Studies in Higher Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/cshe20

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To cite this article: Marta F. Arroyabe, Martin Schumann & Carlos F. A. Arranz (2022): Mapping the entrepreneurial university literature: a text mining approach, Studies in Higher Education, DOI: 10.1080/03075079.2022.2055318

To link to this article: https://doi.org/10.1080/03075079.2022.2055318

STUDIES IN HIGHER EDUCATION
https://doi.org/10.1080/03075079.2022.2055318

Mapping the entrepreneurial university literature: a text mining approach

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ABSTRACT

Since the introduction of the concept of entrepreneurial university in 1980s, the number of studies has dramatically increased, in particular since 2015. This had made the literature on the entrepreneurial university complex, fragmented and difficult to navigate. This paper provides a comprehensive review of all topics covered in the body of literature on the entrepreneurial university and identifies the most salient topics and papers within this literature, making use of text-mining techniques. Our paper employs topic modelling that reveals the underlying semantic structure of texts to identify the different underlying. Our study systematically analyses 1,110 papers over the period 1983–2020 using the Latent Dirichlet Allocation algorithm. Our analysis shows that the entrepreneurial university is fragmented around different topics that are very diverse. We find a total of 20 differentiated topics. Our study suggests that topics related to the overarching theme of academic entrepreneurship, in particular to commercialisation of research and the triple helix model are very popular within the entrepreneurial university literature. Finally, our analysis reveals that case-study type of research is losing momentum, giving path to nascent topics of research in the areas of entrepreneurial capability and university-industry alliances, which are becoming very popular within the entrepreneurial university literature.

KEYWORDS

Entrepreneurial university; academic entrepreneurship; text mining; topic modelling; Latent Dirichlet Allocation algorithm

Introduction

With the introduction of the Bayh-Dole Act in the 1980s in the USA, universities have pivoted from the traditional teaching and researching focus to also include the so-called 'third mission'. This third mission emphasises the connection of universities with their external environment and their contribution to social and economic development, in particular through entrepreneurial activities (Etzkowitz 2003; Guerrero et al. 2016; McAdam, Miller, and McAdam 2018). Entrepreneurial universities contribute to the creation of knowledge and leadership that fosters entrepreneurial thinking (Guerrero et al. 2016). Because of its provision to society, the concept of the entrepreneurial university has received increasing attention in the social sciences literature (Forliano, De Bernardi, and Yahiaoui 2021).

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Supplemental data for this article can be accessed https://doi.org/10.1080/03075079.2022.2055318.

The literature on the entrepreneurial university has evolved dramatically since the first paper by Etzkowitz in 1983 (Etzkowitz, 1983), with the number of papers exploding since 2015. The increasing number of papers have contributed to the creation of a rich and diverse body of knowledge on the entrepreneurial university, which in turn has made the literature on this topic more complex and fragmented (Audretsch and Belitski 2021; Forliano, De Bernardi, and Yahiaoui 2021). The literature on the entrepreneurial university has extended beyond the entrepreneurship and management literature to span other fields such as biomedical technologies, health policy services, women's studies and other areas in which the entrepreneurial academic organisations and their agents are important elements of study (Skute 2019). This generates considerable challenges to scholars and practitioners alike for the navigation and exploration of the topic. Against this background, recent papers are calling for literature reviews that provide a more unified definition of the entrepreneurial university and a clear framework of study (Audretsch and Belitski 2021; Forliano, De Bernardi, and Yahiaoui 2021; Mascarenhas et al. 2017). Accordingly, the purpose of this article is to take stock of the literature on the entrepreneurial universities, to identify the different underlying topics, and to outline avenues for fruitful future research. In particular, this paper aims to answer the following two research questions: (1) what are the underlying themes in the entrepreneurial university literature?, (2) which are the nascent areas and the areas that have more potential for research in the entrepreneurial university literature?

