Academic Spin-off Management: A Bibliometric Study

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Abstract

This research broadens the understanding of university spin-off management through a bibliometric analysis of select literature on the subject. Using the ProknowC method, papers published between 2011 and 2021 in the Scopus database were systematically analysed. The process resulted in a portfolio of 37 relevant papers that aligned with the research topics that were subject to bibliometric analyses. The results are expected to contribute to academia, policymaking, and managers in developing theoretical frameworks and actions for academic spin-offs.

Keywords: university spin-off; academic entrepreneurship; technology transfer; bibliometrics

1. Introduction

Technological innovation is the main driving force of economic development, and universities, through the creation and dissemination of knowledge, enable the formation of human capital capable of generating innovation and entrepreneurship, playing a fundamental role in this process. These academic institutions should be the centre of an innovation network, collaborating with companies and other institutions to create and disseminate new ideas, generating disruptive innovations, fostering, and creating new economic sectors (Schumpeter, 2017).

In this context, university spin-offs have emerged, which are companies created from technologies, innovations, or research developed within a university or research institution as a way of transferring technology to industry and society as well as contributing to socioeconomic development. Spin-offs face a series of challenges when attempting to transform academic research into viable commercial ventures – mainly obtaining funding, protecting intellectual property, lacking business skills, and the need for collaboration with external companies, universities, companies, and the government to overcome these challenges and promote academic entrepreneurship (Audretsch, 2013; Shane, 2004).

This article aims to broaden the scientific knowledge about university spin-offs, seeking to select, reference, and qualify scientific production over the last ten years. To achieve this, two objectives are laid out:

- selecting bibliographic references on the academic spin-offs theme and

- performing bibliometric analyses of the selected papers and their references.

The knowledge development process-constructivist (Proknow-C) process was chosen as a tool to achieve the aforementioned objectives. Proknow-C helps the researcher construct knowledge through a structured process to select and analyse the literature that makes up the topic of interest (Lacerda, Ensslin, & Ensslin, 2012).

2. Literature Review

Spin-offs are companies derived from established organisations. Knowledge is conceptualised to have been originally developed and tested in a parent organisation, and then there arises a need, or even the identification of an opportunity, to explore this knowledge through a new organisation (Clarysse, Wright & Van de Velde, 2011). University spin-offs are ventures started within an academic environment and based on technology derived from university research. Broadly, they may or may not involve intellectual property formally disclosed to universities (Rasmussen & Wright, 2015). They are usually formed by faculty, staff, and/or students, and a central idea or technology is transferred from the parent organisation (university or research organisation) to the new organisation (Steffensen, Rogers, & Speakman, 2000), which will have a greater focus on commercial exploitation from its inception. Thus, spin-offs can play a critical role in moving early-stage technologies developed by universities to the market (Boh, De-Haan, & Strom, 2016).

In an attempt to introduce and gain sufficient credibility to access and acquire key resources in the market, university spin-offs usually face substantial obstacles associated with starting a new business, which is based on developing disruptive technologies or tacit knowledge (Oakey, Hare, & Balazs, 1996) (Rasmussen & Wright, 2015), and a traditionally structured research-teaching environment in universities with its idiosyncrasies of entrepreneurial views on commercial applications of knowledge (Landry, Amara, & Rherrad, 2006). Therefore, members of these spin-offs are required to identify and develop competencies, which, despite being influenced by their initial environment, also require a departure from existing trajectories (Rasmussen, Mosey & Wright 2011). The challenge of these ventures is not only to develop more high-tech innovation competencies through research, but also to develop competencies to frame innovations commercially (Rasmussen et al., 2011) – from overcoming possible departmental support barriers to creating relationships with industry actors and gaining access to external resources (Rasmussen, Mosey, & Wright, 2014; Rasmussen & Wright, 2015).

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In this context, several mechanisms and policies can be considered to facilitate technology transfer through spin-offs, which can be designed to address difficulties both on the part of academia and the market (Fini, Grimaldi, Santoni, & Sobrero, 2011) (Boh et al., 2016).

3. Methodology

The method chosen for this research was bibliometric analysis, which is a quantitative method that summarises the intellectual and bibliometric structure of a certain research field; analyses the social relationships among its different constituents, such as authors, countries, and institutions; establishes parameters; and enables the generation of a bibliographic portfolio. It has gained popularity in recent years because of the presence and utilisation of bibliometric software and databases, allowing the acquisition and evaluation of large volumes of scientific publication data (Becker, Lacerda, & Lima, 2022; Donthu, Kumar, Mukherjee, Pandey, & Lim, 2021; Lacerda, Ensslin & Ensslin, 2012).

The tool used, Proknow-C, is divided into four macro-processes, as shown in Figure 1.

