



## PAPER

### Mapping top leading regions and trending topics in innovation policy research

**Authors:** *Pedro López-Rubio<sup>1</sup>, Norat Roig-Tierno<sup>2</sup>, Francisco Mas-Verdú<sup>3</sup>*

**Emails:** *pedloru@doctor.upv.es; norat.roig@esic.edu; fmas@upvnet.upv.es*

**Department and University:**<sup>1,2,3</sup>*Departamento de Economía y Ciencias Sociales, Universidad Politécnica de Valencia (UPV), Spain*

<sup>2</sup>*ESIC Business & Marketing School, Valencia, Spain*

**Subject area:** Economy of knowledge, creativity and geography innovation

**Abstract:** Innovation policies are paramount when trying to approach a more social and sustainable economic model, so Public Administrations are increasingly supporting companies' innovation through different promoting instruments that improve the business environment. Besides, in the last decade the number of academic studies on innovation policy research has grown significantly, aiming at providing rigor and systematicity for the design of these policies, whose effects can also be assessed by this research. This bibliometric study analyzes the academic literature on innovation policy research from 1960 to 2017, using Web of Science Core Collection database to gather all related data. The present study identifies the most relevant contributions in terms of institutions, countries, impact and research topics. The University of Manchester in the UK is the most productive institution and has the highest h-index, while the Lund University in Sweden leads the total citations rank, and the Wageningen University in Netherlands leads the citations per study. Besides, the UK is the leading country, followed by Netherlands, the USA, Sweden, Denmark, Germany, Spain, Austria, France or China depending on the variable used to rank. Moreover, trending research topics in innovation policy are identified through the analysis of the most common author keywords in this field. Finally, the visualization of similarities is displayed by means of some bibliometric mappings of bibliographic coupling and co-occurrence of keywords, implemented with the VOSviewer tool.

**Keywords:** Innovation policy, bibliometric analysis, Web of Science, VOSviewer

**JEL codes:** O29 O30 O38

## **1. Introduction**

Over the last few decades, the number of academic studies on innovation research has grown exponentially (Fagerberg & Verspagen, 2009; Martin, 2012; Shafique, 2013). Moreover, its rate of growth is greater than in other research areas, which denotes that academics from multiple disciplines are interested in the effects of innovation activities and processes in our economies (Cancino, Merigó & Palacios-Marqués, 2015). The main global objective of this kind of research is the development of new business taking also into consideration the utmost importance of achieving a higher social and economic well-being (Cajaiba-Santana, 2014; Igarashi & Okada, 2015; Neumeier, 2012).

Innovation policies play a leading role within innovation research. This kind of policies are paramount to approach a more social and sustainable economic model (Mazzucato, 2013; Mazzucato & Semieniuk, 2017). Consequently, regional and national authorities as well as international organizations are increasingly focusing on innovation policies, providing wide support to companies' innovation through different promoting instruments that aim at improving the business environment (OECD, 2011, 2015; European Commission, 2014a; UNIDO, 2013; Edler, Cameron & Hajhashem, 2015).

Also, in the last years scholars from all over the world are focusing even more on innovation policies research, due to their important role in the creation of innovations as well as in the development of more social and sustainable economic models. This research includes the most relevant issues related to innovation policies, such as systems of innovation, policy design, implementation and evaluation, or innovation policies aimed at solving particular social challenges (Flanagan & Uyarra, 2016; Edler & Fagerberg, 2017; Coenen, Asheim, Bugge, & Herstad, 2017; Uyarra & Ramlogan, 2016), as well as reviews of innovation policies implemented in different regions or countries (McCarthy, Puffer, Graham & Satinsky, 2014; Fu, Wing & Hou, 2016; Asheim & Moodysson, 2017; Isaksen, Normann & Spilling, 2017).

In view of this background, the main objective of this article is to analyze the academic studies on innovation policy research using bibliometrics, aiming at mapping top leading regions (countries and institutions/universities) and topics in this research field. Firstly, up to now there are many bibliometric studies about innovation and related topics like R&D (Research and Development). Some of these studies are focused, for instance, on the contribution of universities and countries in these fields (Moed, Burger, Frankfort & Van Raan, 1985; Linton, 2004; Cancino, Merigó & Coronado, 2017a) or on

the main authors in innovation research (Cancino, Merigó & Coronado, 2017b), but there is no bibliometric study focused on innovation policies. Secondly, for scholars who want to prepare their research on innovation policies, the great number of academic studies on this topic may hinder them achieving a general picture when starting to search information, so this article shows the aim and span of the existing studies, especially focusing on discovering the top leading regions (countries and institutions/universities) and trending research topics. Finally, readers can easily look up the most important information about innovation policy research, like the publication and citation evolution, the most productive and influential institutions and countries, or the analysis of the most common author keywords. Therefore, this article comes to complement the previous existing research on innovation policy as well as on bibliometric analysis.