Methodology and dataset

As compared to recent bibliometric studies on the entrepreneurial university (e.g. Forliano, De Bernardi, and Yahiaoui 2021; Mascarenhas et al. 2017; Skute 2019), our study relies on text mining. Unlike bibliometric studies, which use keywords and emphasise co-author and co-citation networks, our study focuses on the knowledge content of the papers by analysing their abstracts. Our paper employs topic modelling, a text mining approach that reveals the underlying semantic structure of texts, which provides a more granular and comprehensive review of the literature (Blei and Lafferty 2007). Topic modelling allows to extract different topics from the text of papers and to identify the most relevant terms associated with each topic.[1] With this type of analysis, we can obtain an overall picture of the literature on the entrepreneurial university that can assist scholars and practitioners in navigating the increasing body of literature on the subject. Detailed descriptions of text mining and topic modelling are provided in the online Appendix A.

Our study systematically analyses 1,110 papers over the period 1983–2020. Once the topics have been identified, our study ranks them by prominence and links them back to particular articles, allowing us to detect trends in the entrepreneurial university literature as well as hot and declining topics. Detailed descriptions of the data set and data analysis are provided in the online Appendix B.

Results and discussion

We present here a discussion of the results of our analyses, answering our research questions. A detailed analysis of the results is provided in the supplementary material accompanying this paper (see online Appendix C).

What are the underlying themes in the entrepreneurial university literature?

We identified 20 different topics from all the articles published on the topic of the entrepreneurial university until 2020. Table 1 displays the extracted topics together with the topic label we have assigned and the 10 most common terms. The topics identified in our analysis can be divided into two broad themes: academic entrepreneurship and entrepreneurial education. The literature on academic entrepreneurship focuses on the commercialisation of universities' research and on the knowledge transfer process (Klofsten and Jones-Evans 2000; Fini et al. 2018), while literature

Table 1. List of topics with labels and of the most frequent terms per topic.

Topic number	Topic label	Most frequent words
1	Creation and development of spinoffs	USOs, health, economics, partnerships, survival, science-based, medical, founders, USO, RBSOs
2	University-enterprise collaboration	graduates, competencies, PhD, competences, UBC, stem, mobility, responsibilities, profiles, university-business
3	Entrepreneurial education and creativity	people, creative, applications, campus, programme, special, year, intermediaries, creativity, non-academic
4	Case studies on the entrepreneurial university	groups, open, communities, recognition, course, evolved, transformational, mind, egypt, alertness
5	University-industry dynamics	productivity, internationalisation, competence, domain, reputation, scholarship, probability, instruments, spillovers, elearning
6	Evaluating entrepreneurial education	program, school, evaluation, schools, legitimacy, neoliberal, russian, stanford, category, teachers
7	Drivers of academic entrepreneurship	translation, climate, brazil, colleges, SMEs, capitalism, symptoms, translational, complexity, sphere
8	Entrepreneurs' identity	scientists, intentions, identity, identification, conflict, passion, psychological, selfidentity, style, moderating
9	Trajectories of academic entrepreneurs	south, commercialisation, professors, sweden, careers, africa, african, korea, typology, youth
10	Incubators	incubators, incubator, collective, logic, logics, centres, effectuation, channels, intelligence, behaviours
11	Female entrepreneurship	gender, women, female, leaders, republic, spinout, male, entreu, equality, faculties
12	Sustainability and governance	sustainable, governance, sustainability, heis, parks, hong, kong, american, transferring, hei
13	Entrepreneurial capability	capability, parent, family, ties, rules, singapore, east, nascent, progress, embeddedness
14	Entrepreneurial motivation	motivations, choice, motivation, teams, personality, scientist, wealth, star, equity, location
15	University-industry alliances portfolio	invention, ASOs, portfolio, spaces, connections, alliances, failure, materials, alliance, accountability
16	Commercialisation of inventions and patenting	patenting, TTOs, departments, exploitation, TTO, inventors, inventions, department, ownership, publication
17	Case studies on academic entrepreneurship	values, foreign, lab, mit, technology-based, brazilian, entrepreneurialism, planning, offerings, users
18	Entrepreneurial university in sciences	mode, Pls, excellence, biotechnology, investigators, mindset, spatial, microlevel, cluster, urban
19	Entrepreneurial intention	intention, digital, self-efficacy, centres, undergraduate, intent, beliefs, desirability, hub, regulatory
20	Triple helix	helix, triple, motives, nanotechnology, theories, smart, quadruple, boundary, arrangements, specialization

