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SYSTEMATIC REVIEW ON ACADEMIC ENTREPRENEURSHIP INDICATORS

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Abstract

This study aims to explore and synthesize the academic entrepreneurship indicators that can be used by university institutions to understand their degree of development and maturities in supporting entrepreneurship processes. To this end, a systematic review is used to characterize the studies published in the last decade, the researchers who have led this research field, the adopted methodologies, and the structure and dimensions of indicators. The results allowed us to identify a set of 29 indicators distributed by 8 dimensions such as patents, university spinoffs, infrastructures, industry engagement, process creativity, process efficiency, process outcomes, and training. This study is innovative in focusing its analysis on academic entrepreneurship indicators. The knowledge of these indicators is relevant from a conceptual and practical perspective and will help universities to improve their technology transfer processes which will serve as a fundamental element in the implementation of the university's third mission.

Keywords: *entrepreneurship; technology transfer; third mission; entrepreneurial university; innovation*

JEL Codes: *L26, O32*

1. Introduction

The study of entrepreneurship has gained the interest of political agents, academic, and business community. According to Schumpeter (1934), entrepreneurship is directly linked to the economic development of a country, being a fundamental element in its economic growth. In this regard, increasingly financial programs have appeared to support the creation of new companies, which is mainly designed to assist the creation of new jobs for highly qualified young people. At the same time, companies look to entrepreneurship as a business strategy that aims at exploring opportunities and meeting customer needs in a creative, innovative, and sustainable way.

Universities traditionally focused on teaching and scientific research, in which the knowledge produced by the research was disseminated through teaching and

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academic publications, has gradually assumed an increasingly important role in society. With this, the concept of "entrepreneurial university" created by Etzkowitz (1993) arises, in which a series of changes in the relationship between universities and society are presented, emphasizing the role assumed by universities in the transfer of knowledge to the economy. According to this view, universities assume a more active role in the direct commercialization of research outcomes and emerge the appearance of several mechanisms for transferring knowledge to external entities. In this sense, universities assume a predominant role in the economic development of their region and in the dynamization of economic activity and attraction of talent.

One of the most recognized forms of technology transfer promoted by higher education institutions (HEIs) involves the creation of new companies, designated by various authors as academic spin-offs (Rasmussen, Mosey & Wright, 2011; Fini et al., 2011; Fayolle & Redford, 2015; Siegel & Wright, 2015). In this sense, the main adopted indicator is the number of academic spin-offs launched in the market. This indicator, despite its importance, is clearly incomplete and does not encompass all the efforts and results obtained by universities in this field. Therefore, this study intends to present a comprehensive overview map of the various dimensions involved in academic entrepreneurship. The manuscript is organized as follows: Initially, the process of performing the systematic review is described considering its various phases. After that, the results of this study are presented regarding the established research questions. Consequently, the results are discussed considering their relevance to understanding the phenomenon of academic entrepreneurship. Finally, the main results of this study are described, and their theoretical and practical implications are presented.

2. Methodology

The systematic literature review is one of the most widely known types of literature review and aims to summarize all existing information about a phenomenon in an impartial and complete manner. In contrast to the non-systematic process, a systematic review is done in a formal and meticulous form. According to Kraus et al. (2020), this means that researchers must follow the plan defined in the review protocol that is responsible for establishing the sequence of steps. The framework for conducting systematic literature reviews proposed by Xiao and Watson (2019) was adopted, which establishes a set of sequencing steps (e.g., specification of research questions, selection of primary studies, assess quality, synthesize data, report findings, among others) in three key phases (i.e., planning the review, conducting the review, and reporting the review). The following sections present the stages performed and describe the actions taken in each phase of this process.

2.1. Research questions

The following research questions that guide this study have been established:

RQ1: What studies have been published on academic entrepreneurship indicators?

RQ2: What is the adopted methodology?

RQ3: Which countries and researchers are leading this research?

