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Entrepreneurial decision making in academic spinoffs: a bibliometric map and research agenda

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ABSTRACT

In recent decades, universities have put considerable emphasis on their 'Third Mission' and have thus expanded their portfolio of core activities to include activities related to university-industry collaboration and science commercialisation. An important mechanism to implement the university's third mission is the creation of academic spinoffs that are start-ups based on research produced at universities and other public research institutions. Research on academic spinoffs has thus experienced significant growth, and several literature reviews have sought to map the often-fragmented knowledge in this topic area. Yet, we still lack an overview of the decision making of academic entrepreneurs and relevant stakeholders – an overview that is of paramount importance in the effort of scholars and policy-makers to understand what drives the creation of (more) academic spinoffs that have good chances of surviving and thriving. This paper is based on 60 papers published during the period 2003–2021 and provides a comprehensive overview of all topics covered in the body of literature on the entrepreneurial decision making of academic spinoffs, by identifying the most salient topics, papers, and trends within this literature. Our analysis shows that the literature on the topic clusters around four macro-areas: contextual factors, spinoff development and performance, nascent academic entrepreneurship, and science parks. Our study further compares and contrasts our findings with the highly influential framework for entrepreneurial decision making of Shepherd, Williams, and Patzelt [2015. "Thinking About Entrepreneurial Decision Making: Review and Research Agenda." *Journal of Management* 41 (1): 11–46] and proposes future research directions in light of the unique characteristics of academic entrepreneurs and academic spinoffs.

KEYWORDS

Academic spinoffs; decision making; entrepreneurship; bibliometric analysis; systematic literature review

Introduction

In recent decades, the traditional role of universities has substantially changed due to the growing importance of the knowledge economy (Clark 1998) and the ever-pressing grand societal and environmental challenges. In line with the Triple Helix thesis (Etzkowitz 2008; Etzkowitz and Leydesdorff 2000), universities have launched their 'Third Mission' to complement their core teaching and research activities with activities related to university-industry collaboration and the commercialisation of scientific discoveries (Arroyabe, Schumann, and Arranz 2022; Etzkowitz and Leydesdorff 2000;

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McAdam, Miller, and McAdam 2018; Padilla-Meléndez and del-Aguila-Obra 2022). In particular, creating start-ups based on research from universities and other public research institutions – i.e. academic (or university) spinoffs – is considered an important mechanism for commercialising research (Fini et al. 2017; Mathisen and Rasmussen 2019) with significant benefits for the economy, the society, and the environment (Compagnucci and Spigarelli 2020; Fini et al. 2018). The creation, development, and performance of academic spinoffs have, thus, attracted considerable interest among scholars and policy-makers (Fini et al. 2017) and review papers have sought to provide an overview of research efforts in the field (e.g. Mathisen and Rasmussen 2019; Miranda, Chamorro, and Rubio 2018; Nikiforou et al. 2018). For instance, Mathisen and Rasmussen (2019) outline the diverse outcomes used in the literature to assess the development, growth, and performance of academic spinoffs, as well as the determinants of these outcomes. Nikiforou et al. (2018) narrow down their focus on the role of teams in academic spinoffs, given that this type of start-ups are typically team-based ventures rather than solo ventures.

However, despite the merits of prior research, we lack an overview of how the aforementioned aspects are tied to the decision making of academic entrepreneurs and relevant stakeholders, such as university departments, technology transfer offices (TTOs), and policy-makers. Providing such systematisation is important since there are a variety of stakeholders involved in academic spinoff creation, as well as fluidity in the transition between the academic and the commercial setting (Fini et al. 2019) – rendering the decision making in academic spinoffs distinct from that in other entrepreneurial settings. Therefore, the purpose of our study is to provide an overview of the state of the field, by performing bibliometric analysis and review of the literature on the decision making in academic spinoffs. This contributes to the systematisation of the current knowledge in this context that offers a unique setting for entrepreneurial endeavours. Most importantly, we will propose directions for future research that will guide scholars in their research and will also help policy-makers to re-design their policies in a way that fosters the creation of academic spinoffs and increases their success potential.

Theoretical background

To assess the state of the field and propose a research agenda on entrepreneurial decision making in academic spinoffs, we draw upon the highly influential framework that Shepherd and co-authors (2015) developed for entrepreneurial decision making. Shepherd et al.'s framework includes seven dimensions. Four of the dimensions are related to key entrepreneurial activities and decisions: (1) the *opportunity assessment decision*, (2) the e*ntrepreneurial entry decision*, (3) the *decision about exploiting opportunities*, and (4) the *entrepreneurial exit decision*. The remaining dimensions are related to (5) the *heuristics and biases* that may guide the decision-making process of entrepreneurs, (6) the *characteristics of the decision makers*, and (7) the *environment as an entrepreneurial decision context*. Combining this framework with our literature review and bibliometric analysis will not only allow us to point out which research areas remain underdeveloped in the decision making of academic spinoffs but will also indicate how the broader research on entrepreneurial decision making can benefit and learn from this unique context of academic spinoffs (Fini et al. 2019).

Methods

Our paper aims at providing a comprehensive, yet succinct, knowledge map of extant research investigating entrepreneurial decision making in academic spinoffs. In particular, such a knowledge map will provide an overview of what we know (i.e. the main findings of extant research) and what we still do not know and is worth knowing (i.e. future research directions). In so doing, we have built upon best practices in systematic literature reviews and bibliometric studies and combined the two methodologies to achieve simultaneously breadth and depth of the analysis. Although the simultaneous use of these two complementary methods has been recently introduced, it has already been

validated in several studies (Dabić et al. 2020; Caputo et al. 2018, 2021). Its strength lies in the fact that it allows researchers to investigate a topic in depth through a systematic literature review while maintaining a wider picture of the evolution of knowledge through the bibliometric analysis.