Figure 1: Macroprocesses do knowledge development process – Constructivist (ProKnow-C). (adapted from Lacerda et al., 2012)
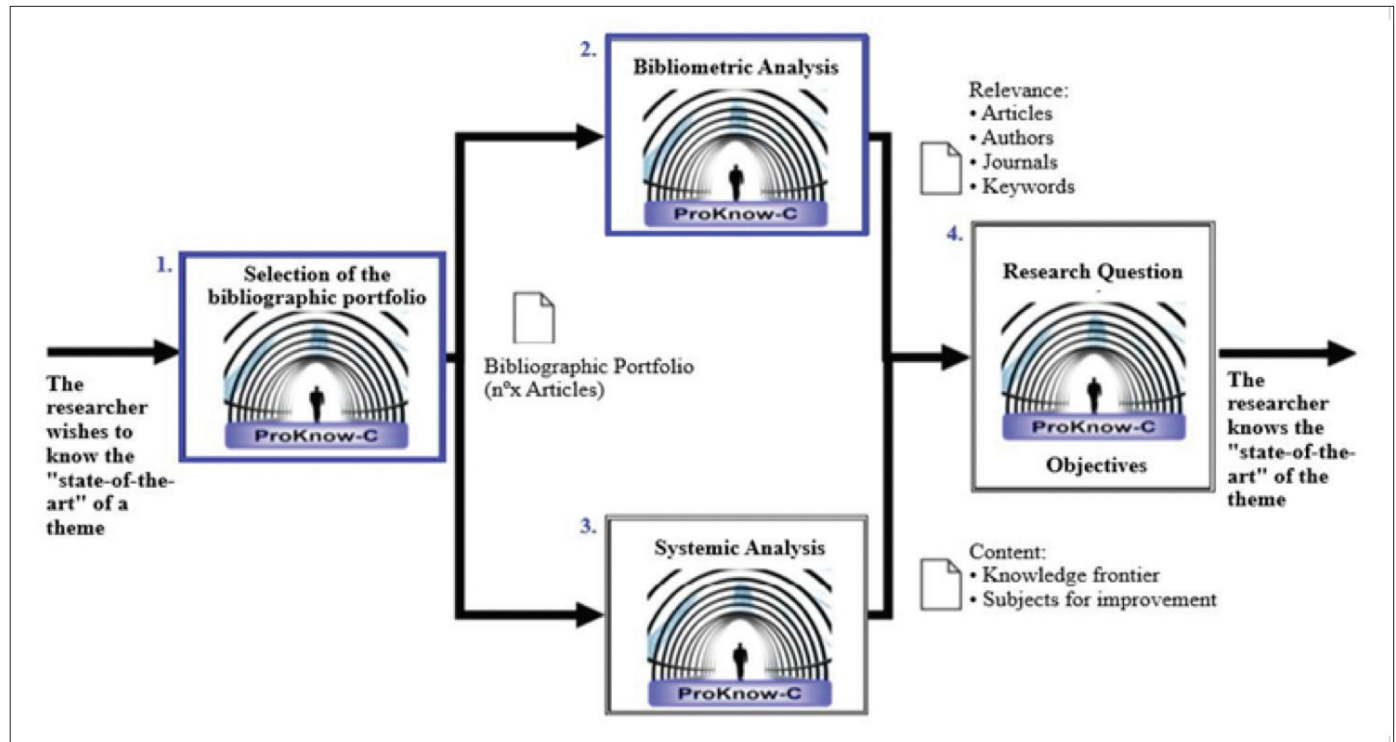
The present study used macro-processes 1 and 2 to achieve its objectives: to select relevant articles to form a portfolio for theoretical support of the present theme on academic spin-offs and to perform bibliometric analysis of this portfolio. Descriptions of the procedures at each stage are presented in the following sections.

4. Database Research Process and Bibliographic Portfolio Formation

4.1 Selection of Raw Data Bank

The first step of Pronknow-C, called 'Selection of Raw Articles Bank', reflects the initial filter for article selection. At the beginning of the process, the researchers defined research axes and selected keywords for each axis. They then combined these keywords and inserted them into a database.

The authors of this study chose to use the Scopus scientific database, considering its ranking amongst the largest multidisciplinary databases in the world, covering areas of knowledge such as social sciences, and Elsevier's Scirus search engine to search for pages with scientific content (Mesquita et al., 2006). Scopus is also useful for accessing a wide variety of non-Anglo-Saxon sources, making it possible to find work developed in countries where English is not the main language (Pranckutė, 2021).

After choosing the database, two central themes were defined for research that addressed the know-how of entrepreneurship possibilities within the academic environment. 'University' was chosen as the first axis and 'entrepreneurship' as the second axis. These themes guided the selection of keywords that were combined and inserted into the database. For this purpose, keywords had to be present in the titles, keywords, or abstracts of the references. These procedures were carried out in November 2021 and cover a ten-year time frame of publications, from 2011 to 2021. Because the aspects to be identified are related to management, which falls under the category 'Business, Management and Accounting', the search was limited to this subdivision. The search returned 3,233 works, as shown in Figure 2.

Figure 2: Initial selection of the bibliographic portfolio: Raw data bank. (Source: Authors)

Therefore, the raw data bank, composed of the total results of the searches, became the basis for the next steps of analysis and article selection to compose the theoretical framework of the present topic.

4.2 Selection of Portfolio Articles

For better management, all references were imported into the Zotero software (Mueen Ahmed & Al Dhubaib, 2011). With the help of the software, it was possible to consider only scientific articles, as these documents usually undergo a rigorous peer review process before being accepted for publication, aiming for greater reliability of the resulting portfolio. The analysis yielded 2008 non-repeated articles.

Continuing with Proknow-C, the titles of articles in this database were read to verify their alignment with the research topic. Through this analysis, 1657 articles misaligned with the topic of this research were eliminated.