The rest of the article is structured in the following sections. Section 2 describes the bibliometric methods as well as the data used in the paper. Section 3 presents the results of the bibliometric analysis. Finally, Section 4 gathers the main findings.

## **2. Bibliometric methods and data**

The research method used in this article is the bibliometric analysis. Bibliometrics (Pritchard, 1969) is usually defined as the research field that studies all the quantitative aspects of the bibliographic material (Broadus, 1987). Scientometrics (Nalimov & Mulchenko, 1969) and informetrics (Nacke, 1979) are also terms used to define the study of all aspects of the literature on science and technology. Nowadays, bibliometrics, scientometrics, and informetrics are considered analog terms that define the quantitative study of bibliographic material (Sengupta, 1992).

The most commonly used bibliometric indicators include the total number of articles, the total number of citations, and the h-index (Hirsch, 2005; Merigó, Gil-Lafuente & Yager, 2015). The total number of articles is a proxy variable of productivity, whereas the total number of citations and the h-index are proxy variables of influence. Both type of variables should be considered in bibliometric analyses in order to measure the scientific production more accurately and objectively (Podsakoff, MacKenzie, Podsakoff & Bachrach, 2008). Neither a large number of publications nor a greater number of citations implies necessarily higher quality of research. The h-index tries to overcome these drawbacks by taking into account both the number of articles and the number of citations at the same time, although the h-index is not free from criticism

either: sometimes a researcher with a low number of articles published but of high influence (many citations) could have the same h-index as a researcher with great experience and many articles, but not all of them cited with high frequency (Alonso, Cabrerizo, Herrera-Viedma & Herrera, 2009). In this case, the indicator would treat the productivity alike even though it is obviously different. However, this issue may be arranged by calculating other indicators that improve the accuracy of the bibliometric analysis, such as the citations per year and the citations per study.

The bibliometric analysis conducted in this article deals with the indicators mentioned above. Furthermore, to ensure an accurate visualization of some results, different bibliometric mappings are implemented. A bibliometric mapping is a spatial representation of how research fields, disciplines, authors and their affiliations, and articles and their keywords are interrelated (Small, 1999); therefore, it allows monitoring a scientific field to determine its cognitive structure, its evolution and its main actors (Noyons, Moed & Van Raan, 1999).

The most commonly depicted bibliometric mappings include: bibliographic coupling, co-citation, co-authorship and keyword co-occurrence (Merigó, Cancino, Coronado & Urbano, 2016). Bibliographic coupling and co-citation are based on bibliographic references: bibliographic coupling (Kessler, 1963) occurs when two documents cite the same third document (the number of references shared by citing documents); co-citation (Small, 1973; Marshakova, 1973) happens when two documents receive a citation from the same third document (the number of times in which they are cited together). Bibliographic coupling is retrospective, because it calculates a relationship between the set of documents under study, whereas co-citation is essentially a forward-looking perspective, as it calculates a relationship between the references cited by this set of documents (Garfield, 2001). Co-authorship analyzes the number of co-authored documents to study the social structure and research collaboration networks (White & Griffith, 1981). Finally, keyword co-occurrence or co-word analysis is based on the study of the most common keywords used in the document, which determine the conceptual framework of a research field (Callon, Courtial, Turner & Bauin, 1983; Ding, Gobinda & Schubert, 2001).

In order to map the bibliographic material, we use the VOSviewer tool because it supports all the mappings required for this study (Van Eck & Waltman 2010). Nevertheless, there are other bibliographic software tools, each of them with their own

advantages and drawbacks (Cobo, López-Herrera, Herrera-Viedma & Herrera 2011). VOSviewer is freely available and further information can be found at: <http://www.vosviewer.com/>.

### *2.1 Data*

As a source of information, we use Web of Science (WoS) database, owned by Clarivate Analytics, which is the most widely accepted and frequently used database for analysis of scientific publications (Yang et al. 2013). Moreover, this database is considered to be the most important source of data for bibliometric analysis in the sciences (Van Leeuwen, 2006). Compared with other scientific databases like Scopus or Google Scholar, its records are more consistent and standardized (Bettencourt & Kaur, 2011; Adriaanse & Rensleigh, 2013). In this article we specifically analyze the publications about innovation policies indexed in the Web of Science Core Collection database. Currently, Web of Science database includes coverage from the year 1900 to present, having indexed more than 18,000 high impact journals, over 180,000 conference proceedings, and over 80,000 books from around the world.

To obtain all the records of our interest dealing with innovation policies, a series of filters were applied to the WoS Core Collection database. Firstly, we executed the query “innovation policy” OR “innovation policies” until the year 2017 on the database field “Topic” (this database field includes title, abstract and keywords of the publications). Secondly, the result of this query was revised observing that, according to the WoS operating method, this query returned all the records containing not only “innovation policy” in the title, abstract or keywords, but also the records containing, for instance, “innovation-policy”, “innovation, policy” or “innovation: policy”, some of which were not directly related to innovation policies. Therefore, from this set of records we only considered those research areas that are focused on innovation policies from a managerial, design, application, or empirical perspective, giving a total of 21 research areas and 2056 records. Figure 1 shows the 21 research areas considered for this study. It is important to note that one publication can cover multiple research areas.