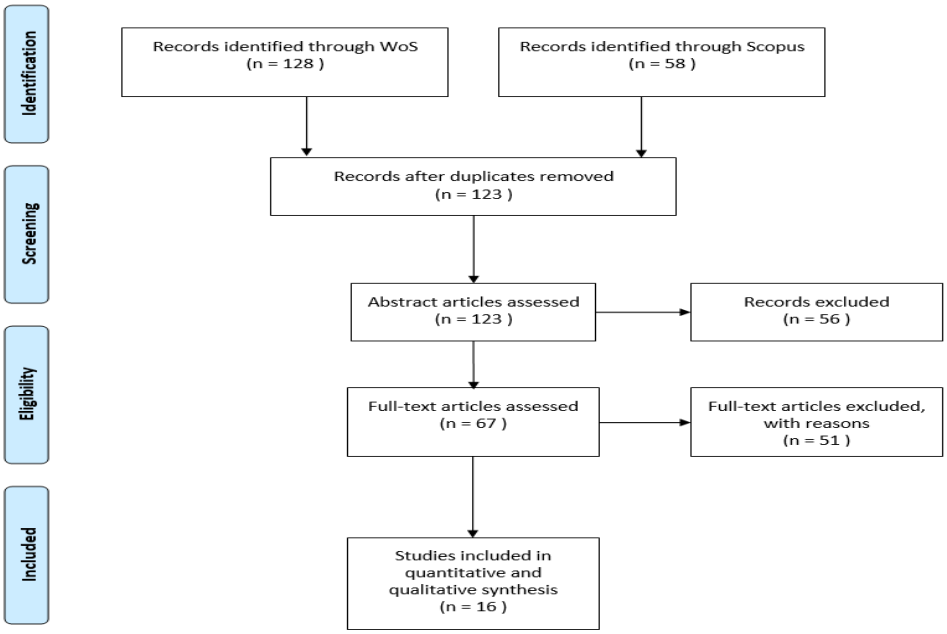
RQ4: What kind of indicators can be identified?

The established research questions are aligned with systematic reviews carried out in the entrepreneurship field such as Bazan et al. (2020), Champenois (2020), and Liñán and Alain (2015) in which the research questions drive the process of detailed analysis following a systematic review protocol using PRISMA as a framework to include, exclude and analyze the relevant studies. In this study, the same approach was adopted in which the relevance of each research question was previously evaluated. RQ1 is relevant to reveal the evolution of studies published in this area over the last decade; RQ2 allows exploring the methodologies used in these studies (e.g., quantitative, qualitative, mixed-methods, literature reviews, among others); RQ3 identifies the countries and researchers that have led this area of research, which is a piece of relevant information for the establishment of future research partnerships; and RQ4 is key to identifying the typologies and characteristics of each indicator.

2.2. Protocol development

Xiao and Watson (2019) protocol was used in the process of identification, collection, and analysis of the studies considered in the systematic review. This protocol comprises a set of eight sequential steps that include: (i) formulate the problem; (ii) develop and validate the review protocol; (iii) search the literature; (iv) screen for inclusion; (v) assess quality; (vi) extract data; (vii) analyze and synthesize data; and (viii) report findings. Xiao and Watson (2019) recommend that in the process of identifying the studies to be included in the systematic review, the title, abstract, keywords and full-text should be carefully analyzed. Figure 1 presents the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), in which the number of studies included and excluded in each phase is indicated.

Figure 1. PRISMA diagram



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A total of 123 publications were identified after the removal of published studies that are simultaneously indexed on the Web of Science and Scopus. After that, the abstract was analyzed to ensure that the studies specifically address academic entrepreneurship metrics. 56 articles were excluded because they address other topics such as the entrepreneurial education process or the economic impact of an HEI entrepreneurial. After this step, there were 67 articles for full-text analysis, of which 51 papers/chapters were excluded for discussing the topic of the entrepreneurial university, but not presenting specific indicators to measure its performance. In the end, a total of 16 studies were considered, respectively: Astebro et al. (2017), Bai and Han (2017), Choudhry and Ponzio (2019), Hayter et al. (2018), Henrekson and Sanandaji (2019), Holgersson and Aaboen (2019), Lai et al. (2017), Marzocchi et al. (2019), Matt and Schaeffer (2018), Mehlhorn et al. (2015), Secundo and Elia (2014), Siegel and Wright (2015), Skute (2019), Sungur and Zararci (2018), Tseng and Raudensky (2014), and Vinig and Lips (2015).

2.3. Inclusion and exclusion criteria

Only scientific studies published in the last decade (i.e., from January 1, 2010 to December 31, 2019) have been included. Only studies published in or translated into English have been considered. Also included were only peer-reviewed studies published in journals, national/international conferences, and book chapters indexed

by the Web of Science and Scopus (regardless of quartile). Gray literature of scientific articles without peer review and indexed by other bibliographic indexers were excluded. Duplicate studies (e.g., indexed simultaneously by the Web of Science and Scopus were also excluded. Dissertations and theses were also excluded. Finally, all studies published before 2010 were ignored.