For the next stage of the process, which consisted of analysing scientific recognition based on the number of citations per article, the 351 articles that, by their titles, appeared aligned with the research topic were submitted to a search on the Google Scholar platform (2021) in order to verify the number of citations each article has received since its publication. Based on these data, the articles were arranged in descending order and a cut-off point representing 80% of the total citations was chosen. At this point, the articles individually had 48 or more citations, totalling 96 articles, representing a total of 13,299 citations out of 16,653 citations, or 79.85%.

This set of 96 articles was subjected to a new analysis of the alignment of their abstracts with the themes of this study. At this stage, 53 articles were excluded for not being aligned according to the

authors' assessment, leaving 43 articles that were selected for scientific recognition determined by the relevant number of citations and for having titles and abstracts aligned with the objectives of this research.

Notably, less representative articles should not be ignored, some of which may be found among the 20% that are important tomorrow (Sanders, 1987), especially in the case of recent articles or articles belonging to the authors who make up the first selection. Therefore, the less-cited articles and, so far, unselected ones were subjected to another analysis criterion with the possibility of being included in the bibliographic portfolio of this study.

Within the Proknow-C process, low-citation articles to be included in the portfolio met one of two possible conditions.

- In the case of recent articles (two years or less since publication), all articles were analysed because they did not have time to be well cited.

- In the case of older articles (more than two years of publication), articles authored by researchers present in the first selection group were analysed (articles by authors of the 43 articles previously selected).

Considering these two propositions, out of the 255 less-cited articles, 104 comprised the list of recent articles (2019 to 2021). Of the 151 articles published before 2019, 30 were authored by the researchers present in the portfolio of selected articles. A total of 134 articles were selected for analysis of their alignment with the theme of this research, and 125 were eliminated for misalignment.

This process resulted in nine more articles being included in the list up to the present moment, which were added to the 43 articles initially selected, resulting in 52 articles that were subjected to the final procedure for defining the portfolio: a full reading to evaluate each article's contribution to the theoretical framework of the proposed topic.

With all the articles available in their entirety, a study of 52 articles was conducted in April 2022. At this stage, 15 articles were eliminated based on the authors' analyses and the understanding that they did not adhere to the theme of this research. Figure 3 summarises the filters applied.

Figure 3: Article selection steps. (Source: Authors)
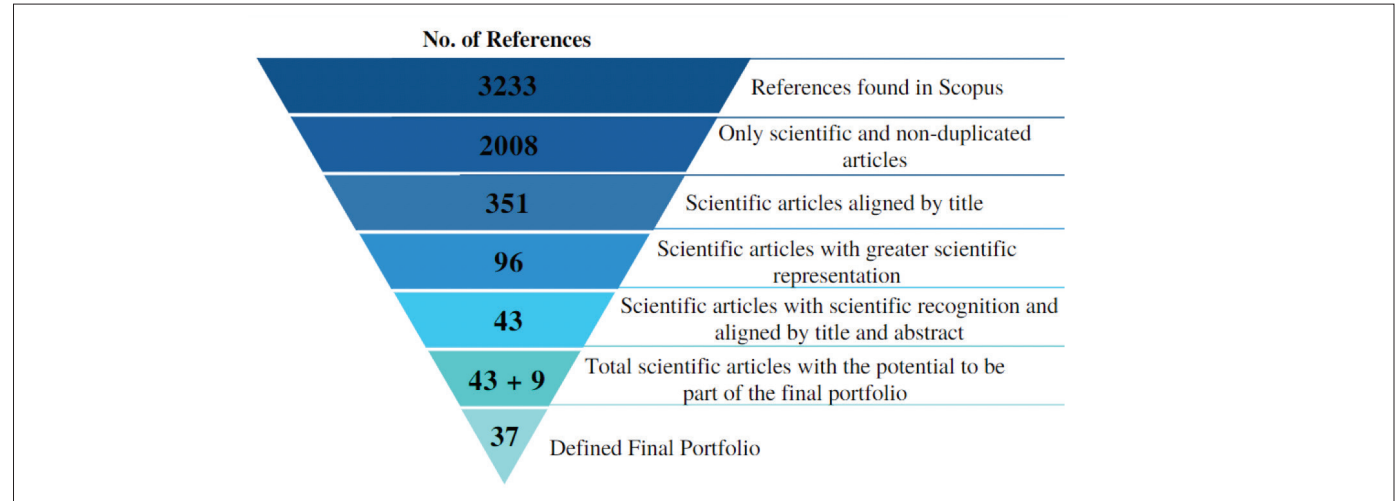
The final portfolio comprised 37 articles, as shown in Table 1.

Table 1: Presentation of the Bibliographical Portfolio (BP). (Source: Authors)