Search protocol

Consistently with the systematic review method (Tranfield, Denyer, and Smart 2003), we formed a panel of experts to define: the field of research, the keywords of the search string, the database, and the set of inclusion and exclusion criteria. We followed then a step-by-step process to identify the final dataset of papers for the review.

Step 1. We adopted the database Web of Science (WoS) Core Collection® (research areas 'Business Economics' and 'Psychology'), after some alternative searches in Scopus and EBSCO because it retrieved a better sample of high-quality articles representative of the research published to date. The choice of Web of Science (WoS) Core Collection® is also supported and validated as appropriate for the field of inquiry by recent bibliometric studies (Caputo et al. 2021).

Step 2. We then developed a wide search string based on multiple layers of keywords (Caputo et al. 2016) to ensure capturing the most relevant papers on the topic. The first layer included the keywords pertaining to the type of the organisation being investigated and it included the keywords: 'spinoff* OR spin-off* OR spin off* OR spinout* OR spin out* OR spin-out* OR entrepreneur* OR founder* OR start?up* OR ventur*'. The second layer included the nature of the venture, and included the keywords 'academic* OR universit*'. The keywords used in these layers are in line with prior studies in the field of academic spinoffs (e.g. Nikiforou et al. 2018). The third layer included the theoretical domain of analysis, and included the keywords 'decision* OR judg* OR inference* OR preference*' and was based on Shepherd, Williams, and Patzelt (2015). The search was run with Boolean operators (AND OR) via the TS command, which searches among Title, Abstract, Author Keywords, and Keywords Plus®. Consistently with best practices in bibliometric research and to ensure comparability among the indicators, the year 2022 was excluded.

Step 3. Due to the wideness of the search string, and the different meanings given to keywords across multiple fields, we proceeded to the 'cleaning' of the dataset. First, we adopted a set of inclusion criteria, retaining only peer-reviewed articles in the areas of Business Economics, Management or Business, published in the English language and included in the Social Science Citation Index (SSCI). The search resulted in a first sample of 293 papers.

Then, we independently read all the titles, keywords, and abstracts of these papers to eliminate those that were clearly not relevant to our research. When it was not possible to assess the relevance from this initial reading, we obtained a digital copy of the full text of the paper. We followed two iterations of this process, resolving conflicting individual categorisations by making a joint decision. Following these criteria, 233 papers were eliminated because they touched upon the topic of interest in a trivial manner or not at all. For instance, some of the papers used the word 'academic' to refer to academic interest in a certain topic rather than to an academic type of start-up. The process resulted in a final dataset of 60 papers.

Analyses

The final dataset of 60 papers was used as a basis for both the bibliometric analysis and the qualitative systematic literature review to develop a comprehensive map of the knowledge in the field. Bibliometrics is a widely-used form of analysis which is a subset of scientometrics and applies statistical methods to the study of scientific activities in a specific scientific community (e.g. Dabić et al. 2020). Examples of bibliometrics are citation analyses, co-citation analyses, citation networks, and productivity analyses. For the purpose of this study, we conducted a performance analysis based on indicators of activity. These indicators provide data about the volume and impact of research during a given timeframe via word frequency analysis, citation analysis, and counting publications

by the unit of analysis (e.g. authorship, country, affiliation, etc.). We also adopted the Sankey Diagram to indicate the relationship between authors, keywords, and journals (Shi et al. 2020). Finally, we employed bibliographic coupling of published articles to organise the dataset by topics, enabling us to identify clusters of articles representing an area of interest (Jarneving 2007). The Bibliometrix package in R (Aria and Cuccurullo 2017) was used to calculate the bibliometric indicators and provide the graphic representation of the networks.

After having identified the clusters with the bibliographic coupling, each article from the dataset was read in full and analysed qualitatively, consistent with best practices in systematic literature reviews (Pittaway and Cope 2007; Barclay et al. 2011). Each article was coded, tagged and grouped to confirm its allocation to the cluster based on its content. The process was dynamic, allowing new tags to be included during the process of reading articles. This also allowed flexibility in categorising information and reducing biases that may arise from a rigidly pre-set system (Bartolacci, Caputo, and Soverchia 2020; Dabić et al. 2020).

Results

Description of the dataset

The dataset for this study contains 60 papers, published from 2003 until 2021 in 25 journals. Articles were on average published for 7.53 years and have been cited on average 44.03 times. The dataset comprised 3,523 cited references. Articles expressed 261 unique Keyword Plus and 184 unique Author's keywords. Considering that each article has usually 4–6 keywords, these numbers show the fragmentation of the literature and the use of a variety of keywords representing the same area of study. The articles are authored by 147 authors, predominantly working in teams (only 5 articles were single-authored). The Collaboration Index is 2.58, calculated as the total of authors of multi-authored articles by the total of multi-authored articles (Koseoglu 2016). Table 1 provides the descriptive statistics of the dataset.

Figure 1 shows consistent scientific production from our dataset.

In terms of journals, 25 unique outlets have published the 60 papers in the dataset. Figure 2 shows the 10 most relevant journals considering the number of articles published. The *Journal of Technology Transfer* and *Research Policy* can be considered the core sources according to the Bradford's Law (Bradford 1934). These two journals are also the most cited, with 196 and 531 citations respectively, making *Research Policy* the more influential journal outlet in terms of citations per document.