2.4. Data collection and search terms

All publications were collected from September 21, 2020 to November 9, 2020. The publications were mapped in an Excel file. In the first phase, the collected studies were analyzed considering the title, abstract, and keywords. After that, and only the studies that passed this 1st phase were analyzed considering their full-text. After that, and in a 2nd phase only the relevant studies on academic entrepreneurship indicators were considered. For each of these publications, the following information was collected: (i) identification of the authors considering their name, affiliation, and country; (ii) the title of the article; (iii) the title of the scientific journal, conference or book where it was published; (iv) the year of publication; (v) the scientific indexer; (vi) the type of study (i.e. qualitative, quantitative, mixed-methods, and literature review); and (vii) quality evaluation. Furthermore, a summary of the main conclusions of the study and its academic entrepreneurship metrics was also performed. Four teams of three students/researchers in the field of entrepreneurship and innovation participated in this process of collecting and evaluating scientific publications.

The research strategy considered the combination of three groups of keywords: (i) academic and university; (ii) entrepreneurship; and (iii) indicators, measures, indexes, and benchmarks. This combination of keywords resulted in eight search terms: (i) academic entrepreneurship indicators; (ii) academic entrepreneurship measures; (iii) academic entrepreneurship indexes; (iv) academic entrepreneurship benchmarks; (v) university entrepreneurship indicators; (vi) university entrepreneurship measures; (vii) university entrepreneurship indexes; and (viii) university entrepreneurship benchmarks.

2.5. Quality assessment

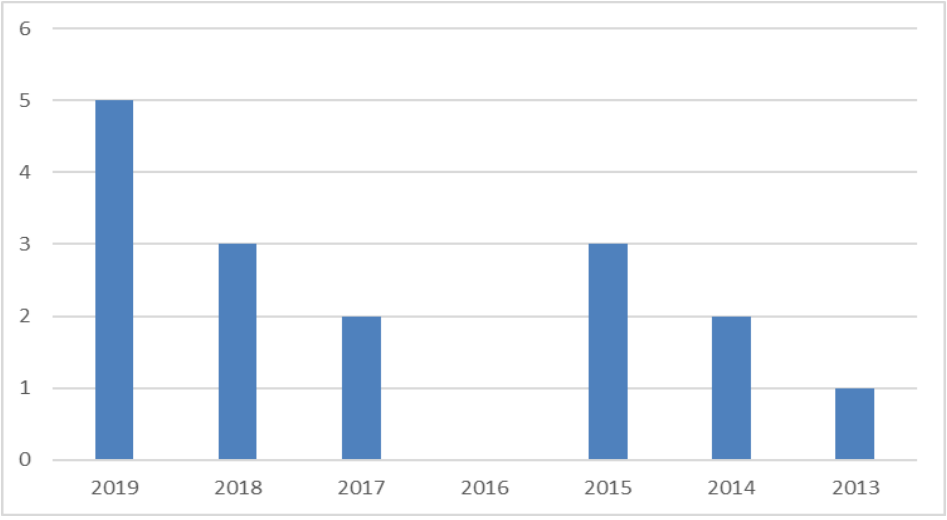
The involvement of a total of 12 students/researchers allowed the process of data collection and evaluation of each study to be distributed. Each study was evaluated by two different teams using a three-level Likert scale (not adequate, undecided, adequate). In case of disagreement in the evaluations, a third team is involved to eliminate inconsistencies. In assessing the quality of each study, the recommendations of Xiao and Watson (2019) were followed, in which the accuracy of the methodology adopted and its theoretical and practical relevance in identifying measures to evaluate the process of academic entrepreneurship undertaken by HEIs were evaluated. All studies with an average evaluation below 50% were rejected.

3. Results

3.1. RQ1: What studies have been published on academic entrepreneurship indicators?

Figure 2 shows the evolution of the number of publications in the last decade on academic entrepreneurship indicators. The first study on the subject appears only in 2013. From this year on there has been a gradual growth in the number of publications until 2015. However, in 2016 it was not identified any publication in the area, appearing again growth in the number of publications in a sustainable way from 2017. The year 2019 is the one with the highest number of publications, representing more than 30% of publications in the last decade. Furthermore, most of the publications are published in indexed scientific journals: 14 of the publications are in scientific journals, while only 2 of them are in national and international conferences. No book chapter type publications were found.

