship. Propose a framework for strengthening the application of entrepreneurial models to higher education research	– Review made exclusively of five leading higher education journals
Yusof and Jain (2010)	1989–2006	72	The authors delineate the boundaries of university-level entrepreneurship and develop a framework that depicts the relationship between its three research categories: entrepreneurial university, academic entrepreneurship and university technology transfer	– Literature review process not defined; the database of journals is not demarcated – Most of the articles reviewed refer to other ways of transferring research results (patents, contracts, etc.); only 29 articles analyse USOs

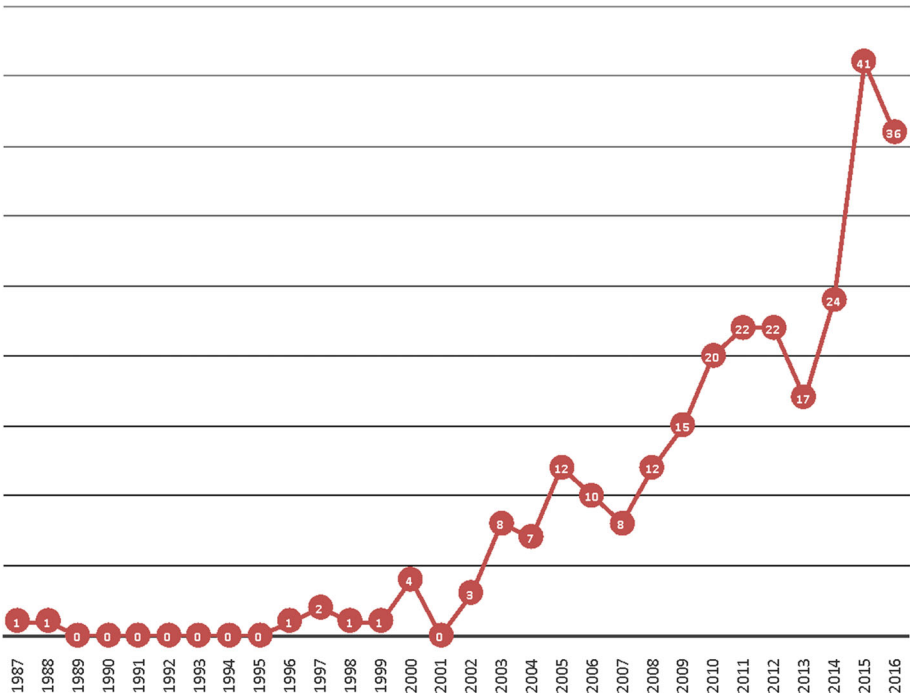

Fig. 1 Evolution of the number of publications USOs

After identifying the articles on the subject, the next step was to analyse each article using a data collection sheet in which the following information was included: year of publication, authors (number and origin), type of work (empirical or theoretical), number of citations (in the Web of Science) and, in the case of empirical work, source and techniques for obtaining the data, time period and geographical scope analysed and unit of analysis. In addition, each article was classified according to the research subject dealt with. Finally, an analysis of the content of the articles was carried out to allow for, on the one hand, their classification according to their purpose within a category and, on the other, the drawing of general conclusions about their main results. From this review of the content it was possible to identify a number of directions for future research in the field of USOs and these are set out in the final section of this work.

4 Results

4.1 Descriptive characteristics

The first two articles published in the journals analysed were "Growth pattern of academic entrepreneurial firms" published in *Journal of Business Venturing* by Doutriaux (1987) and "Academic Entrepreneurship at Belgian Universities" published in *R&D Management* by Vandierdonck and Debackere (1988).

Figure 1 shows that the annual number of publications on this topic was very low until 2002 (< 1 paper/year = 0.875). If we look at the entire period of analysis (1987–2016),

the first 2 decades (1987–2006) account for 19.03% of the analysed works and 37 of the 51 analysed works published in those first 20 years (72.55%) are from the 2003–2006 period; meanwhile, 80.97% of the works analysed in this study were published in the last decade, 2007–2016. This 2007–2016 period contributes most to the database (more than 80%) and is not included in most of the reviews carried out so far (the most recent, Mars and Rios-Aguilar (2010), covers up to 2008).