Rank	Citations (No.)	Reference
1	561	The evolution of entrepreneurial competencies: a longitudinal study of university spin-off venture emergence (Rasmussen et al., 2011)
2	367	Complements or substitutes? The role of universities and local context in supporting the creation of academic spin-offs (Fini et al., 2011)
3	347	Entrepreneurial origin, technological knowledge, and the growth of spin-off companies (Clarysse et al., 2011)
4	295	The influence of university departments on the evolution of entrepreneurial competencies in spin-off ventures (Rasmussen, Mosey, & Wright, 2014)
5	251	University technology transfer through entrepreneurship: faculty and students in spinoff (Boh et al., 2016)
6	242	How can universities facilitate academic spin-offs? An entrepreneurial competency perspective (Rasmussen & Wright, 2015)
7	220	Technology transfer offices and academic spin-off creation: the case of Italy (Algieri, Aquino, & Succurro, 2013)
8	195	A trajectory of early-stage spinoff success: the role of knowledge intermediaries within an entrepreneurial university ecosystem (Hayter, 2016)
9	179	Success factors of university-spin-offs: regional government support programs versus regional environment (Sternberg, 2014)
10	169	Institutional determinants of university spin-off quantity and quality: a longitudinal, multilevel, cross-country study (Fini et al., 2017)
11	161	The impact of university-based incubation support on the innovation strategy of academic spin-offs (Soetanto & Jack, 2016)
12	151	Are science parks and incubators good "brand names" for spin-offs? The case study of Turin (Salvador, 2011)
13	125	Can a magic recipe foster university spin-off creation? (Berbegal-Mirabent, Ribeiro-Soriano, & Sánchez García, 2015)
14	107	The effects of university rules on spinoff creation: the case of academia in Italy (Muscio, Quaglione, & Ramaciotti, 2016)
15	100	Creating entrepreneurial universities in an emerging economy: evidence from Brazil (Dalmarco, Hulsink, & Blois, 2018)
16	81	University support and the creation of technology and non-technology academic spin-offs (Meoli & Vismara, 2016)
17	79	Getting the right balance: University networks' influence on spin-offs' attraction of funding for innovation (Soetanto & Van Geenhuizen, 2015)
18	78	Characterization of university spin-off as a mechanism for technology transfer through a cluster analysis (Sánchez, Maldonado, & Velasco, 2012)
19	76	Technology transfer offices as boundary spanners in the pre-spin-off process: the case of a hybrid model (Huyghe, Knockaert, Wright, & Piva, 2014)
20	71	The determinants of academic spin-off creation by Italian universities (Ramaciotti & Rizzo, 2015)
21	69	Key resources and actors for the evolution of academic spin-offs (Fernández-Alles et al., 2014)
22	65	The development, growth, and performance of university spin-offs: a critical review (Mathisen & Rasmussen, 2019)
23	61	University spin-off's performance: capabilities and networks of founding teams at creation phase (Huynh, Patton, Arias-Aranda, & Molina-Fernández, 2017)

Rank	Citations (No.)	Reference
24	57	The emerging role of university spin-off companies in developing regional entrepreneurial university ecosystems: the case of Andalusia (Fuster, Padilla-Meléndez, Lockett, & del-Águila-Obra, 2019)
25	56	Brokering knowledge from universities to the marketplace: the role of knowledge transfer offices (Berbegal-Mirabent, Sabaté, & Cañabate, 2012)
26	56	A resource-based view of university spin-off activity: new evidence from the Spanish case (Pazos, López, González, & Sandiás, 2012)
27	53	Universities' institutional settings and academic entrepreneurship: notes from a developing country (Fischer, Moraes, & Schaeffer, 2019)
28	53	Evolving missions and university entrepreneurship: academic spin-offs and graduate start-ups in the entrepreneurial society (Marzocchi, Kitagawa, & Sánchez-Barrioluengo, 2019)
29	53	The university entrepreneur: a census and survey of attributes and outcomes (Marion, Dunlap, & Friar, 2012)
30	49	Opportunity recognition and international new venture creation in university spin-offs— cases from Denmark and Ireland (Hannibal, Evers, & Servais, 2016)
31	38	Which factors are perceived as obstacles for the growth of Italian academic spin-offs? (Galati, Bigliardi, Petroni, & Marolla, 2017)
32	23	Support for public research spin-offs by the parent organizations and the speed of commercialization (Slavtchev & Göktepe-Hultén, 2016)
33	19	Drivers, barriers and success factors of academic spin-offs: a systematic literature review (Hossinger, Chen, & Werner, 2020)
34	17	Open innovation in the public sector: resources and performance of research-based spin-offs (Venturini & Verbano, 2017)
35	13	University spin-off: a literature review for their application in Colombia (Castrillón Muñoz, Moro, Collazos, & López, 2019)
36	13	What matters: the formation of university spin-offs in Europe (Hunady, Orviska, & Pisar, 2019)
37	5	University entrepreneurial ecosystems and spinoff companies: configurations, developments and outcomes (Prokop, 2021)

The construction of a bibliographic portfolio (BP) that allows for theoretical support on the topic of academic spin-offs concludes the first macro-process of Proknow-C and achieves its first objective.

Therefore, the second objective is to perform a bibliometric analysis of this portfolio. Thus, in the next section, analyses motivated by the second macro-process of the tool are presented.

5. Results

5.1 Bibliometric Analysis of the Articles in the BP and their References
Bibliometric analysis was conducted on the articles in the BP, as well as the articles referenced in the BP, based on authors, journals, keywords, and citations. A comparative analysis was performed between BP and its respective references.