Figure 2. Evolution of publications



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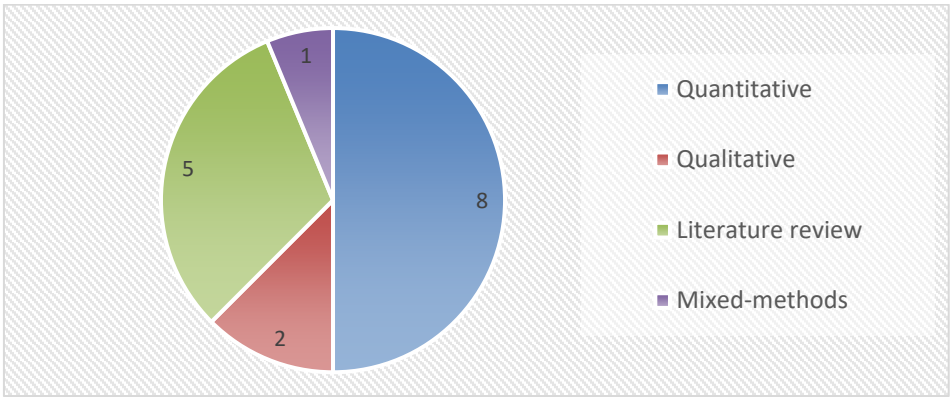
3.2. RQ2: What is the adopted methodology?

Figure 3 concisely shows the distribution of the studies considering the methodology adopted. Four types of methodologies were identified: (i) quantitative; (ii) qualitative; (iii) literature review; and (iv) mixed-methods.

Figure 3. Distribution of methodologies



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The quantitative methodology is the methodology that has been most used in studies published in the field. Half of the published studies apply quantitative methods for data exploration. Several approaches have been used as regression analysis, factor analysis, and meta-data analysis. The use of quantitative methodology has allowed studies to use local panels of data from several educational institutions in which the efficiency of technology transfer processes is assessed. This knowledge has been used to improve policies to support the launch of new academic spin-offs and to improve the processes of teaching entrepreneurship.

Secondly, the literature review is a methodology that has been used to understand the academic entrepreneurship ecosystems. However, contrary to this study, these literature reviews do not specifically focus on indicators of the academic entrepreneurship process but focus their analysis on understanding the characteristics of entrepreneurs and the entrepreneurial university. Several methods are applied like the grounded-theory and benchmarking.

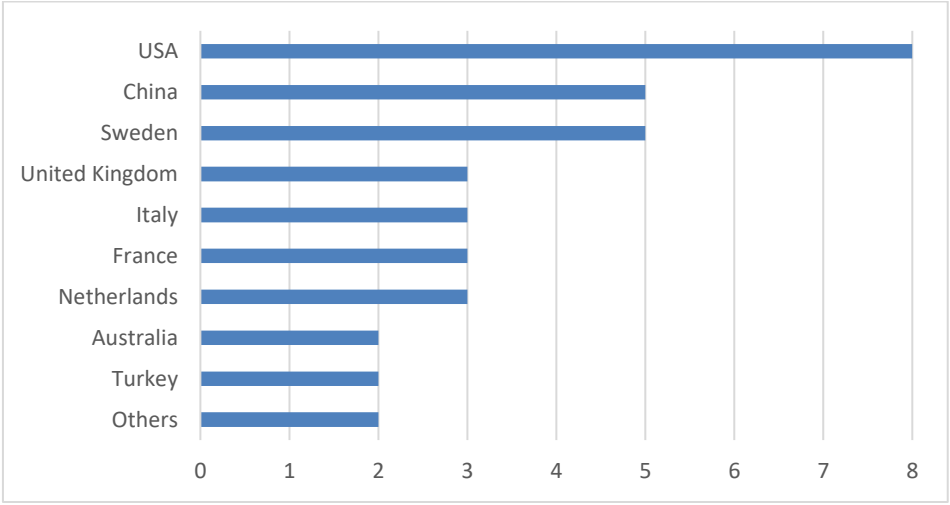
Finally, and with less representativity, qualitative and mixed-methods methodologies emerge. The qualitative methodologies apply the case studies and focus group methods. These approaches become useful to understand the phenomenon considering the unique aspects of each university and research center. Mixed-methods allow combining quantitative and qualitative techniques in a single study. Only the study by Mehlhorn et al. (2015) complements the quantitative analysis of a survey distributed among university agricultural programs in the USA, Australia, and New Zealand with a qualitative study that explores several strategies to improve entrepreneurship programs.