One explanation for this increasing interest in research on USOs can be found in the relevance that USOs have achieved in Western economies. In the last decade, USOs have become one of the most useful mechanisms for transferring R&D knowledge from universities to companies.

In Europe, this institutional endeavour for developing USOs can be seen from several actions carried out in this regard, such as considering the development of a USO as an advantage when it comes to staff promotion or the creation of university programmes supporting academic entrepreneurship (Sánchez et al. 2012). Actions of this sort have triggered a rise in the number of USOs in recent years (ESM 2016).

The 268 articles analysed have been published in a total of 76 academic journals. Just two journals, *Journal of Technology Transfer* (17.91%) and *Research Policy* (16.04%), represent more than 30% of the articles published and, in addition, 63% of the articles published in the period are concentrated into ten journals. Figure 2 shows the ranking of the 20 journals that have published more than two articles on this topic.

After the two aforementioned journals, the following ones are *Technovation* (6.72%), *Small Business Economics* (5.60%) and *R&D Management* (3.73%). Most of the journals included in this research are journals specialising in areas broadly related to the topic analysed (innovation, transfer, entrepreneurship, higher education institutions, etc.) and there are only a few of a generalist nature. For example, there are no publications in the leading journals in the field of management, such as *Academy of Management Review* and *Academy of Management Journal*.

If we consider the impact of the journals, we note that most of the articles analysed were published in journals included in the first quartile of the SSCI, specifically more than 43% of the total. In terms of the number of articles published, in this quartile the journals that

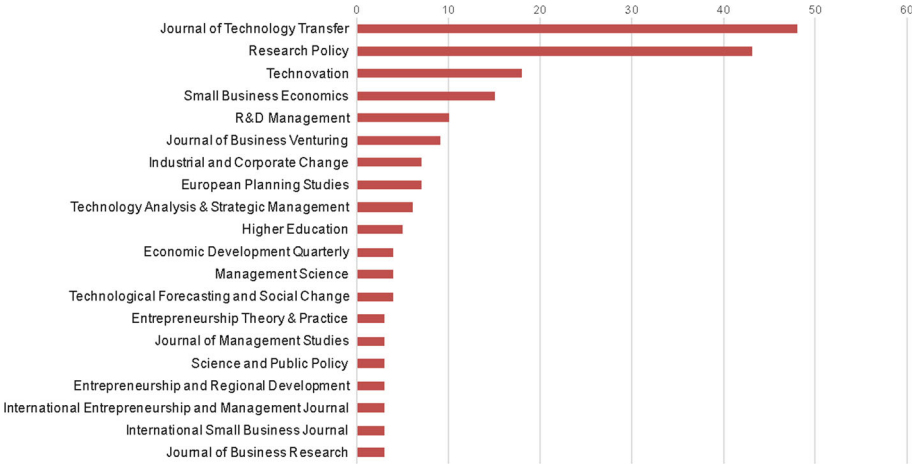

Fig. 2 Articles about USOs published by journal (1987–2016)

stand out include *Research Policy*, *Technovation*, *Journal of Business Venturing*, *Management Science* and *Entrepreneurship Theory and Practice*.

The principal authors in the discipline are cited in Fig. 3. The most prolific author, well above the rest, is Professor Mike Wright (Imperial College Business School, London) with 20 publications, followed by Professor Simon Mosey and Professor Einar Rasmussen, both from the University of Nottingham, with 8 publications. These three authors are part of the same research team in several publications.

Figure 4 shows the distribution of articles by geographic area (country of the author) and here we observe that most works come from Europe (68% of the total) compared to 22% of works from North America. The USA and the UK are the countries with the highest number of publications, followed at some distance by Italy and Spain. Despite the diversity of countries, 67.5% are written by an author or team based in one country, compared to 25.4% in two countries and 7.1% in three countries.

4.2 Methods used

Regarding the research methods used, we observe that most of the works are empirical (85.4%), rather than eminently theoretical works or literature reviews. Within the empirical works, 33.9% follow a qualitative methodology, a large majority of which perform case studies (88.1% of the qualitative studies). We found no research that utilizes both qualitative and quantitative data from the same set of individuals, firms, industries, and/or countries.