Looking at the authors, Table 2 shows the list of the 20 most cited authors from the dataset.

Table 1. Descriptive statistics of the dataset.

Description	Results
Timespan	2003:2022*
Journals	25
Average years from publication	7.53
Average citations per document	44.03
Average citations per year per doc	3.88
Cited references	3523
No. of Keywords Plus	261
No. of Author's Keywords	184
Authors	147
Authors of multi-authored documents	142
Single-authored documents	5
Authors per Document	2.45
Collaboration Index	2.58

Notes: *our search string excluded articles published in 2022. However, some records were published online first in 2021, but with issue number in 2022. We retained these records.

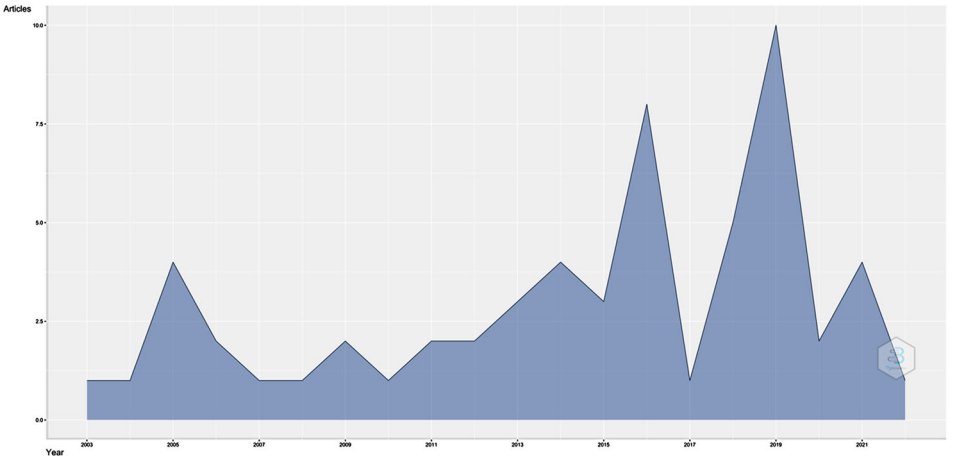

Figure 1. Number of papers published per year.

Looking at the scientific production per country, it can be noted that the field has consolidated mostly in the United Kingdom, the United States, and Italy (Table 3).

Sankey Diagram: relationship among authors, keywords, journals, and citations

A Sankey Diagram depicts flows of any kind, where the width of each flow pictured is based on its quantity. It is conventionally utilised to represent the flows of energy or materials in several networks and procedures, and it has been increasingly employed in bibliometric studies to represent the relationships among bibliographic categories (Shi et al. 2020). The diagrams of rectangular shape are used to represent pertinent elements with various colours. The rectangle's height indicates the relationship among multiple features, such as countries, sources, prominent authors, and author-keywords. The larger the size of the rectangle, the more relationships exist between various components. A Sankey Diagram has been constructed to show the evolution of relationships among authors, keywords, and journals.

Figure 3 shows the relationships between the authors (left), the keywords (middle), and the sources/journals (right). The analysis identified which Keywords Plus in the dataset were used

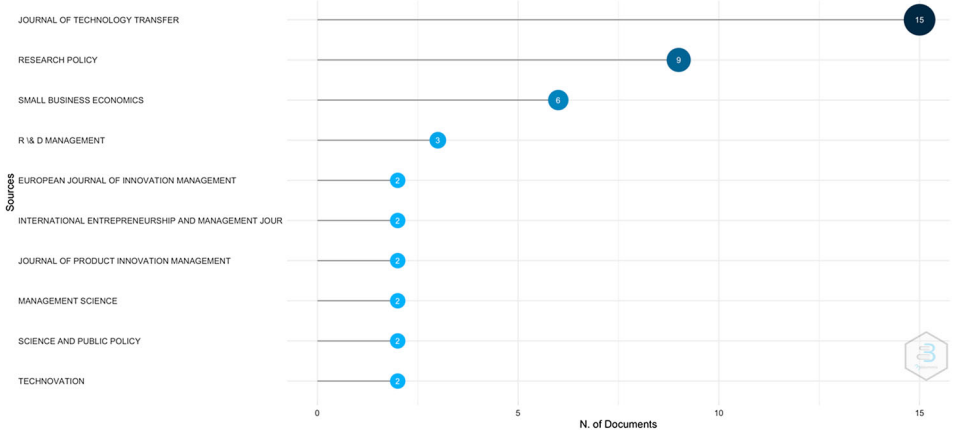

Figure 2. Most relevant journals.

Table 2. Top 20 most cited authors.

Author	Citations	Papers	H index[1]	G index[2]	M index[3]	PY start[4]
WRIGHT M	772	4	4	4	0.211	2004
LOCKETT A	599	2	2	2	0.105	2004
VOHORA A	533	1	1	1	0.053	2004
DEBACKERE K	367	1	1	1	0.056	2005
VEUGELERS R	367	1	1	1	0.056	2005
CLARYSSE B	329	3	3	3	0.167	2005
SALTER A	205	1	1	1	0.083	2011
TARTARI V	205	1	1	1	0.083	2011
LOWE RA	172	1	1	1	0.059	2006
ZIEDONIS AA	172	1	1	1	0.059	2006
GRIMALDI R	157	3	3	3	0.214	2009
BUCK T	137	1	1	1	0.067	2008
FILATOTCHEV I	137	1	1	1	0.067	2008
LIU X	137	1	1	1	0.067	2008
FINI R	135	2	2	2	0.143	2009
SOBRERO M	129	1	1	1	0.071	2009
MORAY N	88	1	1	1	0.056	2005
EL-GANAINY A	66	1	1	1	0.063	2007
MOSEY S	66	1	1	1	0.071	2009
PIVA E	66	1	1	1	0.071	2009