Thus, starting the analysis by examining the data that reflect the authors present in the BP, it is observed that two of the authors of the most prominent articles in scientific recognition (Table 1) also stand out when analysing the number of times they appear in the BP, namely, Mike Wright and Einar Rasmussen, with six and five contributions, respectively. When analysing the references of the articles in the BP, the author Mike Wright stands out again, with the contribution of 59 articles (Table 2):

Table 2: Most prominent BP authors and in BP references. (Source: Scopus and Authors)

Author	Affiliation	Representativeness in the BP references	Representativeness in BP
Wright, M.	Imperial College Business School	59	6
Clarysse, B.	ETH Zürich	22	1
Rasmussen, E.	Nord University Business School	15	5
Grimaldi, R.	University of Bologna	16	1
Knockaert, M.	Ghent University	15	1
Fini, R.	University of Bologna	13	2
Hayter, C.S.	Arizona State University	12	1
Sobrero, M.	University of Bologna	10	1
Vismara, S.	University of Bergamo	10	1
Mosey, S.	University of Nottingham	7	2

The author's significant contribution and prominence in the presented topic are demonstrated in quadrant A of Figure 4 and are highlighted both in the portfolio and references. This was followed by Quadrant B, the prominent author in the portfolio. It is worth mentioning that the highlighted authors have co-authorship work and are therefore of great relevance to the research topic. Quadrant C indicates other authors who are present in the BP and are cited in the BP references.

Figure 4: Relevance of authors in the Biography Portfolio in their references. (Source: Authors)
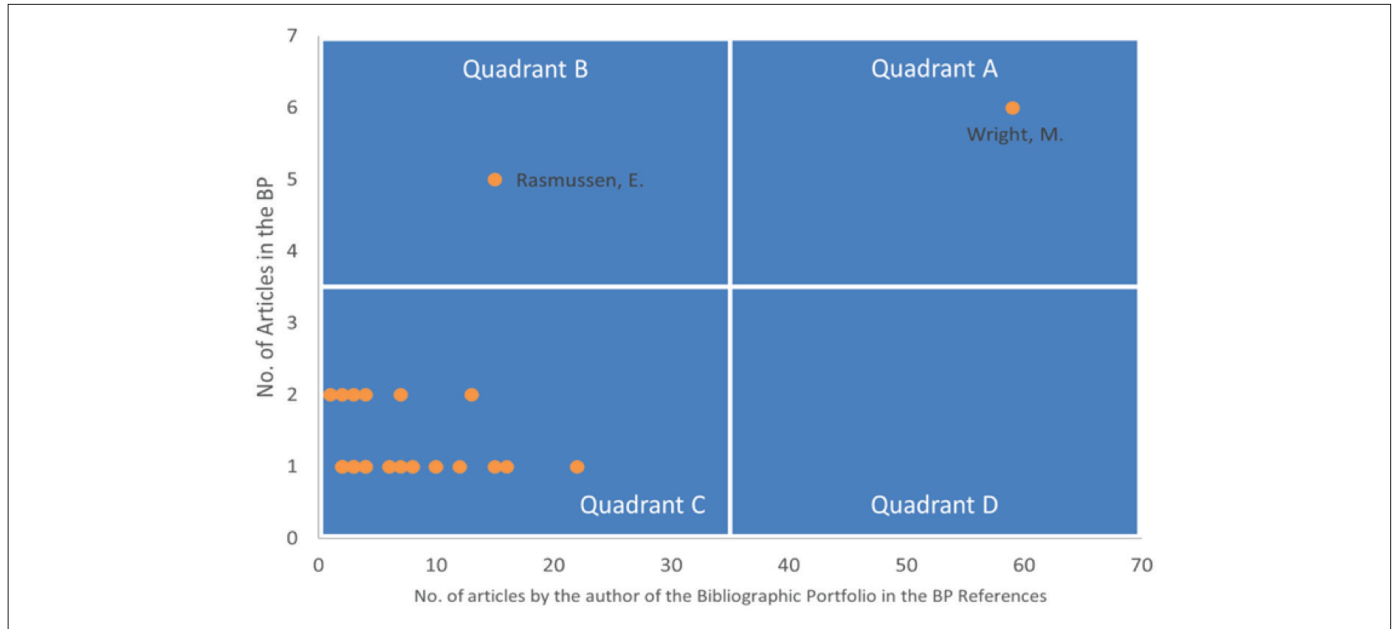

In this context, the relevance of collaborative work among prominent authors in this field can be perceived. Therefore, with the aid of VOS-viewer software (Van Eck & Waltman, 2010), Figure 5 displays the co-authorship relationship among the BP authors by grouping them into clusters based on the frequency with which they collaborate on articles and the network of co-authors they share.