Among the quantitative works (67.3%), the most commonly used techniques are multiple linear regression models (38.4%), followed by non-linear models such as logit, probit or logistic regression (21.7%) and structural equation models (10.1%). We must emphasise that 14.5% of the works analysed only use descriptive statistics to present their findings.

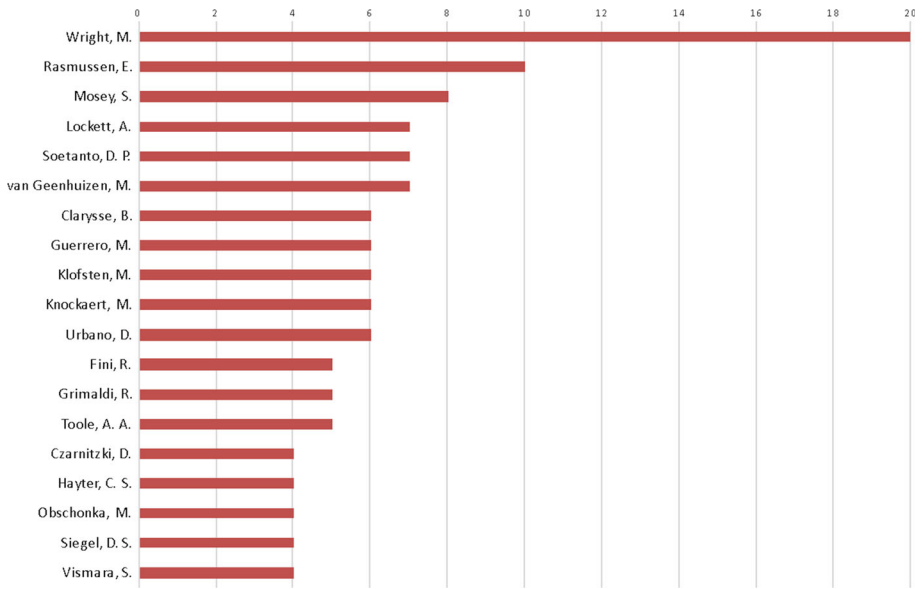

Fig. 3 Ranking of authors by number of articles published (1987–2016)

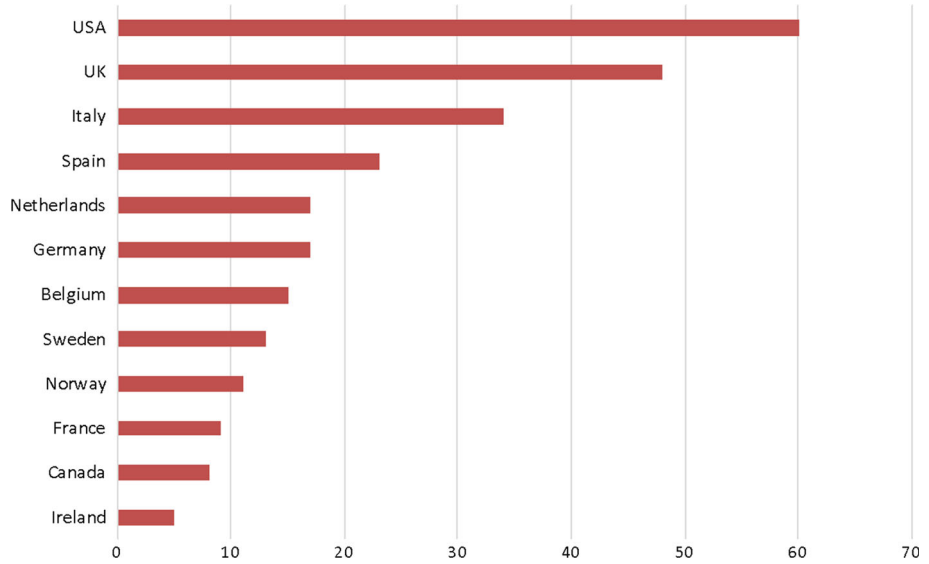

Fig. 4 Research centre of the authors (1987–2016)

If we compare these results with those obtained by Rothaermel et al. (2007) we observe that in recent years the number of quantitative works has increased, which, following their argument, must be interpreted as a maturing of the discipline, which has passed from the initial development of theories stage to the validation of theories stage. As Rothaermel et al. (2007) outline: "as a field develops beyond the embryonic stage, researchers tend to shift from more qualitative studies to more quantitative ones, a pattern consistent with the one observed in mainstream management journals".