Notes: [1]The Hirsch index (H-index) is a journal's (or author's) number of published articles (h), each of which has been cited in other articles at least h time (Hirsch 2005).
[2] '… the highest number g of papers that together received g^2 or more citations' (Egghe 2006, 1).
[3] '… the median number of citations received by papers in the Hirsch core' (Bornmann, Mutz, and Daniel 2008, 832).
[4]Publication year.

most frequently. The investigation of the top authors, keywords and journals indicated that the top authors have all contributed to the main topics, such as technology transfer, performance of academic spinoffs, innovation and knowledge creation, and commercialisation. Looking at the right side of the figure, it can be shown that *Research Policy* seems to focus on topics such as commercialisation, university strategies, firms-industry dynamics, and knowledge transfer, while the other journals have adopted a broader scope.

Identification of thematic clusters by coupling

To identify the thematic clusters, the bibliographic coupling technique was adopted (Jarneving 2007). A bibliographic coupling analysis examines the reference lists of documents to identify where articles share a common reference. The degree of overlap between the articles' reference lists represents the strength of the connection between them. A great overlap means that two documents share a large proportion of references, and thus a greater probability that the content is

Table 3. Country's scientific production.

Country	Articles	Frequency	SCP[1]	MCP[2]	MCP Ratio[3]
UNITED KINGDOM	14	0.2333	5	9	0.643
USA	11	0.1833	9	2	0.182
ITALY	10	0.1667	8	2	0.2
GERMANY	4	0.0667	2	2	0.5
NETHERLANDS	4	0.0667	2	2	0.5
BELGIUM	3	0.05	2	1	0.333
CHINA	3	0.05	3	0	0
SPAIN	3	0.05	3	0	0
CANADA	2	0.0333	0	2	1
FRANCE	2	0.0333	0	2	1

Notes: [1] Intra-country collaboration.
[2]Inter-country collaboration.
[3]Inter-country collaboration ratio, % of inter-country collaborations over the total production.

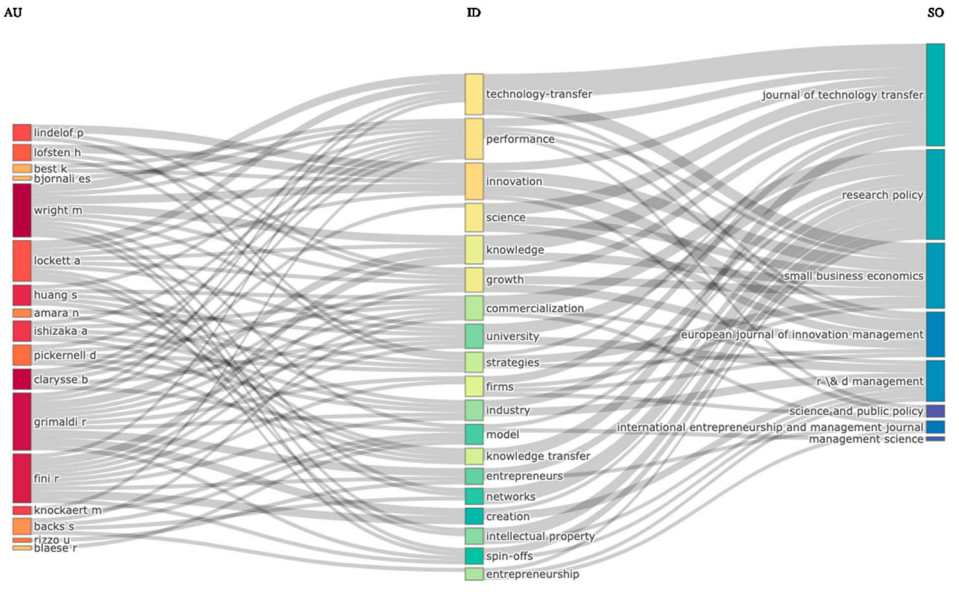

Figure 3. Sankey Diagram.

focused on related topics. Conversely, a little overlap indicates that the documents are based on distinct pieces of literature, with few commonalities. Therefore, the bibliographic coupling is among the techniques used to organise published articles by topics, enabling the identification of articles within a given area of interest. Figure 4 shows the network structure of the four identified clusters and how published articles are allocated.

The identified clusters were then qualitatively analysed to identify their thematic content. A systematic review was, thus, performed, as described in the following.

A systematic review of the thematic clusters

Cluster 1. Contextual factors

The principal focus of this cluster is on the contextual factors that may affect the decisions and attitudes of academics to engage in entrepreneurial activities. Extant research assesses an array of factors that belong to the traditional layers of a social science analysis: (i) the *macro* level, which refers to structural and institutional factors (e.g. the higher education sector, national context, or regional context), (ii) the *meso* level, which refers to organization-level factors that characterise the parent institution and its departments, and finally, (iii) the *micro* level, which focuses on the impact of the elements belonging to the aforementioned levels on academic entrepreneurs and decision makers.