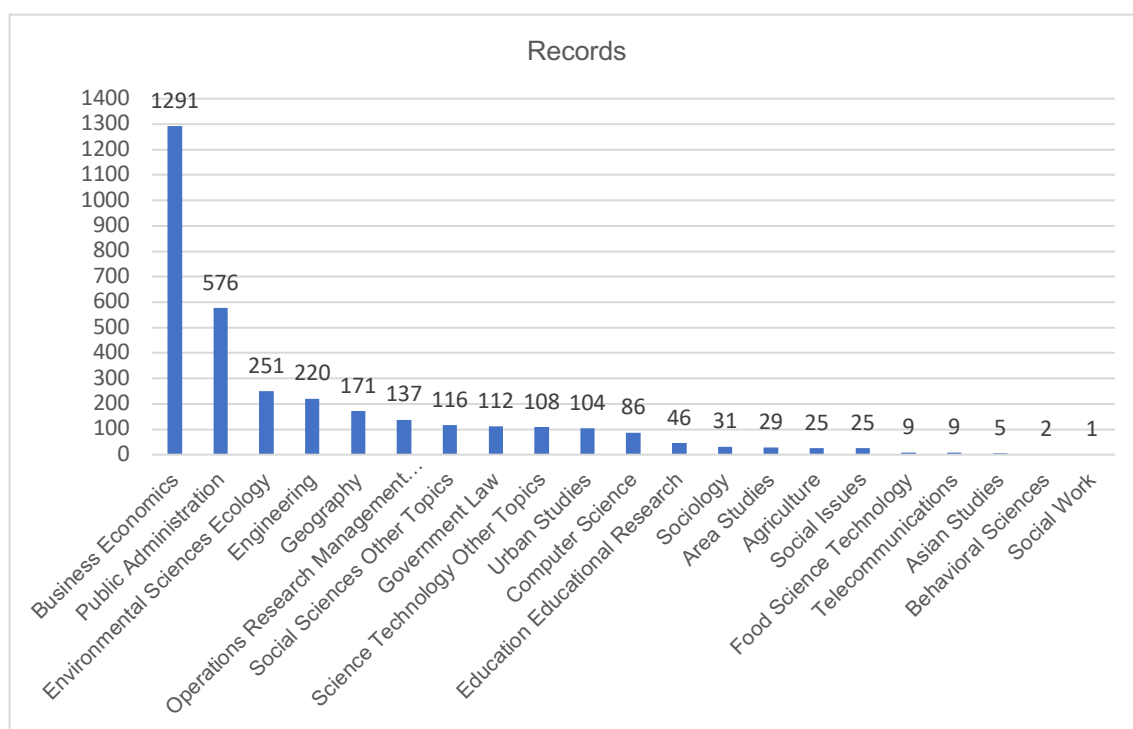


Figure 1. Research Areas selected for this study.

### 3. Results

This section presents the main bibliometric results found in WoS Core Collection for the selected set of documents about innovation policy research until the year 2017. The 2056 studies comprise 1464 articles, 469 meetings, 197 books, 106 reviews, 67 editorials, 2 news, 1 abstract, 1 biography and 1 letter. Up to 2017, the number of citations received by this set of studies is 22,164, making a ratio citations per study of approximately 11. The h-index is 63, which indicates that, of the set of 2,056 studies, 63 have received 63 citations or more.

#### 3.1. Publication and citation evolution

Figures 2 and 3 show, respectively, the annual number of studies on innovation policy research indexed in WoS Core Collection until 2017 and the total number of citations received by these studies.

Until 1980, there is only one study published in 1962 and another one in 1978. From 1980 on the production of documents is continuous. The 50 and 100 studies thresholds are overcome in 2005 and 2009, respectively, reaching its maximum of 294 studies in 2017. Therefore, the significant and constant increase of innovation policy studies begins in year 2005. This rise is mainly owed to three factors: (1) the research production has considerably improved with the fast development of Internet and

computers because it facilitates to collect data and to be connected to the newest trends in any research field, (2) the remarkable increase in the number of researchers along the developing nations and the consolidation of the knowledge economies, and (3) the importance of these studies to approach a more social and sustainable economic model.

These publications have received a wide attention by the scientific community, as judged by the high number of citations. Again, the consolidation of the knowledge-based economies as well as the search of more social and sustainable economic models are considered to be crucial in the increase of the number of citations of innovation policy studies. As expected, according to the annual number of studies, the number of citations is very low until 1997, when studies receive 1577 citations. The maximum number of citations is reached in 2005, with 2554 citations.