on the entrepreneurial education looks at how the universities' teaching links with the third mission and at how the university fosters entrepreneurial competency (Bae et al. 2014; Fini et al. 2012; Martin, McNally, and Kay 2013; Van der Sluis, Van Praag, and Vijverberg 2005).

Our analysis also identified the most prevalent topics in the entrepreneurial university literature (see online Appendix C for details). In the area of academic entrepreneurship, we find the topics '*Commercialisation of inventions and patenting*', '*University-enterprise collaboration*' and '*Incubators*' to be the most prevalent ones. For the area of entrepreneurial education, the topic '*Evaluating entrepreneurial education*' was among the top topics. The topic on '*Entrepreneurs' identity*', which can be included in both overarching themes, was also among the most prevalent ones.

Perhaps it should not come as a surprise that most of the papers on the entrepreneurial university look at the academic university. In the context of a knowledge-based economy, a growing scholarly interest has emerged on the transition of universities from teaching and research institutions to hubs of knowledge creation and transfer (Audretsch 2014; Guerrero et al. 2016). The so-called third mission of universities (which refers to the process of knowledge transfer as a key force enabling and promoting innovation and social and economic development), has attracted increasing attention (e.g. Audretsch, Keilbach, and Lehmann 2006; Centobelli, Cerchione, and Esposito 2019).

The enactment of the Bayh-Dole Act in 1980, which promoted the commercialisation of university science, has acted as a catalyst for the literature on the '*Commercialisation of inventions and patenting*'. Studies in this topic have explored the efficacy of the university ownership regime in commercialising inventions through different pathways focusing on patenting, licensing and spin-offs (Fini et al. 2011; Kenney and Patton 2011; Link, Siegel, and Bozeman 2007 Roessner et al. 2013; Siegel, Wright, and Lockett 2007). More specifically, the articles with the highest loadings in this topic have explored the factors and environment necessary for the patenting and commercialisation of academic research (e.g. Chang, Yang, and Chen 2009, 2016; Meyer 2006a, 2006b; Rybnicek et al. 2019; Walsh and Huang 2014).

The work of Etzkowitz and Leydesdorff (1995) on the triple helix model is instrumental for the entrepreneurial university literature. The triple helix model depicts the relationships among universities, firms and governments in an innovation system (Etzkowitz and Leydesdorff 1995), and has been employed to examine the interactions between universities and firms (e.g. Guerrero and Urbano 2017). Articles on the topic on *'University-enterprise collaboration'* explore the interactions between universities and firms to generate technological knowledge (Rothaermel, Agung, and Jiang 2007). These papers highlight the role of the university within the innovation ecosystem and note the crucial role universities play in collaborating with enterprises to expand research, co-create knowledge and obtain public funds for further research (D'Este and Patel 2007; Mowery and Sampat 2004; Perkmann and Walsh 2009). Recently, the mechanisms that facilitate and hinder university–enterprise collaboration relationships have gained substantial attention (e.g. Bruneel, D'Este, and Salter 2010; Perkmann et al. 2013). In this line, some of articles with the highest loadings in this topic propose different frameworks aiming at promoting and improving the collaborations (e.g. Towers et al. 2020; Castro-Spila 2018).