In relation to the first level, the creation of academic spinoffs may be stimulated by the structural conditions of the (academic) job market for Ph.D. holders. For example, Rizzo (2015) highlights that the funding constraints of the higher education system, limited job alternatives, and the presence of public policies supporting the creation of science-based start-ups favour the creation of academic spinoffs. Similarly, regional factors are used to assess the impact of academic spinoffs and to guide the university decision makers in the allocation of resources. Academic spinoffs can arguably create value and wealth for the region and communities, creating, thus, a virtuous learning loop for the university and fertilising a scientific atmosphere in the region (Mariani, Carlesi, and Scarfò 2018). However, Calcagnini et al. (2016) partially challenge the benefits of the university's Third Mission

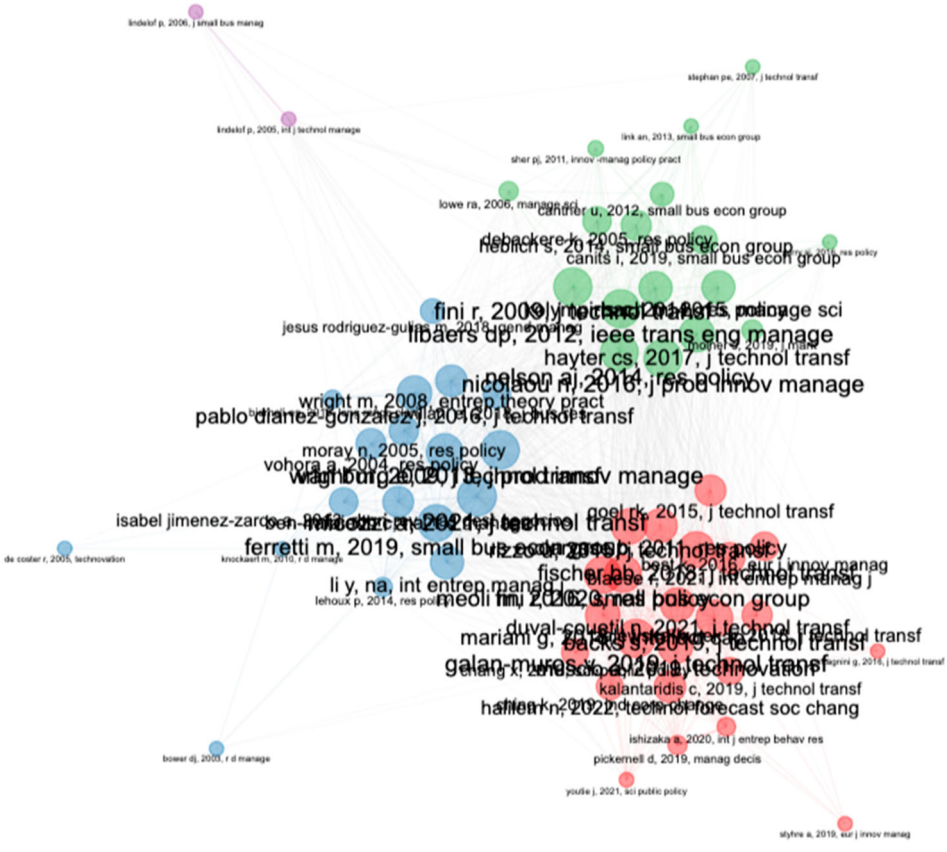

Figure 4. Network visualisation of bibliographic coupling of articles.

(such as academic spinoffs) that has a surprisingly weak impact on increasing the rate of start-up creation within a region.

The meso level is the most inquired. As previous research has shown (e.g. Mathisen and Rasmussen 2019), the university context is an important nurturing environment for academic spinoffs. Studies have examined different elements, such as the administrative support offered to academics (Meoli and Vismara 2016), the existence of university policies to regulate these activities (Fini, Grimaldi, and Meoli 2020), and the quality and composition of university-industry relationships (Fischer et al. 2018; Ishizaka et al. 2020). Furthermore, the decision of an academic to licence an invention is not only related to the TTO's strategies and personal commitment (Chang, Chen, and Fong 2015), but also to the national intellectual property (IP) transfer regime (Kalantaridis 2019). Finally, research has analysed the role of formal training and education that can be offered to academics to support their decisions and start-up processes (Duval-Couetil, Ladisch, and Yi 2021; Youtie, Kwon, and Woo 2021). For example, Youtie, Kwon, and Woo (2021) present a training programme (I-Corps) at the Georgia Institute of Technology that helps academic entrepreneurs in finding suitable market applications or else, terminating venture projects with no strong value.

Organisational factors can also be understood in terms of (informal) social pressure and contamination among peers. For instance, Backs, Günther, and Stummer (2019) show that patenting and creating an academic spinoff to exploit such patents depend on peer pressure and on the communication taking place in an academic department, in addition to individual preferences and characteristics. However, Clarysse, Tartari, and Salter (2011) suggest that the individual-level characteristics of academics, such as entrepreneurial capacity and previous entrepreneurial experience, are much

stronger predictors of spinoff creation than social influences and the provided organisational support.

Perhaps not surprisingly, the impact of organisational factors on spinning out depends on the characteristics of the individual academics. For example, doctoral students are strongly influenced by their organisational surroundings. The decision of doctoral students to found a spinoff is encouraged by the existence of dedicated university policy frameworks, the applicability of the doctoral research to industry, their previous collaboration with the industry, as well as the formal education in entrepreneurship they had during their Ph.D. (Muscio and Ramaciotti 2019). Furthermore, the level of the founder's seniority has been found to influence the type of start-up created. Student-led academic spinoffs prefer a more open-innovation-oriented approach and early market entry, contrary to senior researchers that prefer a strategy of control through IP rights (Ching, Gans, and Stern 2019).