With respect to the unit of analysis, the studies on USOs can either analyse the spin-offs themselves (44%), the academics (34%), or the university policy supporting USOs and other means of transferring knowledge (15%). From the review of the unit of analysis of the quantitative studies identified, we can observe that most of them (44%) use data from USOs, a much higher figure than the 23% obtained in the work of Rothaermel et al. (2007). This increase would indicate that there has been a noticeable shift in focus in the publications on this topic over the years between the two studies. Thus, the studies designed to analyse the decisions of the founders of USOs through interviews and questionnaires have been leaving the analysis of the entrepreneurial policies of universities in the background.

Of the works, 71.5% refer to studies on different higher education institutions in a single country, while only 12.6% use information relating to different countries. Only 15.8% of the studies analyse performance in a single institution.

4.3 Content

The second phase of the literature review has consisted of performing an analysis of the content of the 268 articles in order to assess which issues have been addressed and propose a series of lines of research on the subject. Starting from the classifications used by Cooper and Gimeno-Gascon (1990) and Terjesen et al. (2016), we have classified the articles into three categories: individual, firm and institutional context, depending on whether the unit

of analysis is the individual faculty member (individual), the USO itself (firm) or there is an analysis of the national or regional context where the USO is based and the impact this could have on it (institutional context).

Within each of the three study categories there has been a sub-classification according to whether the research analyses: (1) characteristics of USOs, (2) antecedents or factors influencing entrepreneurial intention of academics, and (3) outcomes (see Table 2). Antecedent and outcome research is focused on analysing the causes and effects of the entrepreneurial activity of academics, which leads to an increase in our theoretical understanding of the phenomenon of entrepreneurship. In contrast, characteristics research focuses on describing what exists and does not try to determine causes or effects, or aspire

Table 2 University spin-off content and sample research questions

	Characteristics (45.1%)	Antecedent (26.9%)	Outcomes (28.0%)
Individual (26.9%)	n = 21 Gender, institutional context, scientific productivity, personal social networks	n = 39 Individual (experience, perceived control, attitude, self-identity…) and contextual (institutional support, department characteristics, …)	n = 12 Scientific productivity, teaching quality, economic incomes, personal social networks
Research question examples	What attitudes distinguish entrepreneurs and non-entrepreneurs? What are the characteristics of the academic entrepreneurs?	What motivates academics to start a USO?	What effects does the creation of a USO have on the teaching, research and financial performance of its founder?
Firm (30.6%)	n = 31 Stages of academic entrepreneurship, associated business models	n = 6 Management practices, entrepreneurial background, financing, innovation	n = 45 Organizational structures, social capital/networks, human capital, parent organization support
Research question examples	How do academics who have founded a USO differ from other academics? Are there differences in the financial performance of USOs compared to other start-ups?	What influence does the promoter's network of contacts have on the creation of a USO? How does it affect the academic's work environment in the early stages of a USO's life?	How social networks will influence future spin-off success? How experiences incurred during the founding of USO will influence future USO activity?
Institutional context (42.5%)	n = 69 Policies to support the creation of USOs, implemented by public administrations and at the university level	n = 27 Importance of the environment for the creation of USOs; the role of financial incentives and support and advice structures	n = 18 Impact of university entrepreneurship on the local/regional economy and on the reputation and results of the university; factors that influence the outcomes of a USO
Research question examples	What is the role of the university as a promoter of academic entrepreneurship?	How does regional competitiveness affect academic entrepreneurship?	What is the impact of academic entrepreneurship on regional economic growth?

to make predictions, therefore demarcating the phenomenon being studied and providing a suitable context for the theory. This contributes to the development of this field of research (Terjesen et al. 2016).

