

Bibliometric Correlations Regarding the Entrepreneurial University

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Abstract

Throughout this research paper, we want to emphasize the bibliometric correlations regarding the topic of the entrepreneurial university. Starting from the strategic role of universities in addressing the needs of society and business alike we investigate the bibliometric correlations through the lens of the entrepreneurial university paradigm. The issue of the entrepreneurial university has stirred many discussions all around the world and every decade seems to reveal a new trend. The scope of this research is to keep track of the "entrepreneurial university" concept evolution. The main goals of this research are: to conduct a bibliometric analysis on the essential components of the entrepreneurial university; to perform a mapping of the correlations between the main components, and to analyze the evolution over time of research on the subject. As a general hypothesis, we imply that current knowledge on entrepreneurial university concept refers to various niche approaches that might be confusing at some point. An improved approach would require a more rigorous correlation with the practical reality in the world of entrepreneurship. The research combines a two-dimension approach by correlating two types of bibliometric analysis. To identify the theoretical descriptors of the "entrepreneurial university" concept we performed a bibliometric analysis by using VOSviewer software selecting the published articles in the Scopus database during 10 years. The relevance of this analysis consists in the opportunity of extracting the most relevant information on the analyzed topic according to several criteria such as keywords, co-occurrence, co-citation, country, or publication topics by year. From this perspective the facts are meaningful and we shall present them within the sections of the paper. First, we implemented a network visualization analysis in VOSviewer software for the database extracted from Scopus on the "entrepreneurial university" phrase. The network visualization provides an output containing 5 conceptual clusters which show the main discussion trends in correlation with the analyzed issue. We argued the clusters' components as they reveal insightful and novel knowledge. Another visual result of this stage is the overlay visualization that shows the theoretical debate evolution between 2010-2020. Secondly, we implemented a network visualization considering the origin countries of publications' authors on the "entrepreneurial university" topic. In this case, we closely analyzed both outputs: the network visualization retrieving the 4 clusters by country and the overlay visualization showing each year's publication distribution by country. Within the last section, we present the conclusions and propose further research tracks.

Keywords

Entrepreneurial university; entrepreneur; knowledge transfer; VOSviewer; bibliometric analysis; clusters; co-occurrence.

Introduction

This topic of the relationship between universities and the business environment has been studied for many years, but every decade it focuses its attention on a new level, on new connections, or new theories. For the recent decade, the expression 'entrepreneurial university' has been at the forefront. Universities have always been seen as a source of help for society, as a result of their intellectual capital; initially through the transfer of knowledge, later through the transfer of skills, and more recently through the transfer of business potential (Bratianu, 2014; Dinning, 2015; Prelipcean & Bejinaru, 2016).

As we know, the main mission of the university is to transfer knowledge to students. Adapting better and better to the changes in society, universities have extended the limits of their traditional mission of education and research by intensifying their potential to bring value to society. Nowadays, the value we are talking about involves an extensive transfer of knowledge, technology, and know-how to society to meet its needs and support value creation and economic growth (Bratianu, Hadad, & Bejinaru, 2020; Bratianu, Prelipcean, & Bejinaru, 2020; de la Torre et al., 2017; Giuri et al., 2019).

In global research, opinions are divided regarding the success of universities in entrepreneurial involvement. An apparently contradictory perspective is that of the authors Garcia-Aracil, as well as Palomares-Montero (2012) and de la Torre et al. (2017) according to which the relationship between entrepreneurial activities and the teaching process is negative, but instead, the link between entrepreneurial initiatives and research projects in universities is quite positive. Regarding the concept of the entrepreneurial university, Sam and van der Sijde (2014) clarify that the implementation of such projects with entrepreneurial activities does not immediately confirm this status, but rather must be evaluated the value resulting from this two-way collaboration.

At the moment, a strategic goal for universities is to address the needs of society and business alike (Kapetaniou & Lee, 2017) which translates into a simple and clear expression as - "the third mission" (TM) of the university (Abreu et al., 2016; Rubens et al. 2016; Urdari et al., 2017). We consider that it is a phenomenon that is already taking place on several levels, namely: challenging university governance to consider the third mission, educating the skills necessary for students to succeed in the labor market; greater relevance of research; streamlining collaboration with the business environment to meet the needs of the economy and create viable self-financing mechanisms (Bejinaru & Prelipcean, 2017; Bratianu & Bejinaru, 2016; Bratianu & Pinzaru, 2015; Maresch et al., 2016).