Furthermore, contextual factors strongly affect spinoff creation when the gender of academics is considered (Goel, Göktepe-Hultén, and Ram 2015). Case in point, female academics engage less in entrepreneurial activities, compared to their male counterparts, even when other individual characteristics are comparable and environmental conditions are similar (Halilem, De Silva, and Amara 2022). This may be so because entrepreneurial activities, in general, and those of academic entrepreneurs, in particular, are typically associated with the male gender, thus making them less appealing to female academics (Best et al. 2016).

The last level of analysis, i.e. the micro level, highlights how individuals perceive their environment and how these perceptions influence their decisions. For example, academics who couple a perceived organisational autonomy with the necessity for a strategic interdependence with the private sector are more likely to engage in knowledge exchange and entrepreneurial activities (Zalewska-Kurek et al. 2018). Another factor could be the job (dis)satisfaction that they experience, as job (dis)satisfaction has been argued to moderate the relationship between individual factors and entrepreneurial intentions and entry decisions (Blaese, Schneider, and Liebig 2021). Furthermore, when involved in an academic spinoff, academics often have the perception of working in a stimulating environment and for a meaningful purpose, overshadowing the downsides of venturing, such as high uncertainty and lower levels of compensation (Styhre and Norbäck 2018).

Cluster 2. Spinoff development and performance

Studies in this cluster have predominantly focused their attention on the effect of the characteristics of the entrepreneurial decision makers and of those of their environment on the development and performance of academic spinoffs. This is in line with previous reviews on academic spinoffs that have underlined the dominance of input–output empirical models in the field (Mathisen and Rasmussen 2019; Nikiforou et al. 2018) and provides evidence to the notion that early decisions about the composition of academic spinoffs will have an imprinting effect on firm outcomes (Colombo and Piva 2008). For instance, the proportion of non-academics to academics in a spinoff team has been linked to the entrepreneurial orientation (Diánez-González and Camelo-Ordaz 2016) and the performance of the spinoffs (Ferretti et al. 2019; Ben-Hafaïedh, Micozzi, and Pattitoni 2018). Aside from the characteristics of academic entrepreneurs, the context, in which academic spinoffs are created and operate, also has an influential role in the development of spinoffs in several ways (Moray and Clarysse 2005; Wright et al. 2009). For instance, the presence of a public research institution (such as the university TTO) in the extended entrepreneurial team can moderate the relationship between team composition (e.g. teams composed of academics only, practitioners only, or a mix of academics and practitioners) and firm commercial performance (Ben-Hafaïedh, Micozzi, and Pattitoni 2018).

Interestingly, a few studies have turned their attention to the decision making of externals to the university constituents, such as financial providers (e.g. banks and VC investors), when they are faced with the decision to provide funding to an academic spinoff (De Coster and Butler 2005; Knockaert et al. 2011). For example, Knockaert and co-authors (2010) have examined the selection behaviour of

VC investors in this context, and have identified three types of investors: those who focus on the human capital (people investors), those who focus on the technology (technology investors), and those who focus on the financial aspects of academic spinoffs (financial investors).

Finally, some studies – that are also the most cited papers in the cluster – have examined key decisions that are made at different stages of the entrepreneurship process (Bower 2003: Lehoux et al. 2014; Wright et al. 2008; Vohora, Wright, and Lockett 2004). For instance, Vohora, Wright, and Lockett (2004) explore how academic spinoffs transition from one developmental phase to the next, and highlight that each phase is characterised by an iterative process of development that may require revisiting some of the earlier decisions and activities.

Cluster 3. Nascent academic entrepreneurship

This cluster primarily focuses on the aspects of the entrepreneurial entry decision of academics (Fini, Grimaldi, and Sobrero 2009; Link and Welsh 2013), such as their decision to locate the spinoff in the parent university's home region (Heblich and Slavtchev 2014), the decision of scientists to leave academia to concentrate fully on the spinoff compared to staying affiliated with the university (Nicolaou and Souitaris 2016), as well as the decision of junior scholars to engage in entrepreneurship as a founder versus a joiner, or not at all (Roach and Sauermann 2015). Taken together, these studies highlight that the entrepreneurial entry decision is multifaceted and influenced by several individual- and environmental-level factors.

At the individual level, several characteristics of the academics, as well as heuristics and biases, have been identified to play a role. For instance, risk aversion has been linked to female scientists affecting their entrepreneurial activity (Stephan and El-Ganainy 2007), while risk tolerance has been strongly associated with the interest of science and engineering PhD candidates in becoming start-up founders (Roach and Sauermann 2015). Furthermore, the influence of demographic characteristics (Link and Welsh 2013), personal-related benefits, such as personal earnings and reputation (Fini, Grimaldi, and Sobrero 2009), gender (Stephan and El-Ganainy 2007), and neurodiversity (Canits et al. 2019) on entrepreneurial entry and entrepreneurial preferences have been studied.

At the environment level, studies have also examined a range of contextual factors: from the more proximal departmental and university context, such as TTOs, to the more distal national level, such as national funding (e.g. Fini, Grimaldi, and Sobrero 2009; Debackere and Veugelers 2005). Interestingly, research has also highlighted the importance of academics' perceptions of institutional support and departmental norms towards entrepreneurship, as perceptions of a situation can be more closely related to behaviour than the actual situation (Nicolaou and Souitaris 2016).