4.3.1 Individual level research

Individual-level research accounts for 26.9% of all the studies analysed and can be classified into:

4.3.1.1 Characteristics Of the individual level studies, 27.1% analyse the characteristics of the academic entrepreneurs, especially their gender, university context, research productivity and social networks.

Several studies analyse the importance of the university context (focus on teaching or on research) on the entrepreneurial attitude of academics (e.g. Abreu et al. 2016). This series of studies concludes that "the university cannot be seen as homogeneous in how academic entrepreneurship is supported, but rather as a multi-layered organization" (Bienkowska et al. 2016). There are also several studies that analyse the important role that university structures to support entrepreneurship can play in the entrepreneurial process, for example, trying to avoid the excessive emphasis of academic entrepreneurs on the scientific-technical aspects of their entrepreneurial project, to the detriment of commercial and financial issues (Kolb and Wagner 2015).

In relation to gender, Goel et al. (2015) demonstrate a lower entrepreneurial intention among female academics. Unlike men, the entrepreneurial attitudes of women are not determined by the number of patents obtained, their institutional leadership, obtaining a doctorate degree or by their preference for open research.

Finally, we should mention another series of studies that tries to analyse the differential characteristics of the entrepreneurial phenomenon in different sectors: health and life sciences (Provasi et al. 2012; Lehoux et al. 2014; Kolympiris et al. 2015; Han and Niosi 2016), creative arts (Abreu and Grinevich 2014), renewable energies (Han and Niosi 2016), etc.

4.3.1.2 Antecedents Most of the studies at the individual level (55.9%) analyse the main antecedents of the entrepreneurial intention of academics. Usually, such antecedents are classified into individual and contextual factors.

Meusburger and Antonites (2016) demonstrate the greater relevance of individual factors compared to contextual factors, emphasizing as the main antecedent of entrepreneurial intention the previous business experience of the academic.

Other individual factors that have demonstrated their influence on entrepreneurial intention are: perceived control (Obschonka et al. 2012; Goethner et al. 2012; Huyghe and Knockaert 2015; Huyghe et al. 2016; Ferrero and Bessiere 2016), entrepreneurial attitude (Goethner et al. 2012; Obschonka et al. 2012), risk-taking behaviour (Ferrero and Bessiere 2016), scientific productivity (Bourelos et al. 2012), self-identity (Obschonka et al. 2014), the size of the personal network of contacts (Karlsson and Wigren 2012; Krabel et al. 2012; Fernandez-Perez et al. 2015) or entrepreneurial passion (Huyghe et al. 2016). Several studies also analyse the influence of gender on the antecedents of entrepreneurial intention (Rosa and Dawson 2006; Alonso-Galicia et al. 2015).

Within contextual factors, there are several studies that demonstrate the importance of the work environment on entrepreneurial intention, so those academics working in research

groups with a higher percentage of business funding (Foo et al. 2016) or with a stronger tradition when it comes to protecting research results (Erikson et al. 2015; Moutinho et al. 2016) demonstrate a greater entrepreneurial intention. Other contextual factors that influence this intention are institutional support for entrepreneurship (Bourelos et al. 2012; Fernandez-Perez et al. 2015; Huyghe and Knockaert 2015) and social norms (Obschonka et al. 2012).

4.3.1.3 Outcomes Finally, a fewer number of articles (16.9%) analyse outcomes for the academics themselves. This is the case for Hayter (2011, 2015) who researches motivations and definitions of success among academic entrepreneurs, how they evolve, and why.

The main results obtained by these works regarding the link between academic entrepreneurship and research productivity are contradictory. While most of the works indicate that academic entrepreneurs have a higher research productivity than the rest of their colleagues (Abramo et al. 2012; Shichijo et al. 2015), in some studies (Lowe and Gonzalez-Brambila 2007; Buenstorf 2009) the observed relationship is the opposite.

The results of the studies carried out so far make it difficult to draw clear conclusions. Thus, for example, the effect of the creation of a spin-off on the financial income of academics is unclear (Astebro et al. 2013). So being a promoter of a USO is not demonstrated to have a significant impact on the financial income of the academic, or on their future promotion possibilities. Thus, most academics embark on the business venture with a clear vocation to provide a public service to support local development rather than seeking to improve their income.