Methodology of the bibliometric analysis

For the bibliometric research stage, we will use the VOSviewer software which helps to identify conceptual networks and clusters of useful knowledge to draw an overview of the studied concept. Thus, to identify the coordinates of the entrepreneurial university,

we will implement in turn the specific objectives, namely: (1) conducting a bibliometric analysis on the essential components of the entrepreneurial university; (2) performing a mapping of the correlations between the main components; and (3) analyzing the yearly evolution of publications on the subject. One hypothesis, issued in this phase, is that the current knowledge on the entrepreneurial university requires a more rigorous correlation with the practical reality in the world of entrepreneurship as it has become too scattered.

Specifically, what we did through the VOSviewer software, was to process a co-occurrence analysis, to identify the spread and consistency of the expression "entrepreneurial university" in research articles published within the data basis of SCOPUS, in the last 10 years. Using version 1.6.17. of VOSviewer software allowed the extraction of a network-based bibliometric map (Van Eck & Waltman, 2011). According to specialists, this type of bibliometric map highlights the strongest links of the basic concept with other related concepts that have been discussed together in various papers. This map has a significant relevance as it allows a clear visualization, as a scheme, of the phenomena studied in the literature, offering, in a concentrated manner, knowledge on several levels and areas of the problems (Zupic & Cater, 2015).

The search transcription is according to the code: TITLE-ABS-KEY (entrepreneurial AND university) AND PUBYEAR > 2009 AND PUBYEAR < 2021 AND (LIMIT-TO (LANGUAGE , "english")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (PUBSTAGE , "final")) AND (LIMIT-TO (OA , "all")).

The sample consists of 951 open-access journal articles that were published from 2010 to 2020 in the Scopus database. We argue this approach from the premise that we need consistent and up-to-date research on the concept analyzed. According to the rules of use of VOSviewer version 1.6.17 (Van Eck & Waltman, 2020), co-occurrence analysis may require data cleaning operations to ensure the accuracy of the analyzed data set. In this case, we implemented article cleaning for the following categories of terms:

- insignificant expressions that show a very weak connection to the objective of the research ("sector" or "engineering education").
- names and abbreviations are ignored ("E.I.", "e-learning" or "HES").
- general and specific research terms are excluded as they don't bring added value to the purpose of the analysis ("higher education", "university", "learning", "economics", etc.).
- synonyms and plurals of key concepts are carefully selected to ensure a clean conceptual distribution network (e.g.: "entrepreneurial education", "entrepreneurship education" and "education" labels have been established to "entrepreneurial education"; "universities", "university" and "higher education" labels have been established to "university", "students" and "student" have been replaced with "student"; "regional economic development", "regional development", and "regional planning" labels have been established to "regional development", etc.).

In this case, the first data set recovered was extremely accurate and the cleaning procedure removed only 14 items from the total of 45 initially and remained 31 items as final. We obtained 5 clusters, quite homogeneous, which means that there is a

significant consensus on the basic ideas of the "entrepreneurial university" in the publications of the last 10 years. In the following sections, we shall present each type of bibliometric analysis in part together with their figures.

Bibliometric cluster analysis

According to the standard procedure, for the csv. database extracted from Scopus, we launched the specific VOSviewer functions for network type bibliometric analysis. In a first step, we obtained a total of 1143 keywords, of which only 45 exceeded the threshold value of 5. Furthermore, the software calculated the total intensity connections between the 45 keywords and rendered graphically only the strongest of them thus outlining a colorful and very suggestive map. In summary, the coordinates regarding the descriptive statistics of the sample of the analyzed article are 951 articles belonging to the database, 31 selected keywords, 5 clusters, 272 links, and 836 total links strengths. Based on the visual network of the co-occurrence (figure 1), 5 clusters of different colors can be observed, which we named after the main term, according to the highest value within the analyzed sample. For the correct interpretation of the map, it is important to know certain meanings (Van Eck & Waltman, 2020). First of all, the keywords with the highest number of occurrences are located as close as possible to the center of the graph. Second, the higher the number of keywords used by more authors at the same time, the closer their position will be and the thicker the lines of connection. Another very important issue is that the dimension of the colored ball depends on the degree of use of those keywords by the authors. The advantage of this software is that through a single operation it renders several possibilities of observing the sample. Thus, in Figure 1, the clusters are visible due to the colors that strongly differentiate them and in Figure 2, the color gradient highlights the evolution over time of the keywords in the literature.