3.3. RQ3: Which countries and researchers are leading this research?

Figure 4 shows the countries that have led this line of research. The USA stands out as the country that involves the greatest number of studies in this field, followed

by China and Sweden. Interest in this phenomenon does not appear to be concentrated in a single country but is distributed in a relatively balanced way among the various geographical areas. Overall, Europe has more published studies than the USA and China as a whole. The researchers involved in this area of science have been quite diverse, there is not any researcher with more than one publication in the area. In this sense, it is confirmed that there is no geographical concentration in the analysis of this research theme.

Figure 4. Geographical distributions



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3.4. RQ4: What kind of indicators can be identified?

A total of 29 indicators aggregated by 8 dimensions were identified in Figure 5. The patents dimension includes indicators related to the process of new patents granted and transferred to the business sector. The university spinoffs dimension provides a diverse set of metrics related to the number of spinoffs created from the university. However, not only the total number of spinoffs is relevant, but it is also important to understand the profitability of these spinoffs considering a distinct set of elements such as turnover, market share, created new jobs, among others. The infrastructure dimension looks at the physical structures that are made available to support entrepreneurial activity such as technological labs, incubators, and science parks. The industry engagement dimension explores the role of the relationship with the business fabric through four metrics: (i) Cooperative Research and Development Agreements (CRADAs); (ii) User Facility Agreements (UFAs); (iii) publications with industry partners; and (iv) consulting services. The training dimension considers that it is equally important to look at the role of the entrepreneurial educator. Several

indicators can be identified. From one perspective, indicators on the number of existing courses and the number of participants in each of these courses arise, but also indicators that seek to understand the dynamics of this training, particularly in exploring the multidisciplinary dynamics of teams and the increase in risk-taking propensity. Finally, three dimensions emerge related to the various phases of the entrepreneurial process from creativity, efficiency, to outcomes. In creativity, metrics related to the innovative ideas and inventive concepts emerge; in efficiency, we find transaction times, time needed to find a licensee (TNFL), and bureaucratization level; and, in outcomes, we have research projects, prototypes, pilot applications, and number of products and services developed.

Figure 5. Academic entrepreneurship indicators

Source: Own source

4. Discussion

Patents are widely highlighted in the literature as key elements to protect inventions and ensure technological development (Crass et al., 2019; Rockman, 2020). The protection of intangible assets has gained increasing prominence and not only manifests itself at the time of protection of the invention but can be fundamental to know what can be explored and how it can be exploited. A simplistic way to evaluate the success of a patenting process is through its acceptance ratio (Choi et al., 2015; De Beer, 2016; Horner, 2014). However, as Holgersson and Aaboen (2019) point out, this single metric does not allow us to understand the phenomenon of intellectual property rights by not exploring how the transfer technology offices manage intellectual property or support inventors. In this sense, complementary metrics like filing ratio and transfer ratio have emerged that allow increasing visibility on the various phases of the licensing process from patent filing to licensing and commercial exploitation.

The number of university spinoffs launched by each university is an indicator that has also gained quite notoriety (Hunady et al., 2019; Mathisen & Rasmussen, 2019; Miranda et al., 2018). It is an indicator that has become more important as the 3rd mission of the university has consolidated itself in scientific circles. The link to society and the economic role of universities is nowadays recognized as a relevant element that can complement university funding (Berghaeuser & Hoelscher, 2020; Compagnucci & Spigarelli, 2020; Rubens et al., 2017). Several indicators are used in this dimension and exploit the results obtained by these spinoffs such as turnover, market share, and number of created jobs. In particular, the latter indicator has a double effect since, according to Scholten et al. (2015), spin-offs are able to attract qualified employees from universities. Consequently, they also act as tools for the advanced training of students and facilitate their integration into the labor market. Another highly relevant indicator associated with the results obtained by academic spin-offs is their survival rate. Furthermore, another relevant indicator is related to the process of financing start-ups. The way these companies can attract external funding is also another indicator that allows us to gauge the economic impact of spin-offs on society. There are also indicators related to infrastructures for the process of creation and development of technology and spin-offs. The technological labs emerge as central elements in technology research and development, often assuming the commitment to advise the government in scientific areas for the preparation of public policies (Osorio et al., 2019). Incubators are relevant elements to encourage entrepreneurial activity by supporting the development of new businesses in a technical and managerial way (Carrasco & Aceytuno, 2015; Hess & Siegwart, 2013). Finally, and in a more mature phase, the science parks host technological start-ups in an environment of great proximity and sharing of resources among the start-ups hosted there. Lamperti et al. (2017) point out that science parks are instruments that

facilitate technological policies associated with innovation policies that foster synergies between business, government, and educational institutions.