The topic *'Incubators'* explores the set of different activities universities engage with to foster entrepreneurial activities on campus through the creation of new firms through academic spin-outs and start-ups (Etzkowitz et al. 2000; Shane 2004). The scholarly interest on incubators arises from studies indicating that university graduates are poorly equipped for carrying out business activities, and thus incubators are necessary to provide support (Allen and McCluskey 1991; Mian, Lamine, and Fayolle 2016). Incubators provide access to office space, training and support as well as credibility with stakeholders (Clayton, Feldman, and Lowe 2018; Hackett and Dilts 2004; Rothaermel and Thursby 2005). The papers with the highest loadings in this topic explore different dimensions of these incubator facilities (e.g. Sansone et al. 2020; Klofsten et al. 2020; Secundo et al. 2016; Redondo and Camarero 2019). In particular, recent papers are moving away from the classical conceptualisation of incubators to explore the role of social impact, corporate social responsibility, business ethics and social capital on incubators and their success (Sansone et al. 2020; Redondo and Camarero 2019).

Regarding the entrepreneurial education-oriented papers, our analysis finds the topic '*Evaluating entrepreneurial education*' to be the most salient one. Literature on the entrepreneurial education looks at how the university's teaching links with the third mission and at how the university fosters development of entrepreneurial attitudes and skills (Arranz et al. 2017, 2019; Bae et al. 2014; Fini et al. 2012; Martin, McNally, and Kay 2013; Van der Sluis, Van Praag, and Vijverberg 2005). A large part of the literature in this topic, including the articles with the highest loadings, employ surveys at particular institutions or case studies to evaluate the impact of entrepreneurial education (e.g. Vesper and Gartner 1997; Eesley and Lee 2021; Lyons and Zhang 2018). Given the wide variety of context for these studies, the literature has found mixed evidence of the impact of entrepreneurial education on the creation of new ventures: while early studies such as Gorman, Hanlon, and King (1997) and Pittaway and Cope (2007) found a positive effect, more recent studies such as Oosterbeek, Van Praag, and Ijsselstein (2010) or Eesley and Lee (2021) do not find a positive effect.

In recent years, the entrepreneurship literature exploring the psychological characteristics of entrepreneurs has become increasingly interested on the identity related characteristics of entrepreneurs (e.g. Krueger 2007; Jain, George, and Maltarich 2009; Fauchart and Gruber 2011). Articles in the topic '*Entrepreneurs' identity*' have aimed at uncovering the underlying characteristics of

entrepreneurs. Some of the papers with the highest loadings in this topic have explored factors such as entrepreneurial passion, behaviour, and social and self-identity (Obschonka et al. 2012; Huyghe, Knockaert, and Obschonka 2016; Zollo et al. 2020; Obschonka et al. 2015; Shi, Zou, and Santos 2020; Zou et al. 2019). These studies have also explored the different identities of entrepreneurs and the possible identity conflict. For instance, Shi, Zou, and Santos (2020) investigate the tension of duality between the academic identity and the entrepreneur identity while Zou et al. (2019) explore the roles of entrepreneurial and scholarly identification.

Which are the nascent areas and the areas that have more potential for research in the entrepreneurial university literature?

To understand the evolution of the popularity of the topic and to identify emerging topics, we conduct a regression analysis (see Table A7 of the online Appendix). Our analysis identifies '*case studies on the entrepreneurial university*', '*entrepreneurs' identity*', '*commercialisation of inventions and patenting*', and '*triple helix*' as all-time popular[2] topics in the entrepreneurial university literature. Moreover, our analysis reveals some clear trends in the popularity of the topics and identifies some nascent topics (Table 2 synthesises these results).

First, our analysis reveals that papers aligning with the topic *'Commercialisation of inventions and patenting'* and the *'Triple Helix'* tend to have higher impact (as measured by the number of citations) and receive substantial scholarly attention in all periods and sub-periods of the analysis. These two topics look into mechanisms by which scientific knowledge is transferred into practical applications and across economic agents. Moreover, they also lend themselves to conduct policy evaluation- type of research, which, given the large sums of money governments invest on fostering the entrepreneurial university (Fini et al. 2018), generates debate and engages scholars in the discussion of the potential impact of the entrepreneurial university and best-practices for its implementation.