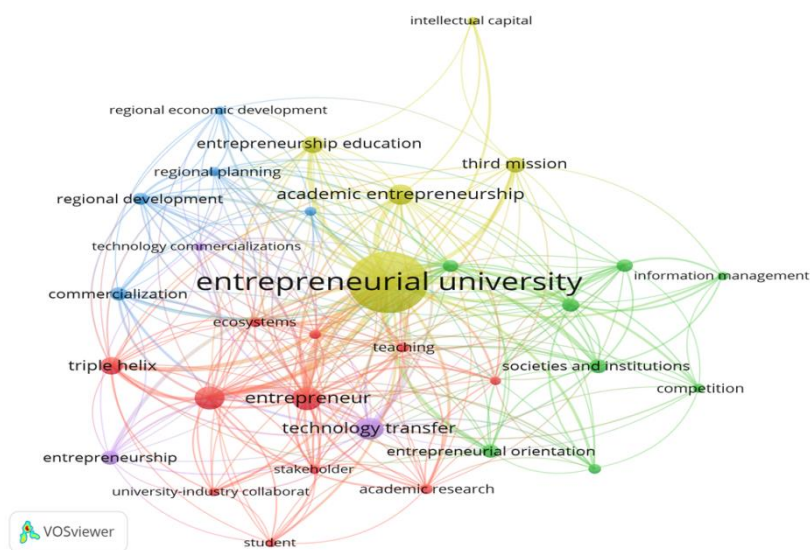


Figure 1. Network visualization by VOSviewer software version 1.6.16 for "entrepreneurial university" (author's research)

According to the information in Table 1, we can discuss the composition of the colored clusters. Even if the most obvious is the Yellow cluster – named “entrepreneurial university”, the software ranks the clusters according to the number of keywords included. Thus we shall start the presentation with Cluster 1 -Entrepreneur, in red color, because it includes the largest number of items, namely 11. The composition of this cluster reflects the related issues mostly mentioned by authors when discussing the “Entrepreneur” subject, like innovation, University spin-offs, University-industry collaboration, or Technological forecasting. Focusing on these items combination we can remark that the evolution of the entrepreneur is highly connected to generating innovation and to technological trends and forecasts. The red links between items like “student”, “entrepreneur” and “university-industry collaboration” support two major theories. One represents the idea that indeed students have a high potential of becoming entrepreneurs if they are accordingly guided throughout their studies (Neamtu et al., 2019). The other theory is that even mature entrepreneurs might benefit from the help and guidance of universities throughout collaboration protocols (El Hadidi & Kirby, 2016).

Cluster 2 –Knowledge transfer, represented in green color is very homogeneous in composition, including only specific items, like Patents and inventions, Competition, Information management. This cluster is intensely connected to Entrepreneur and Entrepreneurial university clusters which strengthens the idea that knowledge transfer is necessary and useful for all stakeholders. Furthermore, we can deduce that entrepreneurship initiatives may be highly connected to patents and inventions in the information management field (Bejinaru, 2018).

Cluster 3 -Commercialization, in blue color, connects very well with all the other clusters, but mostly to red and purple ones. Reading through the items included in cluster 3, we can conclude that regional economic development is highly dependent worldwide by the evolution of entrepreneurship. This cluster contains a very suggestive key phrase, namely “developing countries” – which stands for a clear statement that entrepreneurship has the potential to generate economic growth especially in developing countries and that there is still a great gap in comparison to well-developed states (Forliano et al., 2021).

We return to Cluster 4 -Entrepreneurial university, as we mentioned it to be the most visually obvious in yellow color. This cluster has a simple and eloquent composition: academic entrepreneurship, third mission, and intellectual capital. The keywords in this cluster represent the core elements of the entrepreneurial university paradigm. As the values show, this cluster has the highest values for its items, meaning that when authors are discussing the entrepreneurial university, these issues should always be included in the research (Prelipcean & Bejinaru, 2018; Svensson et al., 2012; Trencher et al., 2014).