Figure 5: Co-authorship relationship between portfolio authors. (Source: Authors)
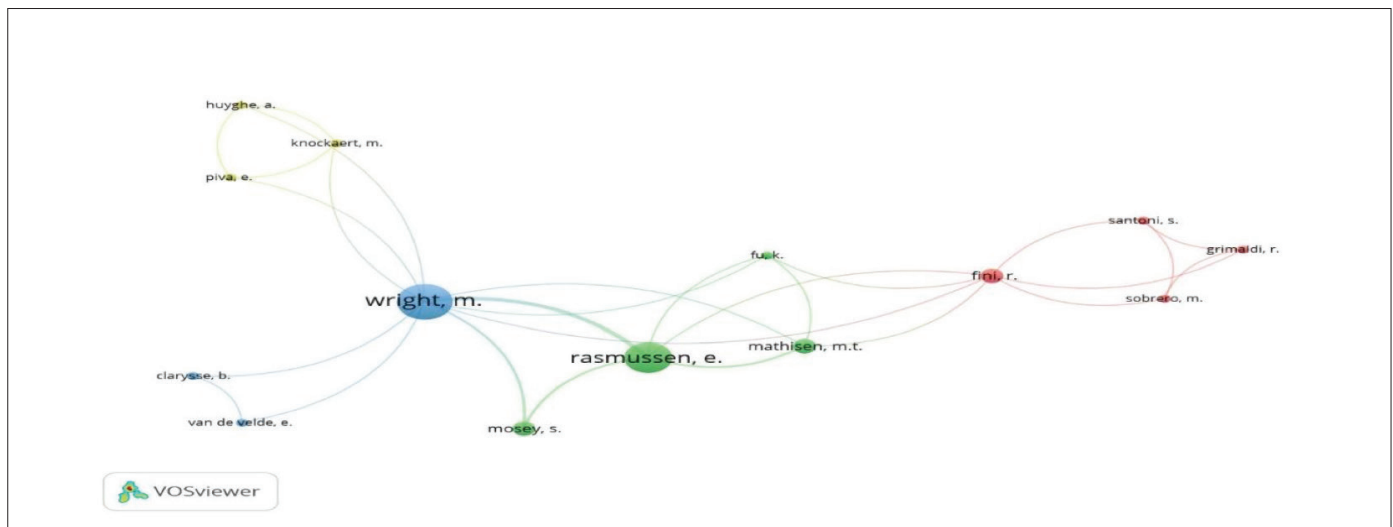
It is possible to identify, through colours, four relationship clusters present in the portfolio, suggesting the existence of four distinct groups of authors who have similar co-authorship patterns. This provides a useful view of the relationship between them by highlighting patterns and groupings that may not be obvious just by looking at the BP's list of names. Therefore, it was also possible to investigate the relationships between the keywords (PC) of the BP articles. Thus, Figure 6 presents the frequency of occurrence of each PC according to the size of the circle and the strength of association according to the proximity between them, resulting in six association clusters.

Figure 6: Portfolio keyword association. (Source: Authors)
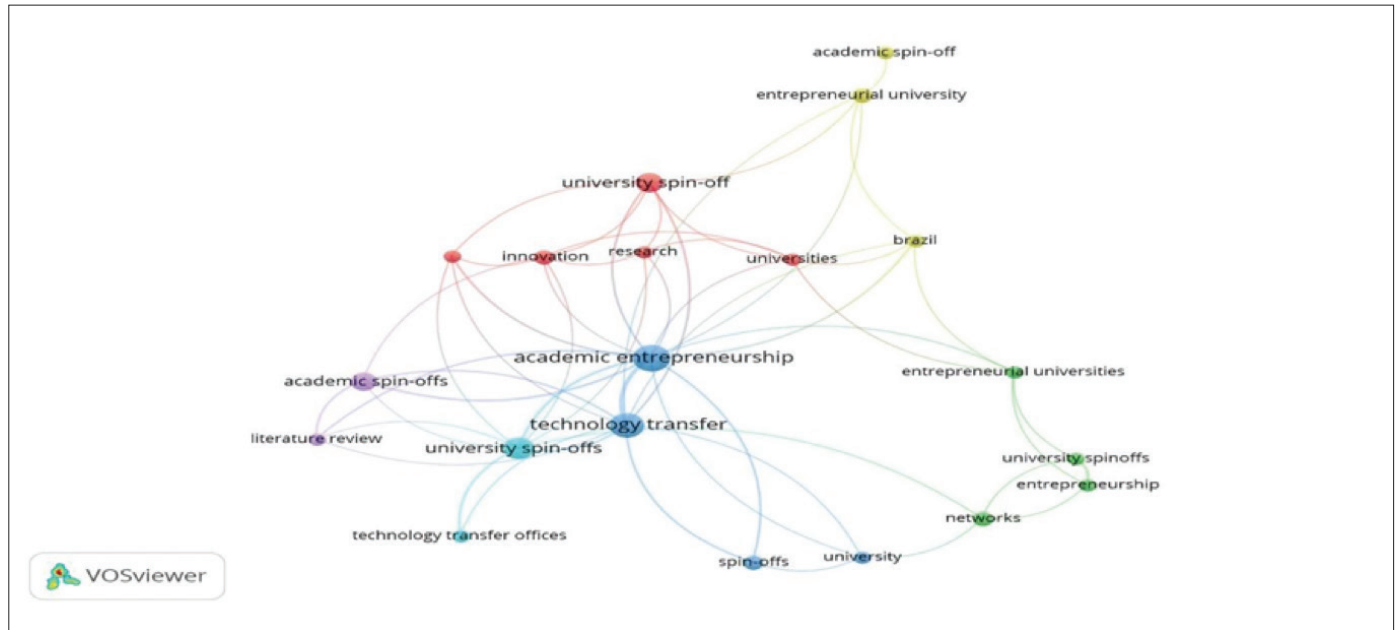
Each keyword is represented by a node (or point), and the lines (or edges) that connect the nodes indicate a strong co-occurrence relationship between the keywords; that is, if two or more keywords frequently appear together in article abstracts, it suggests that they are related. In this way, it was possible to identify 'Academic Entrepreneurship' as the keyword that appeared most frequently in searches for articles on the topic, with a strong relationship with technology transfer and university spin-offs, both with the highest highlights.

This finding suggests that the search for technology transfer through academic spin-offs is closely linked to the study of entrepreneurship in academia, corroborating the importance of the presented portfolio.