Cluster 4. Science parks

In addition to cluster 1 on contextual factors, a fourth cluster has emerged that focuses specifically on the context of science parks, indicating that papers belonging to the latter cluster are based on distinct pieces of literature and highlighting the importance of this contextual factor. Specifically, the focal cluster is composed of only two papers that compare and contrast academic spinoffs with corporate spinoffs that are located in science parks (Lindelöf and Löfsten 2005, 2006). Drawing upon the systematic differences that often characterise these two types of new technology-based firms, the studies explore the different types of support that science parks provide to academic spinoffs, compared to corporate spinoffs, as well as differences in firm employment, sales, and growth. Notably, the importance of science parks for the decision to start a firm is quite high for both corporate and academic spinoffs (52.9% and 66.7% respectively), but even more so for those originating from academia.

Setting a research agenda

Following the review of each cluster, we applied an established method to create an interpretative framework (Pellegrini et al. 2020) that will form the base for a future research agenda. As premised, we used the dimensions of the entrepreneurial decision-making framework of Shepherd, Williams, and Patzelt (2015) to examine how these dimensions have been studied in academic spinoffs. In Table 4, we present, in a summative way, the level of attention that each cluster has paid to the dimensions of Shepherd et al.'s framework.

This visual representation has helped us to identify research gaps that are important to examine, and thus to propose some future research directions. This is not to say that future research should focus only on dimensions that have received little attention so far. These dimensions may indeed be uncharted territories for future research, serving for completely explorative research (Pellegrini et al. 2020). Yet, there are also still pressing questions concerning the other dimensions of an exploitative nature, as the challenges of academic entrepreneurs and technology transfer intermediaries, and the interpretation of the literature on academic spinoffs reveal (e.g. Mathisen and Rasmussen 2019; Nikiforou et al. 2018).

Finally, it is important to note that our research agenda is far from exhaustive and that further research in this topic area will likely lead to the restructuring of the thematic areas and the generation of possibly new aggregations into clusters.

Future research related to Cluster 1. Contextual factors

There are several ways to move forward in the academic debate on the contextual factors of academic entrepreneurship. Following the thematic analysis of the cluster, interesting theoretical investigations can be conducted at the three levels of analysis, i.e. macro, meso, and micro, in relation to the entrepreneurial exit of academic entrepreneurs and the use of heuristics and biases – dimensions largely neglected in this cluster (see Table 4). For instance, future research could seek to explain how contextual (institutional and organisational) factors may foster overconfidence, self-serving, or other types of bias that often characterise entrepreneurs (Shepherd, Williams, and Patzelt 2015). In a positive light, there is also the possibility to examine whether and how organisational and possibly institutional factors stimulate fast and frugal heuristics (Gigerenzer and Gaissmaier 2011) that can be employed to evaluate and exploit opportunities.

In addition, there is a dearth of studies in this cluster examining the impact of contextual factors on the entrepreneurial exit decision. This is not trivial, as public funding and other types of support can exert significant influence on the decision of academic entrepreneurs to continue or terminate their business activity.

Finally, scholars can examine how individuals with certain characteristics perceive the contextual factors and, in turn, how this perception influences their entrepreneurial decision making. While

Table 4. Interpretative framework – Level of attention per dimension.

	Cluster 1. Contextual factors	Cluster 2. Spinoff development and performance	Cluster 3. Nascent academic entrepreneurship	Cluster 4. Science parks
Opportunity assessment decisions	High	Medium	Low	Low
Entrepreneurial entry decisions	Medium	Low	Medium	High
Decisions about exploiting opportunities	High	Low	Low	Low
Entrepreneurial exit decisions	Low	Low	Low	Low
Heuristics and biases in the decision-making process	Low	Low	Low	Low
Characteristics of the entrepreneurial decision maker	Medium	High	Medium	Medium
Environment as entrepreneurial decision context	High	Medium	Medium	High

there is already such type of inquiry related to the gender of academics (e.g. Goel, Göktepe-Hultén, and Ram 2015; Halilem, De Silva, and Amara 2022) and their seniority (Ching, Gans, and Stern 2019), there are also other individual characteristics of interest. For instance, scholars can explore how demographic characteristics, neurodiversity, or disability play a role in this regard (Canits et al. 2019; Link and Welsh 2013). Finally, as suggested by Galan-Muros and Davey (2019), future research could adopt a more holistic approach that can simultaneously address all three layers of analysis.

Future research related to Cluster 2. Spinoff development and performance

Future decision-making research in academic spinoffs should put more emphasis on the fact that spinning out can be a lengthy process with many critical junctures that academic entrepreneurs need to overcome before they move from one developmental phase to the next (Vohora, Wright, and Lockett 2004). This opens the path for many interesting research questions, especially pertaining to entrepreneurial heuristics and the entrepreneurial exit decision that have been significantly understudied. For instance, scholars can examine to what extent academic entrepreneurs employ heuristics, as well as what type of heuristics, across the different stages of spinoff development. Detailing the use of heuristics employed by entrepreneurs that Shepherd, Williams, and Patzelt (2015) have proposed is particularly important in the context of academic spinoffs. This is because academic entrepreneurs – especially the ones working in the STEMM academic disciplines – have a strong science identity (Jain, George, and Maltarich 2009) that may make it more difficult for them to apply decision-making shortcuts, compared to non-academic entrepreneurs. In addition, scholars can examine the entrepreneurial exit decisions in more depth. While there are studies examining the failure (versus survival) of academic spinoffs once they have matured, the decision of academics to terminate their entrepreneurial activity is little understood when they are at the earlier stages of the spinoff development.