The last one, but still important is Cluster 5 – Technology transfer, with purple color balls, which ranks second according to the link strength values, together with cluster 2-Knowledge transfer, both recording 91 total link strengths. The composition of this cluster clearly expresses how entrepreneurship could be best supported under the

umbrella of the entrepreneurial university throughout knowledge transfer and technology commercialization. The many direct connections to cluster 2 -Knowledge transfer stand for the same strategy. Universities undertaking the entrepreneurial path should support and facilitate intensive knowledge and technology transfer towards the entrepreneurship sector (Gibb, 2013). Considering the 2 types of clusters we could imply that here are also connected two areas of research: a rather theoretical one for knowledge transfer and a rather pragmatic one for technology commercialization.

Table 1. Composition of clusters

Keywords	Cluster	Link strength	Occurrence
<i>Entrepreneur</i>	Cluster 1- RED ENTREPRENEUR (144 total link strength)	144	36
Innovation		117	36
Triple helix		65	21
Ecosystems		40	7
Academic research		34	7
Stakeholder		32	5
Teaching		31	7
University spin-offs		26	6
University-industry collaboration		23	5
Technological forecasting		22	5
Student		20	5
Keywords	Cluster	Link strength	Occurrence
<i>Knowledge transfer</i>	Cluster 2 – GREEN KNOWLEDGE TRANSFER (91 total link strength)	91	32
Economics		54	10
Knowledge management		44	12
Societies and institutions		40	13
Entrepreneurial orientation		34	12
Patents and inventions		23	7
Competition		19	6
Information management		18	5
Keywords	Cluster	Link strength	Occurrence
<i>Commercialization</i>	Cluster 3 – BLUE COMMERCIALIZATION (45 total link strength)	45	12
Regional development		44	10
Regional planning		36	6
Developing countries		20	6
Regional economic development		20	5
Keywords	Cluster	Link strength	Occurrence
<i>Entrepreneurial university</i>	Cluster 4 – YELLOW ENTREPRENEURIAL UNIVERSITY (374 total link strength)	374	251
Academic entrepreneurship		77	28
Third mission		37	17
Intellectual capital		9	5
Keywords	Cluster	Link strength	Occurrence
<i>Technology transfer</i>	Cluster 5 – PURPLE	91	32

Entrepreneurship	TECHNOLOGY TRANSFER (91 total link strength)	30	13
Technology commercialization		22	5

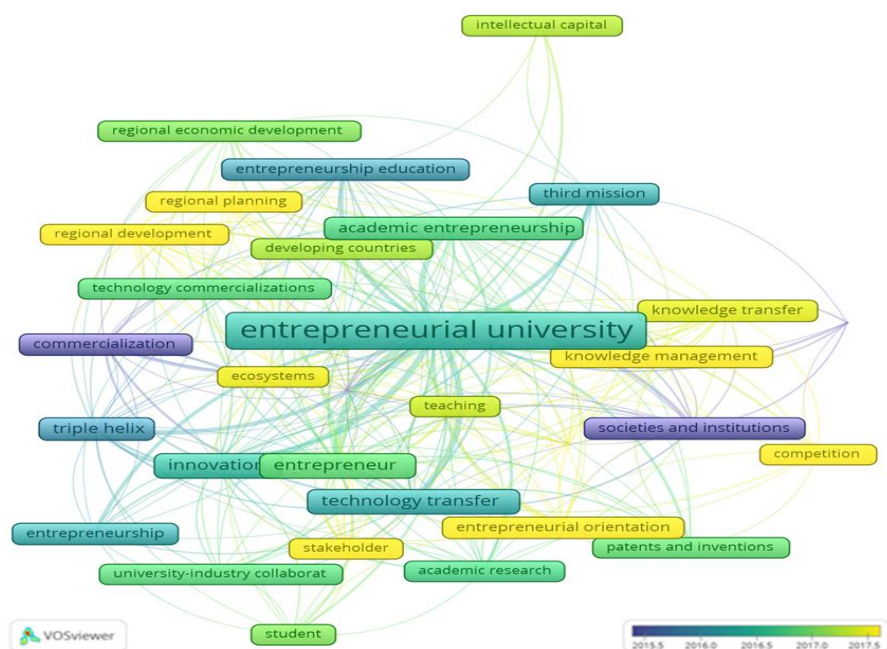
Author's research, extracted from VOSviewer Network Visualization window