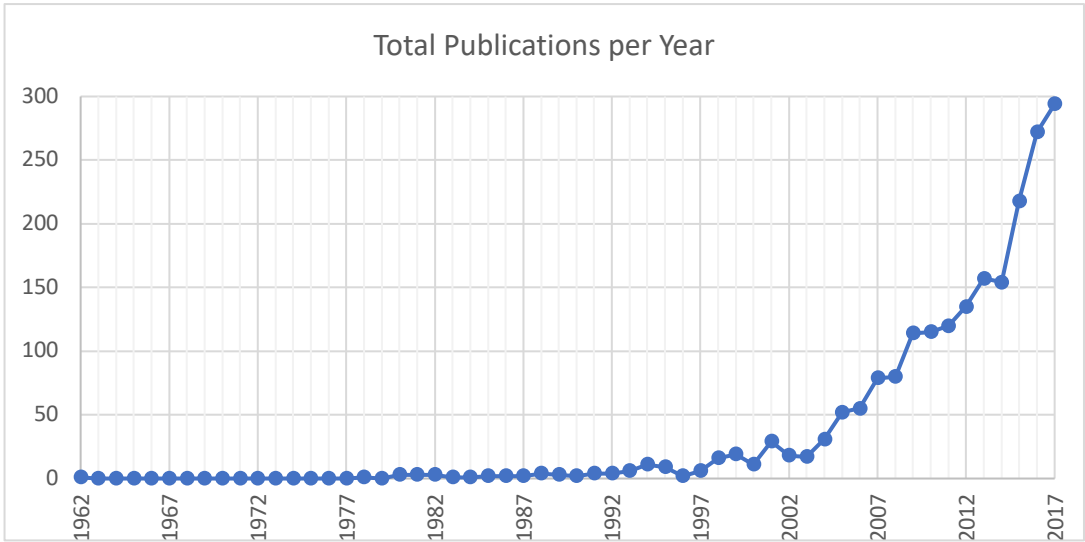


Figure 2. Annual number of studies on innovation policy research.

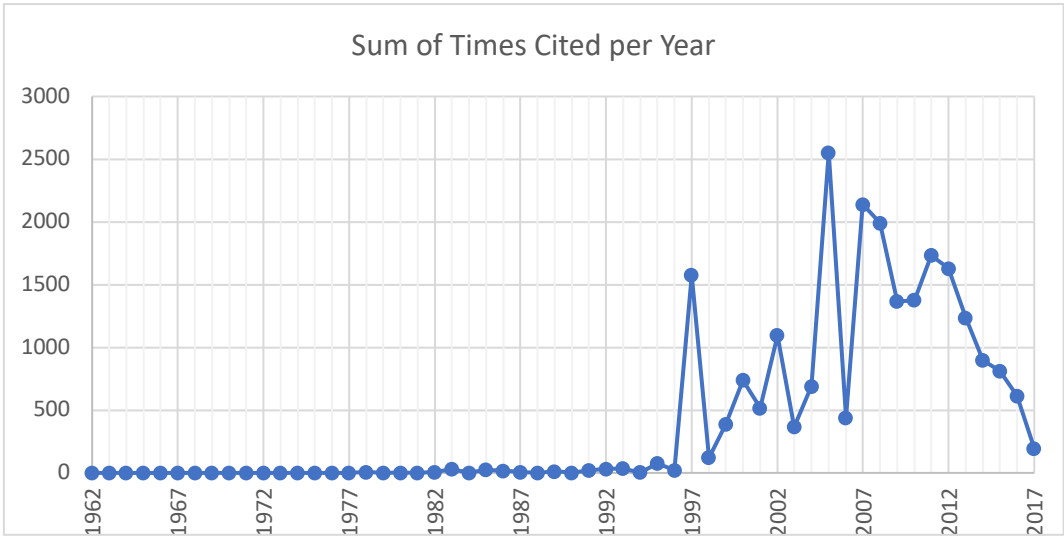


Figure 3. Total number of citations per publication year.

### 3.2. *The most productive and influential institutions in innovation policy research*

Table 1 ranks the most productive institutions in the field of innovation policy research by considering the 30 institutions with 10 or more published documents. The results include institutions from the UK, the USA, European countries -such as Sweden, Netherlands, Germany, Estonia, Italy, Finland, Spain, Norway, Belgium and Czech Republic-, Canada, China and Russia.

Table 2 presents the top 5 institutions according to the following four categories: the total number of studies, the total number of citations, the h-index and the ratio citations per study. This table includes one institution from Sweden (Lund University), three from Netherlands (University of Utrecht, Maastricht University and Wageningen University), two from the UK (University of Manchester and University of Sussex), and one from the USA (Georgia Institute of Technology) and Norway (University of Oslo). Within all these top 5 there are only two institutions included in all the four categories: the Lund University and the University of Utrecht. Furthermore, the University of Manchester and the University of Sussex appear in three of the four top 5; the Georgia Institute of Technology and the Maastricht University appear in two of them; and the Wageningen University and the University of Oslo only appear in the top 5 citations per study ranking.