Furthermore, it is worth exploring the rationale behind the formation of teams with different characteristics. While there is a significant amount of empirical research in exploring the effect of different team configurations, i.e. the characteristics of the entrepreneurial decision makers at the team level, on firm outcomes (see Table 4), we know little about the actual team formation and its underpinning decision-making process (for a review, see Nikiforou et al. 2018). In particular, prior research has highlighted that academics tend to form homophilous teams, i.e. teams with similar others (Colombo and Piva 2008). Is the formation of homophilous teams a conscious decision, because academics do not see value in teaming up with practitioners? Or could this homophily be the result of path dependence, given that researchers tend to sustain network relationships with individuals primarily from research institutions and similar organisations (Renault et al. 2016; Grandi and Grimaldi 2003)? Furthermore, the abilities of individuals have been found to explain entrepreneurial choices (Shepherd, Williams, and Patzelt 2015). Yet, to date, research has not examined to what extent researchers possessing business-related ability (e.g. due to previous start-up experience) are inclined to team up with practitioners, compared to researchers with no such ability. These questions can be further examined in conjunction with the environment in which the academic spinoff teams are formed, as technology transfer ecosystems provide varying types of advice and support to academic entrepreneurs.

Future research related to Cluster 3. Nascent academic entrepreneurship

Studies in this cluster have shown that entrepreneurial entry and opportunity exploitation for academic entrepreneurs is multifaceted. This is not surprising given the uniqueness of the university setting that can serve as an ideal context to study phenomena of general management and entrepreneurial interest (Fini et al. 2019). This lays the path for many interesting research questions, especially at the beginning of the commercialisation process, when the particularities of the

academic spinoffs compared to non-research-based start-ups are even more pronounced (Fini et al. 2019). Future research may enhance understanding in the decision making related to opportunity identification and assessment that has received only limited attention so far in the context of academic spinoffs (see Table 4). For instance, scholars can explore the following questions: How do academic entrepreneurs search for market opportunities for their technologies? What drives them to adopt a proactive versus a reactive approach in their search for market opportunities, such as technology broadcasting (Andries, Clarysse, and Costa 2021)? What makes them choose a structured way of identifying market opportunities (Gruber and Tal 2017) over relying on heuristics and effectual logic (Sarasvathy 2001)?

Furthermore, future research can explore how the human capital endowments of entrepreneurial decision makers influence key decisions as the academic spinoff emerges. While there is a considerable body of work examining the effects of the human capital of founders on academic spinoff outcomes (Mathisen and Rasmussen 2019; Nikiforou et al. 2018), scholars have yet to examine how the human capital of researchers will influence their decisions around opportunity assessment and exploitation, as well as entrepreneurial entry. Researchers may, on average, lack work experience outside academia, yet some possess industry and/or entrepreneurial experience (Mosey and Wright 2007). These more experienced academics may follow very different decision-making processes and rely on heuristics compared to the ones with no business-related experience. Thus, they may need different levels and types of support from the focal department, university, and other support entities.

Finally, future research can explore the interrelations between the key early-stage entrepreneurial decisions of Shepherd et al.'s framework, namely, entrepreneurial entry, opportunity assessment, and opportunity exploitation. For instance, scholars can examine how the identification and assessment of an entrepreneurial opportunity influence the decision of academics to found a spinoff, and how in turn, this decision will influence the (further) assessment of the entrepreneurial opportunity and the decision to exploit this opportunity (or pivot). For example, Molner, Prabhu, and Yadav (2019) have illustrated how the market scoping mind-set one adopts regarding the identification of market spaces for early-stage technologies determines market space decisions and outcomes.

Future research related to Cluster 4. Scientific parks

In addition to the research agenda that we proposed concerning the contextual factors in general, it is worth exploring several research questions at the intersection of academic spinoffs, decision making, and the specific context of science parks. For instance, future research, instead of focusing on the comparison between academic and corporate spinoffs, can dive into the pool of academic spinoffs that can differ significantly from one another. Indeed, academics are not a uniform group of individuals as they have often been presented in prior research on academic spinoffs, and therefore they may envision creating spinoffs that differ significantly in some dimensions, such as the scope of activities and growth potential (Balven et al. 2018; Zellmer-Bruhn et al. 2021). Scholars can, thus, examine which academic spinoffs decide to be located in science parks, as well as when and under which circumstances spinoffs decide to leave the science park premises and set up their own business premises. Relatedly, there is the need to understand what decision-making processes, toolsets, and criteria science parks (can) employ to select participating spinoffs and to choose what type of support they will provide to them. These future research directions go hand in hand with exploring the characteristics of the decision makers that – depending on the research question – could be the individual researchers, the academic spinoff team or science park management.

Conclusion

The purpose of our study was to provide an overview of extant research on entrepreneurial decision making in academic spinoffs. In so doing, we combined a bibliometric analysis and a literature review

that allowed us to study, map, and systematise relevant knowledge around four cluster areas: contextual factors, spinoff development and performance, nascent academic entrepreneurship, and science parks. We interpreted prior studies in light of the highly influential framework on entrepreneurial decision making developed by Shepherd, Williams, and Patzelt (2015), and we indicated which research areas in the decision making of academic spinoffs require further investigation, as well as how research in this unique setting of start-up creation (Fini et al. 2019; Nikiforou et al. 2018) can advance decision-making research in the broader entrepreneurship literature. To conclude, our study is particularly timely given the current emphasis on the third mission of universities (Arroyabe, Schumann, and Arranz 2022; Padilla-Meléndez and del-Aguila-Obra 2022) and can provide a springboard for entrepreneurship scholars, academic entrepreneurs, and policy-makers.

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