Bibliometric overlay analysis

As previously mentioned, the advantage of VOSviewer is that it offers the possibility to observe the evolution of the analyzed subject in the selected time interval. The Overlay Map (Figure 2) shows a colorful evolution of the main keywords during the selected period, 2010-2020. Thus, we can see that from 2010 to 2016, were studied with priority topics such as commercialization or societies and institutions, which are highlighted in shades of purple and indigo. The temporal association of the 2 expressions induces the idea that the academic debates about entrepreneurship began to propose, at least in theory, the collaboration between universities, society, and industry to commercialize knowledge and economic development (Hapenciuc et al., 2016).

The shades of blue and turquoise show the transition to 2017, bringing to attention an agglomeration of terms, which denotes the intensification of publications on this topic but also a greater variety of expressions. We refer here to expressions such as entrepreneurship education, innovation, third mission, or technology transfer. What can be depicted very clearly is the fact that the paradigm of the entrepreneurial university is in the foreground and takes shape. Crossing the year 2018, we identify the expressions in tones of green that highlight the connection between universities, entrepreneurs, and industry in terms of regional economic development and technology commercialization.

The yellow color flags show the concepts that appeared most recently in the literature, respectively after 2018. However, the variety of expressions in yellow frames induces a little confusion and does not clearly define a certain trend. Associating terms such as ecosystem, knowledge management, entrepreneurial orientation, competition, or regional development, specified from the center to the margins, i.e. in the order of their popularity, we can deduce only a broadening of the scope of discussions towards other research goals. In conclusion, the overlay map reveals in a gradient of nuances, the temporal evolution of discussions on the central concept of "entrepreneurial university" and at this time provides numerous indications of where the interest of authors around the world is focused, which is a real advantage for any researcher.



**Figure 2. Overlay visualization by VOSviewer software version 1.6.16
for “entrepreneurial university”
(author’s research)**

Bibliographic coupling of the countries

The analysis of bibliographic coupling by countries is represented in Figure 3 with network visualization and reveals the number of common citations (either from within or apart from the set of papers analyzed) within the same group of publications focusing on “entrepreneurial university”. As technical specifications, we mention that we decided that a country’s minimum number of articles was 2 to have stronger links and a relevant distribution (Karakus et al., 2019). From a total of 60 countries, only 23 met the threshold of at least 2 items. As shown in Table 2 for each country on the network were calculated: the number of publications, the number of citations, and total link strength. We arranged the countries in descending order of the total citations number, as it is considered the most relevant.

Observing table 2 it is easy to notice that the country with the greatest number of citations is the United Kingdom (1.685), the greatest number of publications (43), and the greatest total link strength (22.729). The countries that follow the same pattern, ranging in top 5, are Spain with 1.427 citations, 29 publications, and 20.714 total link strength; the United States with 1.227 citations, 28 publications, and 13.069 total link strength; Italy is ranked fourth with 1.018 citations, 35 publications, and 19.957 total link strength; and Ireland with 619 citations, 6 publications, and 3574 total link strength. Ranking in fifth place, it is worth mentioning that Ireland registers a quite big number of citations with only 6 published papers on the topic of the entrepreneurial university, which emphasizes a higher scientific quality of the publications (Karakus et

al., 2019). The other countries included in the top 10 are Sweden with 480 citations and 20 publications, France with 397 citations and 11 publications, Germany with 381 citations and 13 publications, the Netherlands with 376 citations and 9 publications, and Belgium with 350 citations and 5 publications. In the case of Belgium, it is worth mentioning that the 5 papers have registered a good number of citations which involves a high research level. Table 2 shows the data for all the countries identified by the software (Karakus et al., 2019).