According to Cancino et al. (2017a), the ranking of the leading universities in innovation research is highly dominated by institutions from the USA. Surprisingly, in the particular case of innovation policy research there are only three institutions from the USA in the ranking (the Georgia Institute of Technology in the 4th position, the Massachusetts Institute of Technology in the 26th position, and the University of California Berkeley in the 29th position), while institutions from the UK, Netherlands or Sweden lie ahead of those from the USA. This reveals that institutions from the UK and these European countries are more productive and influential in innovation policy research than those from the USA. The reason behind is that the USA government usually adopts more liberal policies than the UK and the continental European countries. These results show that this also applies to the particular case of innovation policies and, consequently, innovation policy is a more popular and influential research topic in the UK and continental European countries than in the USA. The deep focus of the European Union on innovation policies also reinforces this trend.



R	Institution	Country	TS	TC	h	TC/TS	ARWU	QS
1	Univ Manchester	UK	53	1270	16	24.0	38	34
2	Lund Univ	Sweden	52	1502	14	28.9	101-150	78
3	Univ Sussex	UK	31	550	14	17.7	201-300	228
4	Georgia Inst Technol	USA	29	272	10	9.4	85	70
5	Univ Utrecht	Netherlands	28	827	11	29.5	47	109
6	Fraunhofer Inst Syst & Innovat Res ISI	Germany	26	399	9	15.4	-	-
7	Tallinn Univ Technol	Estonia	22	118	6	5.4	-	601-650
8	Maastricht Univ	Netherlands	22	783	11	35.6	201-300	200
9	Politecn Milan	Italy	18	204	7	11.3	201-300	170
10	Lappeenranta Univ Technol	Finland	17	172	7	10.1	-	501-550
11	Univ Politecn Valencia	Spain	16	171	6	10.7	401-500	373
12	Univ Twente	Netherlands	16	162	6	10.1	301-400	179
13	Univ Oslo	Norway	15	533	4	35.5	62	142
14	Delft Univ Technol	Netherlands	15	96	5	6.4	151-200	54
15	Univ Toronto	Canada	15	63	4	4.2	23	31
16	Tsinghua Univ	China	15	26	3	1.7	48	25
17	Katholieke Univ Leuven	Belgium	14	251	6	17.9	90	71
18	Univ Cambridge	UK	14	220	8	15.7	3	5
19	Masaryk Univ	Czech Republic	14	37	4	2.6	-	551-600
20	UCL	UK	12	109	6	9.1	16	7
21	Univ Tampere	Finland	12	85	5	7.1	-	551-600
22	European Commiss	Spain	12	68	5	5.7	-	-
23	Univ Exeter	UK	12	58	4	4.8	151-200	158
24	Natl Res Univ	Russia	12	34	3	2.8	-	382
25	Univ Birmingham	UK	11	155	4	14.1	101-150	84
26	MIT	USA	11	120	6	11.0	4	1
27	Aalto Univ	Finland	11	83	5	7.6	401-500	137
28	Wageningen Univ	Netherlands	10	392	7	39.2	101-150	124
29	UC Berkeley	USA	10	184	7	18.4	5	27
30	Radboud Univ Nijmegen	Netherlands	10	64	4	6.4	101-150	204

Table 1. The most productive and influential institutions in innovation policy research.

Abbreviations: R = Rank; TS = total studies; TC = total citations; h = h-index; TC/TS = Citations per Study; ARWU = Academic Ranking of World Universities; QS = Quacquarelli Symonds University Ranking.

R	Institution	TS	Institution	TC	Institution	h	Institution	TC/TS
1	Univ Manchester	53	Lund Univ	1502	Univ Manchester	16	Wageningen Univ	39.2
2	Lund Univ	52	Univ Manchester	1270	Lund Univ	14	Maastricht Univ	35.6

3	Univ Sussex	31	Univ Utrecht	827	Univ Sussex	14	Univ Oslo	35.5
4	Georgia Inst Technol	29	Maastricht Univ	783	Univ Utrecht	11	Univ Utrecht	29.5
5	Univ Utrecht	28	Univ Sussex	550	Maastricht Univ	11	Lund Univ	28.9

Table 2. Top 5 leading institutions in innovation policy research.

Another interesting topic related to institutions is how studies on innovation policy research share their cited references based on the authors' affiliation. Figure 4 shows the most productive institutions by using the bibliographic coupling of main institutions in innovation policy research according to the results extracted from WoS Core Collection. Only those institutions with at least 7 publications are considered and the 100 strongest links are displayed.

There are six clusters centered, from largest to smallest, on the Lund University, the Georgia Institute of Technology, the University of Manchester, the University of Sussex, the University of Twente, and the University Polit cnica of Valencia. A look into this mapping shows that clusters are generally formed by institutions from countries that have cultures and/or languages alike, as well as by those which deploy similar policies. This is so because institutions from countries that deploy similar innovation policies often have akin objectives, hence they tend to be influenced by same papers.