In terms of the impact on teaching quality, in all cases (see Holmen and Ljungberg 2015) a positive effect is shown, so academic staff involved in the creation of a USO perceive that their teaching performance has improved significantly by being able to share their business experience with their students, thereby enriching their teaching.

Finally, one of the most clearly identified consequences of the entrepreneurial behaviour of academics is its positive effect on the reputation of both the researcher and the university to which they belong.

4.3.2 Firm-level research

Firm-level research accounts for 30.6% of all the studies analysed, of which most focus on analysing the characteristics and, particularly, the outcomes of the USOs.

4.3.2.1 Characteristics There are several studies that demonstrate that academics who have founded a USO differ from other academics, both in their individual characteristics and in their departmental, institutional and regional environment (Thursby et al. 2009; Fini et al. 2010; Heblich and Slavtchev 2014).

Another series of studies analyses the stages of the academic entrepreneurship process (Wood 2011), the different business models associated with innovation (Clausen and Rasmussen 2013), the different roles of USOs related to resource interaction among business parties (Aaboen et al. 2016), and the stronger performance of this type of company compared to other types of start-up (Czarnitzki et al. 2014).

4.3.2.2 Antecedents We have only identified six studies that analyse antecedents at the company level, so it is difficult to draw conclusions given the heterogeneous nature of these studies.

4.3.2.3 Outcomes Of the studies at the firm level, 54.9% are focussed on analysing the outcomes of USOs. Zhang (2009) show that USOs have a higher survival rate but are not significantly different from other start-ups in terms of the amount of venture capital raised, the probability of making a profit, or the size of employment.

Undoubtedly, the factor most studied as a determinant of outcomes is support from the parent organization in the early stages of the life of a spin-off, that is to say, the systems to support entrepreneurship provided by the university and departmental support for the researchers promoting a USO (Rasmussen et al. 2014; Lundqvist 2014; Slavtchev and Goktepe-Hulten 2016; Soetanto and Jack 2016; Epure et al. 2016; Gubitta et al. 2016).

Other factors studied to date that affect outcomes are: academic and non-academic social networks (Hayter 2015a, b, 2016a, b), technological knowledge obtained from universities (Diez-Vial and Montoro-Sanchez 2016), innovativeness degree (Su and Sohn 2015), outside management (Hayter 2013), specific human capital (Criaco et al. 2014; Visintin and Pittino 2014; Scholten et al. 2015), and venture capital (Hayter 2013).

4.3.3 Institutional context research

Institutional context-level research represents 42.5% of the total number of studies analysed. This area bases its results on the analysis of the regional, national and international context where the USO is created and the impact that this may have on it (institutional context).

4.3.3.1 Characteristics Of the studies at this level, 60.4% fall into the category of "characteristics", limiting themselves to describing the impact of different institutions [public administrations, university, technology transfer offices (TTO), science and technology parks, etc.] on academic entrepreneurship in different contexts.

Although these descriptive studies do not allow us to draw conclusions about the mechanisms that generate differences between the different environments analysed, they do provide an interesting theoretical foundation to support the development of future research studies that allow us to analyse, for example, the different characteristics of academic entrepreneurs in different countries or different regional settings.

This category includes those studies that describe the effect of the policies of public administrations to support the creation of USOs (Meyer 2003; Goldfarb and Henrekson 2003; Mustar and Wright 2010; Gilsing et al. 2010; Munari et al. 2016); it also includes studies that describe the support policies at the university level (Rasmussen and Borch 2010; Urbano and Guerrero 2013; Rasmussen, and Wright 2015), focussing particularly on the important role of TTOs (Nosella and Grimaldi 2009; Garmendia and Castellanos 2014; Shane et al. 2015; Perkmann et al. 2015) and science-technology parks (Link and Scott 2005) in the early stages of the creation of a USO.

4.3.3.2 Antecedents Although the study of antecedents in USOs has undergone a remarkable development in recent years, the 27 studies analysed in this category show inconsistent results. Thus, we find studies that show the importance of the environment on the creation of USOs, both internationally and nationally (Davey et al. 2016; Zhang et al. 2016 Horta et al. 2016), and regionally (Gonzalez-Pernia et al. 2013; Rizzo 2015) and locally (Avnimelech and Feldman 2015).