Table 2. Hierarchy of countries' indicators (author's research)

No	COUNTRY	CITATIONS	PUBLICATIONS	TOTAL LINK STRENGTH
1	United Kingdom	1685	43	22729
2	Spain	1427	29	20714
3	United States	1227	28	13069
4	Italy	1018	35	19957
5	Ireland	619	6	3574
6	Sweden	480	20	9941
7	France	397	11	7640
8	Germany	381	13	4285
9	Netherlands	376	9	4828
10	Belgium	350	5	2275
11	Australia	222	7	2483
12	Brazil	171	9	4510
13	Austria	166	7	2597
14	Russian Federation	117	16	4218
15	Norway	107	6	3703
16	Malaysia	94	9	3162
17	Canada	83	5	2857
18	Denmark	72	5	1357
19	Finland	67	7	3396
20	Mexico	60	7	4832
21	Turkey	46	8	3708
22	Portugal	43	7	4455
23	Iran	38	8	2576

In Figure 3, we can observe the four-country clusters. Cluster 1, in red color, is the largest one, including 9 countries: Australia, Austria, Belgium, Canada, France, Italy, Russian Federation, United Kingdom, and the United States. The second cluster includes 8 countries, symbolized in green color: Brazil, Denmark, Finland, Germany, Iran, Malaysia, Portugal, and Turkey. Cluster number 3, is represented in blue by the following three countries: Ireland, Mexico, and Spain. Cluster 4 is yellow and includes the Netherlands, Norway, and Sweden. The significance of the clusters is that countries belonging to the same cluster have been citing each other more frequently on the topic of the entrepreneurial university. From the four clusters we have, we can observe that the first two are rather heterogeneous and include mainly highly developed countries while clusters 3 and 4 seem to have a different dynamic. Cluster 3 is rather

homogeneous and includes countries with similar geographic characteristics as wide sea-openings. About cluster 4 we can say that is also rather homogeneous and comprises so-called neighboring countries which share similar geographical, cultural, and economic frameworks (Rinaldi et al., 2017).

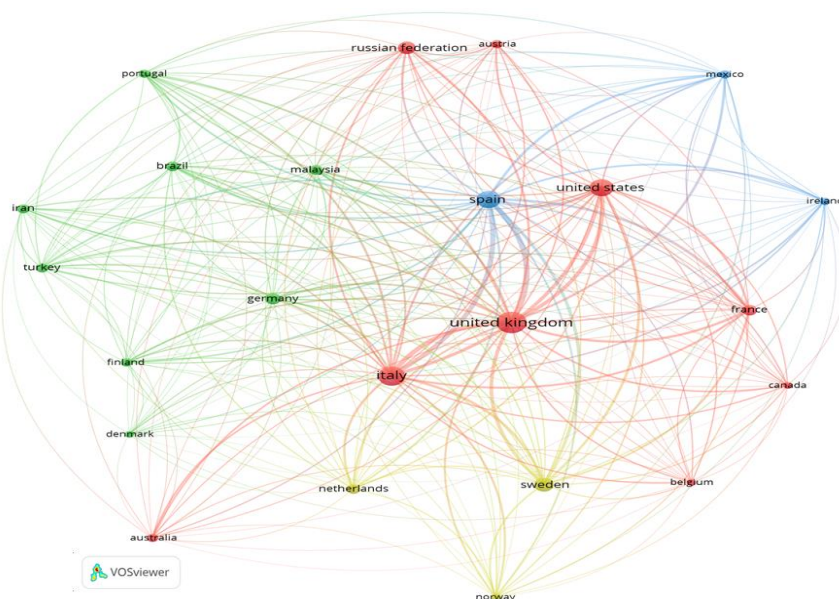


Figure 3. Network visualization of bibliographic coupling of countries by VOSviewer software version 1.6.16 for "entrepreneurial university" (author's research)

Overlay visualization of countries

Another interesting analysis we do based on the overlay visualization is the colorful yearly evolution of publications by country. Starting with deep blue color, which means papers before 2014, we identify countries like Ireland, Canada, and Belgium. Following we observe the light blue color that stands for the year 2015 and reveals countries like the United States, the United Kingdom, Sweden, and the Netherlands. We also must emphasize that these frames are located mostly at the center which means also a higher number of publications by comparison to the first ones, which are located at the edge of the network. Pointing exactly to the year 2016, we have very bright shades of green for countries like Malaysia, at the center, and Iran, at the edge.