Therefore, this study identifies relevant journals that address the topic of university spin-offs. Table 3 displays the most contributing journals to the portfolio and the number of appearances in the references.

Table 3: Journals with the greatest representativeness. (Source: Authors)

Journals	Representativeness in the BP references	Representativeness in BP
Journal of Technology Transfer	132	8
Technovation	78	4
Small Business Economics	58	4
Research Policy	148	3
Technological Forecasting and Social Change	21	3
Revista Europea de Direccion y Economia de la Empresa	0	2
R and D Management	22	2
Journal of Management Studies	15	2
Journal of Business Research	13	2
Business Process Management Journal	0	1

The topic of academic spin-offs is mainly addressed by the *Journal of Technology Transfer*, quadrant A, as highlighted both in its bibliographic portfolio and references, followed by *Research Policy*, quadrant D, as a prominent element in the references, as shown in Figure 7.

Figure 7: Outstanding journals in the bibliographic portfolio and in their references. (Source: Authors)
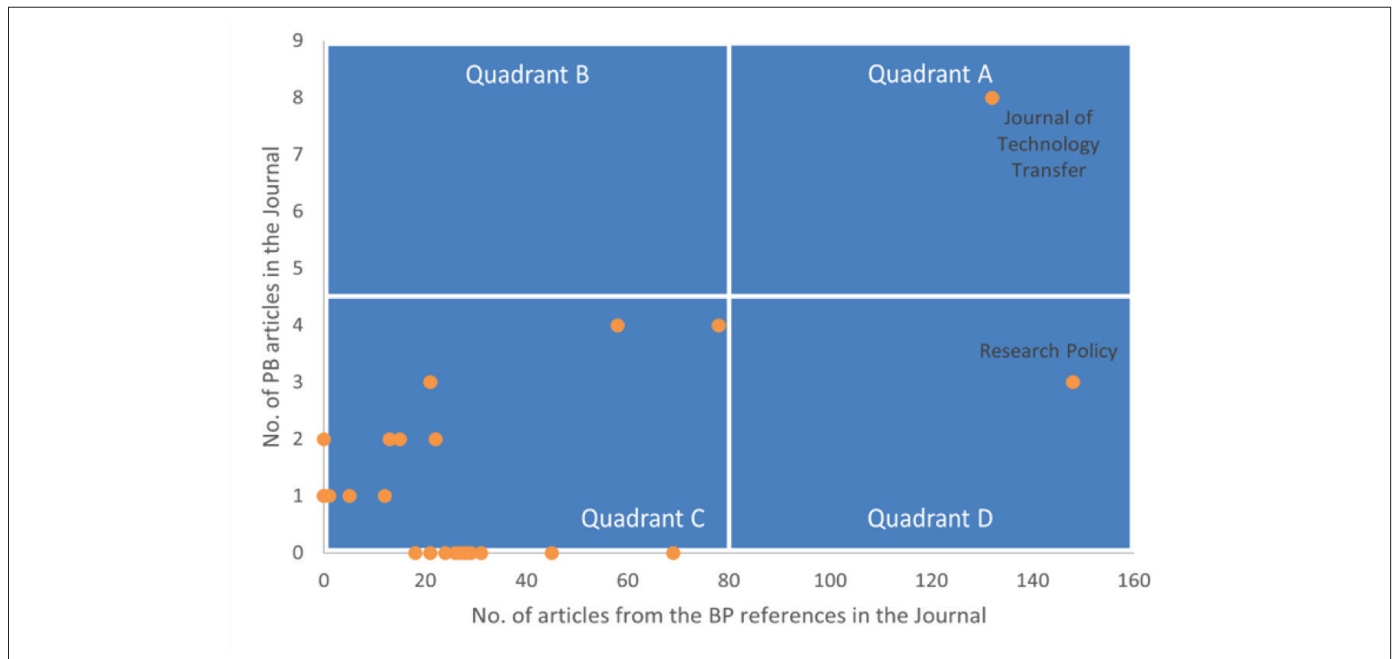
Finally, Figure 8 also displays, through quadrant separation, the results of the analysis of portfolio articles with higher academic relevance and prominence in the references. Quadrant A accommodates the articles with the highest potential to contribute to the research topic, with highlights including 'The evolution of entrepreneurial competencies: a longitudinal study of university spin-off venture emergence' (Rasmussen et al., 2011) and 'Entrepreneurial origin, technological knowledge, and the growth of spin-off companies' (Clarysse et al., 2011).