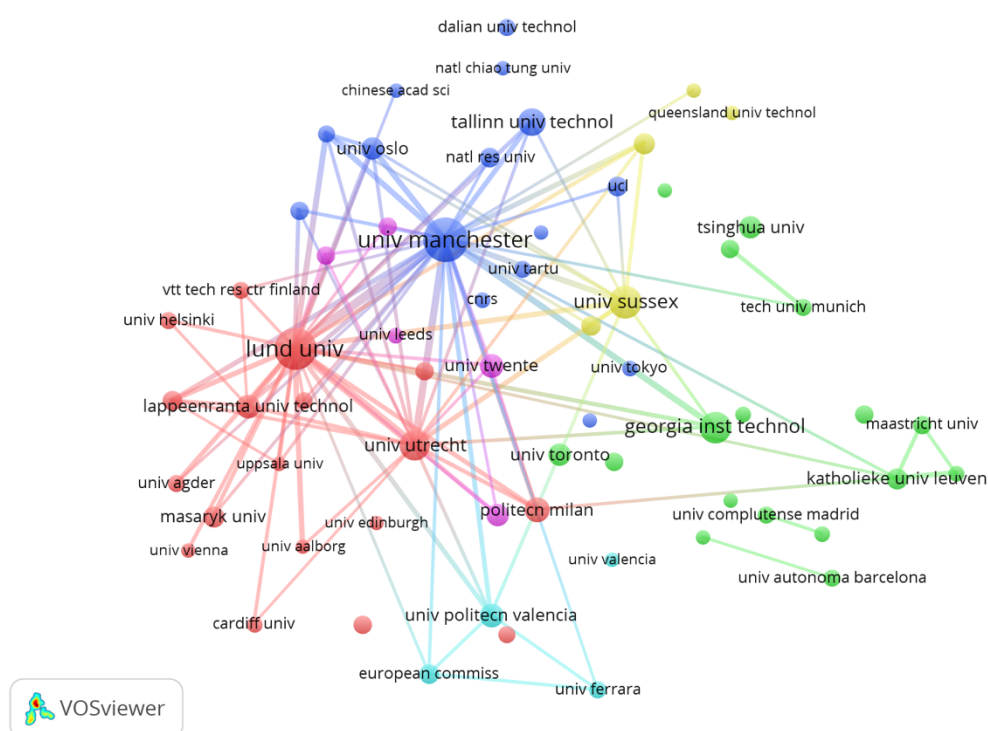


Figure 4. Bibliographic coupling of institutions in innovation policy research.

### 3.3. *The most productive and influential countries in innovation policy research*

Table 3 presents the 25 most productive countries in innovation policy research with 29 or more documents. This ranking is formed by the UK, the USA, European countries - such as Netherlands, Germany, Spain, Italy, Sweden, France, Finland, Norway, Denmark, Austria, Czech Republic, Belgium, Portugal, Estonia, Slovakia or Poland-, China, Russia, Canada, Australia, Brazil and some Asian countries or territories, such as Taiwan and South Korea.

Table 4 presents the top 5 countries according to the following four categories: the total number of studies, the total number of citations, the h-index and the ratio citations per study. On the one hand, considering the total number of studies, which is a proxy variable a productivity, the top 5 comprises the UK with 277 studies, the USA with 233, Netherlands with 156, China with 152 and Germany with 136. On the other hand, the top 5 rankings based on variables of influence are the following: according to the total number of citations the top 5 is the UK with 5192, Netherlands with 3853, the USA with 2770, Denmark with 2208 and Germany with 2207; in the h-index category the top 5 is the UK with an h-index of 34, Netherlands with 29, the USA with 24, and both Germany and Spain with 20; and according to the ratio citations per study the top 5 is Denmark with 40.1 citations per study, Netherlands with 24.7, Sweden with 23.4, Austria with 23.1 and France with 19.2. Therefore, the UK is the leading country in three out of the four previous rankings.

According to Merigó et al. (2016), the USA is the leading country in innovation research in all the previous rankings with a substantial difference over the other leading countries, such as the UK, Canada, Netherlands, Germany or France. However, this study shows that, for the specific case of innovation policy research, the UK is the leading country, followed by Netherlands, the USA, Sweden, Denmark, Germany, Spain, Austria, France or China, depending on the variable used to order the ranking.

Note that China, which occupies the 4th position according to the total number of studies, moves down drastically to the 17th position based on the total number of citations and the h-index, and to the 23rd based on the ratio citations per study. China has developed important innovation policies and deeply promoted innovation research over the last few decades, so there are a great number of Chinese research institutions and Chinese scholars nowadays. As a consequence of that, China has significantly evolved from being an imitative technology latecomer to an innovation-driven economy

(Fu, Wing & Hou, 2016), but these results show that, applying these policies, China have achieved much better results in productivity than in influence variables.