The color gradient continues with shades of yellow that symbolize the transition from 2016 to 2017 and we have here Italy, right at the center – that means a high number of publications (actually 35), then we have Germany, also close to the center (13 publications) and Australia in a lower corner with 7 publications. Continuing to the right, in 2017 start shades of orange corresponding to the Russian Federation, Brazil, Finland, and Denmark – a grouping that shows simultaneous publications and co-citations. Next, we have two coral color countries located towards the edge which are

Portugal and Turkey with a growing number of publications since 2018. The gradient legend ends in red color depicting Mexico, France, and Norway as having the latest publications on the topic of the entrepreneurial university. Publications from these three countries intensively connect to the light blue countries like the United States, United Kingdom, and Sweden – which emphasizes the idea that even recent works rely on previous highly cited publications.

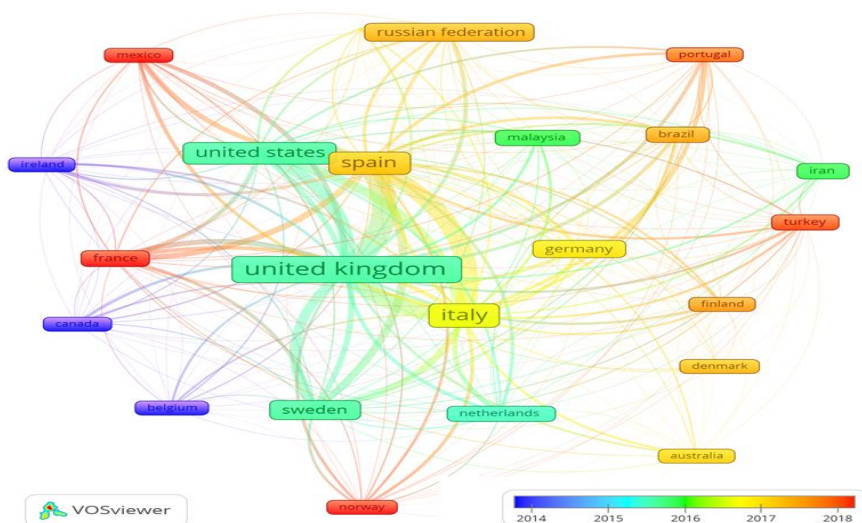


Figure 4. Overlay visualization of countries by VOSviewer software version 1.6.16 for "entrepreneurial university" (author's research)

Conclusions

Concluding over the general scope of the research we state that through the two-dimension analyses and the four visual outputs (in Figures 1, 2, 3, and 4) we have revealed important insights about the evolution of the "entrepreneurial university" concept. According to the co-occurrence network visualization, the composition of the 5 clusters reveals the connection of two areas of research: a rather theoretical one for knowledge transfer and a rather pragmatic one for technology commercialization. At this point, we recall the clusters titles: 1. entrepreneur, 2. knowledge transfer, 3. commercialization, 4. entrepreneurial university, and 5. technology transfer.

On the other hand, the overlay co-occurrence visualization shows in a gradient of nuances, temporal evolution of discussions on the central concept of "entrepreneurial university" and at this time provides numerous indications of where the interest of authors around the world is focused, which is a real advantage for any researcher. As observed, the discussions starting in 2016 included issues like societies and institutions, in 2017 topics like entrepreneurship education, innovation, or third mission, in 2018 discussions focused on economic development and technology

transfer and in 2019 and after the paradigm shifted towards issues like ecosystems, knowledge management, and regional development.

The second dimension of the VOSviewer analysis relied on countries' co-citation protocol which was similar to the previous one. The first map or network visualization of countries' co-citation reveals the formation of 4 country clusters that are frequently citing each other's publications. We recall only the top 3 of the most cited countries: the United Kingdom, Spain, and the United States. In this case, the overlay visualization of countries' co-citation showed unique results as in 2016 the publications were intense in countries like Ireland, Canada, and Belgium, and in recent years the topic of the entrepreneurial university is mostly debated by authors from Mexico, France, and Norway.

As a final conclusion, by correlating the two types of analysis, we state that there is no doubt that research globalization is generating positive effects. During the analyzed period, sub-themes of the entrepreneurial university were many perhaps due to the need of innovating the research. The urgent need for originality and continuous innovation in research might generate confusion while trying to track the main streams of a certain subject. VOSviewer analysis facilitates to drive our research to the conceptual path we need, as detailed as we want and as back in time as we consider useful. For a future paper, we shall enlarge the time horizon and also the publications database to capture more precise and novel information.

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