Figure 8: Articles and their Authors of the most outstanding BP. (Source: Authors)
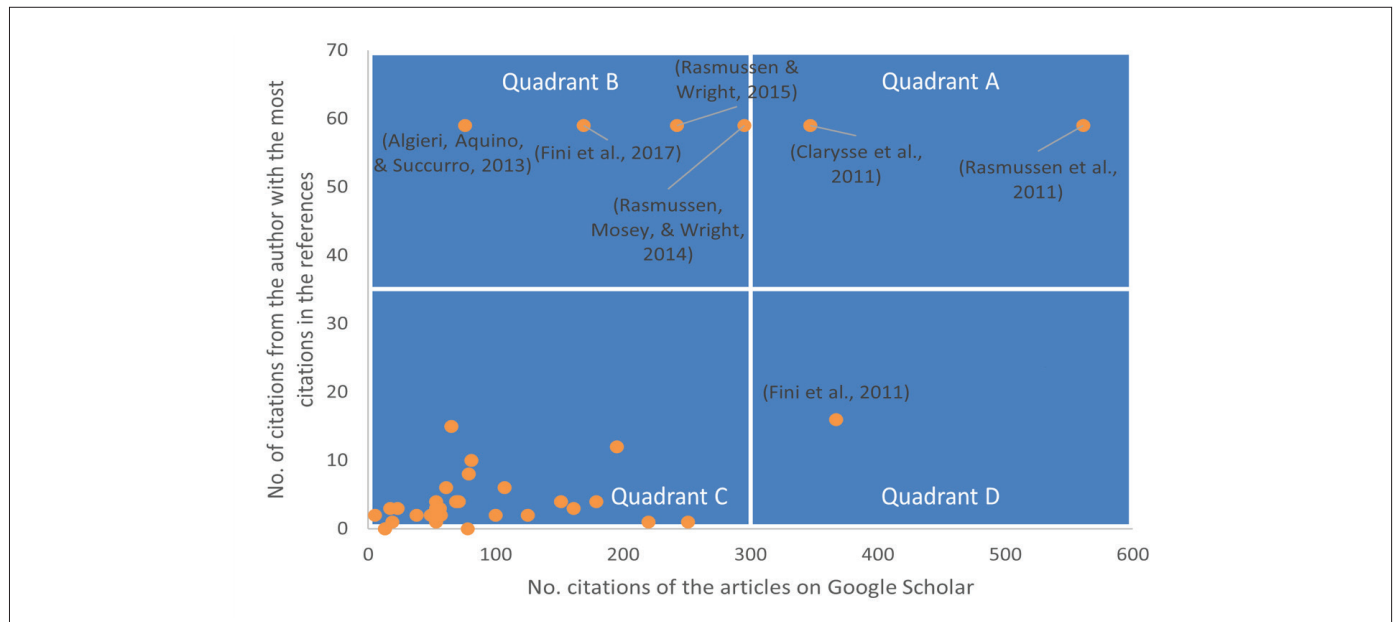
Among the top five, two were case studies (Rasmussen et al., 2011, 2014), two used institutional data (Clarysse et al., 2011; Fini et al., 2011), and one was a theoretical study (Rasmussen & Wright, 2015). Considering that identifying opportunities and threats can be a complex process in the context of spin-off management in which companies must be prepared to face challenges and unforeseen circumstances, portfolio texts provide a foundation and guidance.

For example, the most relevant study in the portfolio points to the possibility of identifying spin-off opportunities before making an

investment, which includes understanding the market, competitors, and trends, as well as assembling a qualified team and a solid business model. The study emphasises that despite the risks involved in managing spin-offs, it is possible to succeed by taking advantage of the right opportunities through the development of the crucial competencies identified in the study and with practical implications (Rasmussen et al., 2011).

The second most relevant text contributes to the perception of possible challenges that spin-offs face, making it possible to identify opportunities and threats for academic and corporate spin-offs. A comparison of the two shows that while broad technology can allow academic spin-offs to experiment in different markets, the novelty of technology can be a challenge for commercialisation. However, corporate spin-offs with narrower scopes of technology can focus on specific products and target markets, but the novelty of the technology may have a limited impact on growth. This suggests differences in management between commercial and academic spin-offs (Clarysse et al., 2011).

Therefore, the portfolio resulting from this study contributes relevant and prominent articles in the academic field, highlighting the importance of studies addressing identification and evaluation in the management of academic spin-offs.

6. Conclusions

Given the perspective for the development of academic spin-offs, with the purpose of building a theoretical basis that contributes to the theme and guiding researchers, academic managers, and business managers, the objective of this work concentrated on the identification and analysis of a portfolio of references, presenting a process for selecting the most relevant scientific articles on the topic, and a bibliometric study of them using the tool called Proknow-C.

Relevant works, authors, and journals were identified for the topic, starting with the identification of 3,233 works, resulting in a portfolio composed of 37 scientific articles after systematic selection, as shown in Table 1. The highlights identified in relation to the journals were the *Journal of Technology Transfer*, *Technology Technovation*, *Small Business Economics*, and *Research Policy*. Regarding the authors, the process highlighted Mike Wright, both for his contributions to the portfolio, with six articles, and for his prominence in the references, which is also well cited by other authors on the topic, as well as for having co-authorship with other authors who were relevant in this research, such as Einar Rasmussen, with five appearances in the portfolio, and Bart Clarysse, the second most prominent in the references. Ultimately, the articles 'The evolution of entrepreneurial competencies: a longitudinal study of university spin-off venture emergence' (Rasmussen et al., 2011) and 'Entrepreneurial origin, technological knowledge, and the growth of spin-off companies' (Clarysse et al., 2011) are the most academically relevant in terms of number of citations and are also by authors with the highest number of citations in the references of the articles selected in the final portfolio.

Finally, it should be noted that this analysis of the scientific production of academic spin-off management tends to contribute to the planning and optimisation of future research on the topic, not intending to determine a conclusive theoretical framework but to suggest a structured process for knowledge construction. For future agendas, it will be necessary to conduct a content analysis of the selected portfolios to identify possible gaps in the literature and research opportunities.

This research has limitations as it considers only scientific articles indexed in the Scopus database and dated between 2011 and 2021 in the Business, Management and Accounting category. It is also available in full format and has been identified in Google Scholar.

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