R	Country	TS	TC	h	C/S	Pop	TS/Pop	TC/Pop
1	UK	277	5192	34	18.7	65637.239	4.22	79.10
2	USA	233	2770	25	11.9	323127.513	0.72	8.57
3	Netherlands	156	3853	29	24.7	17018.408	9.17	226.40
4	Peoples R China	152	335	8	2.2	1379999	0.11	0.24
5	Germany	136	2207	20	16.2	82667.685	1.65	26.70
6	Spain	127	1911	20	15.0	46443.959	2.73	41.15
7	Italy	96	766	15	8.0	60600.59	1.58	12.64
8	Sweden	93	2178	18	23.4	9903.122	9.39	219.93
9	France	83	1593	16	19.2	66896.109	1.24	23.81
10	Finland	81	684	16	8.4	5495.096	14.74	124.47
11	Russia	69	68	4	1.0	144342.396	0.48	0.47
12	Canada	61	535	11	8.8	36286.425	1.68	14.74
13	Norway	59	838	12	14.2	5232.929	11.27	160.14
14	Australia	56	382	11	6.8	24127.159	2.32	15.83
15	Denmark	55	2208	17	40.1	5731.118	9.60	385.27
16	Austria	49	1130	12	23.1	8747.358	5.60	129.18
17	Czech Republic	41	106	6	2.6	10566.33	3.88	10.03
18	Taiwan	38	331	8	8.7	23425	1.62	14.13
19	Belgium	36	381	11	10.6	11348.159	3.17	33.57
20	Brazil	35	141	5	4.0	207652.865	0.17	0.68
21	South Korea	35	133	5	3.8	51245.707	0.68	2.60
22	Portugal	33	457	8	13.8	10325.45	3.20	44.26
23	Estonia	31	155	7	5.0	1315.79	23.56	117.80
24	Slovakia	30	94	6	3.1	5430.8	5.52	17.31
25	Poland	29	29	3	1.0	37970.09	0.76	0.76

Table 3. The most productive and influential countries in innovation policy research.

Abbreviations are available in the previous tables except for: TS/Pop = Total studies per million inhabitants; TC/Pop = Total citations per million inhabitants; Population is in thousands.

R	Country	TS	Country	TC	Country	h	Country	TC/TS
1	UK	277	UK	5192	UK	34	Denmark	40.1
2	USA	233	Netherlands	3853	Netherlands	29	Netherlands	24.7
3	Netherlands	156	USA	2770	USA	24	Sweden	23.4
4	China	152	Denmark	2208	Germany	20	Austria	23.1
5	Germany	136	Germany	2207	Spain	20	France	19.2

Table 4. Top 5 leading countries in innovation policy research.

Figure 5 shows the most productive countries by using the bibliographic coupling of main countries on innovation policy research according to the results extracted from WoS Core Collection. Only those countries with at least 10 publications are considered and the 100 strongest links are displayed. The objective is to represent how studies on innovation policy research share their cited references based on the country of the authors' affiliation.

The biggest cluster includes the UK and Spain as the main nodes, while the second one has the USA and China as principal nodes, and the third one is centered on Netherlands and Germany. As occurred with the bibliographic coupling between institutions, the clusters are generally formed by countries that have languages and/or cultures alike, or by those which deploy similar innovation policies.

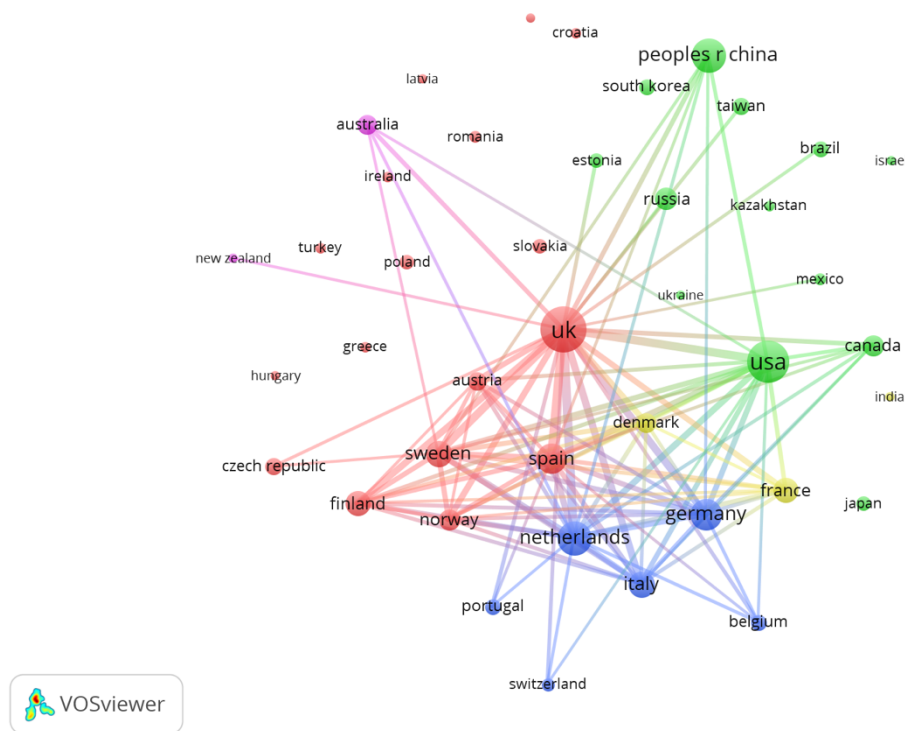


Figure 5. Bibliographic coupling of countries in innovation policy research.