Studies of the impact of financial incentives (Muscio et al. 2016; Ramaciotti and Rizzo 2015) and support and advice structures at the regional/university level (Salvador and

Rolfo 2011; Berbegal-Mirabent et al. 2015; Ramaciotti and Rizzo 2015; Meoli and Vismara 2016; Czarnitzki et al. 2016) on the creation of USOs also show contradictory outcomes.

4.3.3.3 Outcomes The 18 studies that analyse outcomes at this level show the impact of university entrepreneurship on the local/regional economy (see for example Guerrero et al. 2015; Iacobucci and Micozzi 2015), and on the reputation and results of the university itself (see for example Bray and Lee 2000; Pitsakis et al. 2015). Again there are no conclusive results.

Finally, the outcomes obtained by spin-offs after their early years of life depend on several factors, among which we can highlight the strength of their link with the institution from which they come (Soetanto and van Geenhuizen 2015; Cardamone et al. 2015; Fernandez-Perez et al. 2015), the composition of the team of promoters (de Cleyn et al. 2015), the previous experience of the promoters (Nielsen 2015) and the involvement of venture capital firms (Fernandez-Perez et al. 2015).

5 Discussion of future directions

With this work, we have tried first to organize the extensive literature on USOs in order to provide researchers with information about the research that has been completed and, second, to identify gaps that could lead to future works that complement, qualify or expand the results already obtained.

Our review overcomes the main deficiencies detected in the previous works by starting with a rigorous article selection methodology so that we can review publications directly related to USOs and group the works following a systematic classification, already used successfully in previous works (Cooper and Gimeno-Gascon 1990; Terjesen et al. 2016). In addition, our review includes the 2009–2016 period (not included in previous reviews) which is precisely the period in which the greatest increase in the number of publications on USOs occurs (see Fig. 1).

The analysis of the academic literature on academic spin-off companies that has been conducted shows that in recent years the number of empirical works in this field of research has increased significantly. The results of these works may have a significant impact on public policies promoting entrepreneurship and innovation, while in turn they suggest new lines of work that need to be addressed in the coming years. Therefore, this work can serve as a starting point for those researchers who want to tackle these new challenges.

Following the structure of our review of the current research in this area, we highlight knowledge gaps and suggest promising directions for future research.

The research carried out to date has allowed for the identification of the characteristics, antecedents and outcomes of academic entrepreneurship. However, the existing literature is so diverse and fragmented that, for the moment, no definitive conclusions can be drawn.

5.1 Characteristics

The first studies of USOs were based on analysing the characteristics of academic entrepreneurship. Over time, the studies have evolved to examine more causal influences in terms of antecedents and outcomes. However, research into the characteristics remains of particular importance for case studies in certain situations:

- In high added value and knowledge intensive sectors characterised by high levels of uncertainty. Research into these dynamic industries offers great potential to assist the decision-making of both company managers and sector associations and public policy-makers.
- It is also important to evaluate how the phenomena related to academic entrepreneurship develop over time in different countries. Current research on USOs is largely static so we believe that in order to be able to describe the evolution of this phenomenon over time, characteristics-based research offers ample opportunities for future research: for example, there could be longitudinal studies on the accumulation of human and social capital by entrepreneurs, the decline and appearance of new sectors or institutional development to support entrepreneurship. Such research may be particularly relevant for the subsequent development of theories to explain the antecedents and outcomes of academic entrepreneurship at different levels over time.

5.2 Antecedents

Another important line of research has focused on identifying the *antecedents* of academic entrepreneurship. At the individual level, a certain degree of consensus has been reached on the individual and contextual factors that affect the decision to create a USO, but this is not the case for the other levels of analysis.