Besides the traditional processes of creating an academic spin-off, other forms of technology and knowledge transfer emerge. In the systematic review process carried out, two authors stand out who explicitly address this issue and present specific indicators. Choudhry and Ponzio (2019) suggest the measurement of the number of CRADA and UFA. Hayter et al. (2018) present two other metrics related to the consulting services performed and the number of publications with industry partners. Although scientific production is a widely recognized indicator in the 2nd mission of universities, this new approach is distinct in emphasizing that it is important to distinguish publications that are made in conjunction with industry partners. This suggestion is in line with the model advocated by Bentley et al. (2015), in which the importance of universities combining basic and applied research is highlighted.

Indicators were also identified that analyze the process of academic entrepreneurship. At this level Secundo and Elia (2014) present indicators related to the analysis of creativity and outcomes of this process. Creativity is seen in entrepreneurship as an indispensable element. According to Fillis and Rentschler (2010), this relationship is driven by entrepreneurship to provide the creation of a product or service to solve some problem or facilitate the lives of its consumers. The outcomes are also important elements to understand how the processes of technology transfer are effective in the emergence of research projects, prototypes, and pilot applications. These elements are also fundamental to understand how the innovation process has generated results for organizations (Almeida et al., 2019). Besides analyzing the effectiveness of these processes, Choudhry and Ponzio (2019) argue that the efficiency of these processes should also be explored, thus giving rise to indicators related to TNFL and debureaucratization of technology transfer processes.

Finally, indicators emerge that explore the functioning of the processes of teaching entrepreneurship. Entrepreneurial education has been an emerging area of training offered by universities (Aadland & Aaboen, 2020; Linton & Klinton, 2019). If compared to the traditional educational model, whose main concern is the teaching of curricular contents, the training focused on entrepreneurship provides the student with complementary skills that make the individual more competitive in the corporate world. Therefore, entrepreneurial education does not exclusively seek to develop new entrepreneurs. Almeida and Amaral (2019) state that entrepreneurial education allows the development of skills to adapt to new situations and fosters the autonomy, strategic vision, persistence, and proactivity of students. Besides basic indicators related to the number of courses and participants in this field, other indicators suggested by Marzocchi et al. (2019) like the team dynamics and risk-taking propensity also emerge. The way in which these indicators can be measured becomes more complex, often being collected from surveys or semi-structured interviews.

5. Conclusions

The analysis of the phenomenon of academic entrepreneurship is a relatively recent topic, and therefore the first study that explicitly presents a proposal for indicators to measure the performance of universities in this field appeared only in 2013. Countries such as the USA, China, and Sweden that have stood out as the most-innovative economies have taken the lead in this area of research by conducting essentially quantitative studies that aim to understand the performance of technology transfer processes on a national, regional, or local scale.

Although the number of spin-offs and patents launched by each university is the most prevalent indicator, it is important to highlight the role those other complementary indicators can play in characterizing academic entrepreneurship processes. In this sense, it has been proposed indicators that seek to characterize the existing infrastructures to support entrepreneurs (e.g., technological labs, incubators, and science parks). Knowledge and analysis of the technology transfer process emerge as a pillar for the emergence of new indicators that allow us to characterize this phenomenon according to the perspectives of creativity, outcomes, and efficiency. The relationship and proximity with the industry have also served a field that has led to the emergence of indicators such as CRADA, UFA, publications with industry partners, and consulting services. Finally, the relevance of entrepreneurship education for universities has also served the emergence of indicators relating to the success of entrepreneurship education considering multiple perspectives such as the number of courses, number of participants, team dynamics, and risk-taking propensity.

This study offers both theoretical and practical contributions. In the conceptual dimension, this systematic review of the literature has enabled the synthesis of a diverse and complementary set of indicators that characterize academic entrepreneurship. This information is of great relevance to university institutions and technology transfer offices that can use these indicators to assess the degree of maturity of their processes in the academic entrepreneurship field. As a result, it is possible to define quality policies that enable institutions to diversify their sources of funding and increase their visibility at an international level. However, this study presents some limitations that it is relevant to recognize. First, the local context of each of these indicators is not explored, which may become more relevant in the specific context of each university. Secondly, the relative importance of each of these metrics for universities, polytechnics, or research centers is not specified. Finally, no specific and detailed information is given on how each of these metrics can be calculated. In this sense, and as future work, we consider that it is relevant to explore this topic so that associated with each indicator there may be a set of metrics and benchmarking.

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