Second, the topic *'Case studies on the entrepreneurial university'* was losing momentum as reflected by lower citations in recent years. The loss of interest in this topic can be explained by the increasing availability of (large-scale) survey data (e.g. Global Entrepreneurship Monitor, Panel Study of Entrepreneurial Dynamics) that allow for the analysis of the different aspects that compose the entrepreneurial university literature. As compared to studies based on large-scale databases, case studies make it difficult to generalise across instances and contexts, reducing the potential for impactful research.

Table 2. Hot and declining topics in the entrepreneurial university literature.

Topic number	Topic label	1988–2020	1988–2010	2011–2020	2015–2020
1	Creation and development of spinoffs				
2	University-enterprise collaboration				
3	Entrepreneurial education and creativity				
4	Case studies on the entrepreneurial university	Hot topic	Hot topic		Declining topic
5	University-industry dynamics				
6	Evaluating entrepreneurial education				
7	Drivers of academic entrepreneurship				
8	Entrepreneurs' identity	Hot topic	Hot topic		
9	Trajectories of academic entrepreneurs				
10	Incubators				
11	Female entrepreneurship				
12	Sustainability and governance				
13	Entrepreneurial capability				Hot topic
14	Entrepreneurial motivation				
15	University-industry alliances portfolio				Hot topic
16	Commercialisation of inventions and patenting	Hot topic		Hot topic	Hot topic
17	Case studies on academic entrepreneurship				
18	Entrepreneurial university in sciences				
19	Entrepreneurial intention				
20	Triple helix	Hot topic	Hot topic		Hot topic

Finally, our results identified *'Entrepreneurial capability'* and *'University-industry alliances portfolio'* as nascent topics that have attracted scholarly attention. Entrepreneurial capability can be defined as 'the ability to identify a new opportunity and develop the resource base needed to pursue the opportunity' (Arthurs and Busenitz 2006, 199). Entrepreneurial capability encompasses both entrepreneurial capability at the individual level (e.g. academic researchers or students) and the organisational level (e.g. universities, firms or governments). Entrepreneurial capability has become an increasingly important topic that has been used to understand and identify the resources and skills required for effective entrepreneurial activity, providing a more nuanced understanding of the entrepreneurial process (Phillips and Tracey 2007). The rise of the topic *'University-industry alliances portfolio'* reflects the recent phenomenon that universities and firms are engaging with multiple alliances at the same time (Zhang, Yuan, and Han 2020). This literature has received recent attention, since, as compared to traditional alliances, university-industry (research) alliances usually consist of universities and research institutes, which maintain synergistic relationships (rather than competitive ones) with the industry (Bos, Faems, and Noseleit 2017; Guan and Zhao 2013; Zhang, Yuan, and Han 2020).

Conclusion

The literature on the entrepreneurial university has grown exponentially in the last couple of years. This paper provides a comprehensive review of all topics covered in the body of literature on the entrepreneurial university and identifies the most salient topics and papers within this literature, making use of text-mining techniques. Our paper complements the recent bibliometric studies on the entrepreneurial university literature.

Our analysis shows that the entrepreneurial university is fragmented around different topics that are very diverse. We find a total of 20 differentiated topics, some of which focus on the individual level and aim to understand the characteristics of the academic entrepreneur, while some others take a more institutional level focusing on either the university or national systems of innovation. Our study suggests that topics related to the overarching theme of academic entrepreneurship, in particular to commercialisation of research and the triple helix model are very popular within the entrepreneurial university literature. Finally, our analysis reveals that case-study type of research is losing momentum, giving path to nascent topics of research in the areas of entrepreneurial capability and university-industry alliances, which are becoming very popular within the entrepreneurial university literature.

Notes

1. Our paper employs the Latent Dirichlet Allocation (LDA) algorithm to identify the topics. See online Appendix A for more details.
2. As explained in online Appendix C, we define popularity of a topic based on the number of citations. Hence, more popular topics are associated with higher number of scholarly citations as shown in the regressions of Table A7.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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