- Future studies should analyze the skills and capabilities needed for the creation of a USO using data from different cultural contexts, thus allowing for a comparative analysis and in this way, being able to understand the complexity of this phenomenon.
- Furthermore, longitudinal studies will allow us to test whether the entrepreneurial intention shown by the academics in the surveys finally turns into entrepreneurial behaviour and what factors influence this relationship.
- Multilevel research into the antecedents of academic entrepreneurship is an interesting area to be addressed in future studies to investigate whether the antecedents at different levels can interact and how this interaction takes place.

5.3 Outcomes

Finally, research on *outcomes* has focused on the company level, and therefore research opportunities exist at all other levels.

- One of the contributions of existing research is the analysis of relationships between the creation of USOs and economic indicators at the national level (Guerrero et al. 2015; Iacobucci and Micozzi 2015). Academics can expand this research base to cover more countries and longer periods of time.
- Researchers should also examine the possible moderating effects of institutions (universities and regional and national public administrations) on the relationship between academic entrepreneurship and economic growth.
- We recommend extending the analysis of outcomes beyond economic statistics, analysing the impact of entrepreneurship on other aspects of development such as welfare (e.g., health, happiness, life expectancy and job satisfaction) and sustainability.
- In addition, a greater understanding of the role of supranational, national and regional factors affecting the academic entrepreneurial spirit, as well as the interaction of

institutional support mechanisms and the factors that inhibit or facilitate academic entrepreneurship, would provide a greater understanding of this area.

- We suggest research that explores different types of institutions simultaneously, also taking into account the impact of institutions on entrepreneurship and economic growth.
- The results indicate that university support helps USOs to develop a sound business plan and incorporate external capital. However, it is an open question whether support in the early stages is more efficient than support in later stages. Future research should be capable of evaluating the effectiveness of the new entrepreneurship support programmes and the mechanisms for economic and curricular incentives for the creation of companies by academics, trying to establish relationships between these and the entrepreneurial intention and subsequent entrepreneurial behaviour. For example, it would be interesting to test the role that the experience of the managers of science and technology parks could play in the success of the USOs created in their area.
- As for the management and development of the USO, what is lacking is works that analyse the management of the spin-offs using longitudinal data which allows for the testing of the effectiveness and efficiency of the various decisions taken in the early years of this type of business. It is necessary to look in more depth at the process for the growth and development of USOs, especially linking it to the development of technology and/or commercial alliances that facilitate such expansion, given that one of the main limitations of this type of company focuses on the commercial area. An interesting line of research would be to make a typology of strategies to follow depending on the life-cycle stage of each USO.
- Our study reveals a paucity of research on outcomes at the individual level, as well as notable contradictions between the few studies conducted at this level. Future research could explore outcomes in terms of the welfare of the academic (happiness, quality of life, etc.), while continuing to analyse the impact of the entrepreneurial activity on their teaching and research productivity and their income.

To date, characteristics, antecedents and outcomes have mainly been researched in isolation from each other. Therefore, we urge researchers to integrate the research of antecedents and outcomes and to explore the mediating role of academic entrepreneurship on different types of outcomes. The use of multilevel methodologies will enable researchers to better analyse academic entrepreneurship activities in a comprehensive manner and to generate more precise estimates, since the error terms that explain the entrepreneurial spirit and some outcomes may be correlated and, therefore, generate biased estimates.

We recommend that researchers be aware of issues relating to sample selection bias. For example, researchers could only select those people who managed to create a USO or only those USOs with a certain level of turnover, and use two-stage models to take into account the multiple stages of the decision-making process. For example, a first stage would focus on the decision on whether or not to become an entrepreneur, and a second stage on the strategic decisions that are taken after the creation of a USO.

We also suggest that future studies use a more diverse and sophisticated combination of analytical techniques than have been employed to date. For example, although case studies have frequently been adopted in academic entrepreneurship research, other methods of qualitative research (life history calendar, ethnography, repertory grid) can serve as a basis for the development of possible quantitative measures and potentially trigger the development of well-founded theories. In addition, research incorporating both qualitative and quantitative approaches may offer complementary knowledge.

Finally, a meta-analysis of the existing studies would allow researchers to determine which factors are most relevant in the process of creating a USO. Meta-analyses may also serve to reveal general patterns of similarity and dissimilarity between different countries about the antecedents and outcomes of academic entrepreneurship.

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Appendix

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