### 3.4. Analysis of studies citing documents on innovation policy research

Another interesting topic is who cites this set of studies on innovation policy research, because this indicates its influence. Table 5 presents the first 20 institutions and countries that have more citing studies. The institutions and countries are taken from the authors' affiliation. There is a total of 14684 citing documents from WoS Core Collection.

It is usual that institutions or countries with a high number of articles in a research topic, also have a significant number of studies citing the articles on this given topic, because their published material tend to influence future research in these same institutions or countries. However, there may be institutions or countries in this citing articles' ranking that do not appear in the rankings of innovation policy research, which allow us to find other institutions or countries deeply focused on innovation policy research.

Regarding the institutions, there are eleven out of the twenty that are also included in the innovation policy research ranking of institutions, but there are nine that only appear in the citing articles' ranking. These institutions are the CSIC in Spain (the 7th with 133 citing studies), the Wales University of Cardiff (the 8th with 130 citing studies), the London School Economics Political Science (the 12th with 114 citing studies) and the University of Nottingham (the 20th with 98 citing studies) in the UK, the Erasmus University Rotterdam (the 9th with 130 citing studies) and the Vrije University Amsterdam (the 17th with 108 citing studies) in Netherlands, the CNRS (the 10th with 126 citing studies) in France, the Aalborg University (the 15th with 111 citing studies) in Denmark and the Chinese Academy of Sciences (the 18th with 107 citing studies).

Regarding the countries, there is only one country that appears in the citing articles' ranking and is not included in the innovation policy research ranking: Switzerland in the 20th position with 282 citing studies.

R	Institution	Docs	Country	Docs
1	Utrecht Univ	248	UK	2404
2	Lund Univ	237	USA	2096
3	Univ Sussex	222	Netherlands	1270
4	Univ Manchester	210	Spain	1187
5	Wageningen Univ	184	Peoples R China	1165
6	Univ Politecn Valencia	153	Germany	1119
7	CSIC	133	Italy	999
8	Cardiff Univ	130	Sweden	683
9	Erasmus Univ Rotterdam	130	Canada	599
10	CNRS	126	France	573
11	Delft Univ of Techn	114	Australia	569
12	London Sch Economics	114	Finland	463
13	Univ Toronto	114	Taiwan	434
14	KU Leuven	112	Denmark	428
15	Aalborg Univ	111	Norway	407
16	Georgia Inst Techn	110	Belgium	304

17	Vrije Univ Amsterdam	108	Austria	291
18	Chinese Academy of Sciences	107	Portugal	287
19	Univ Cambridge	100	South Korea	283
20	Univ Nottingham	98	Switzerland	282

Table 5. Number of documents citing studies on innovation policy research.

### 3.5. *Analysis of the most common author keywords in innovation policy research*

The purpose of this analysis is to show the conceptual framework as well as the cognitive state and evolution of the innovation policy research. A limitation concerning the analysis of the most common author keywords is that, of the 2056 publications, there are 621 (30.2%) indexed in WoS database with the author keywords field in blank.

Table 6 presents the list with the 20 most common author keyword in innovation policy research for three different periods of time: Global (1960-2017), from 2010 to 2017, and from 2000 to 2009. Of the 2056 publications, there are 1465 studies (71.3%) published between 2010 and 2017, and 486 studies (23.6%) published between 2000 and 2009. Only 105 studies (5.1%) were published between 1960 and 1999, which shows that innovation policy research was not a very prolific topic in the last century. Although in the 2000s there was an increase of studies, almost three quarters of the studies were published in the 2010s.

Obviously, the number of studies within each period of time affects to the author keywords thresholds. In the 1960-2017 and 2010-2017 periods, all the keywords in the list have more than 15 occurrences, while in the 2000-2009 only the first six keywords in the rank occur more than 15 times.

The top 14 comprises the same author keywords in the periods 1960-2017 and 2010-2017, with some minor changes in the order. This top 14 includes the keywords “Innovation policy”, “Innovation”, “R&D”, “Innovation system”, “Regional innovation system”, “National innovation system”, “Policy”, “China”, “Entrepreneurship”, “Regional development”, “Patents”, “European Union”, “Foresight”, and “SMEs” (Small and Medium-sized Enterprises).

On the one hand, some of the previous keywords are also top in the ranking between 2000 and 2009, such as “Innovation policy”, “Innovation”, “Policy”, “R&D”, “Innovation system”, “Regional innovation system” and “National innovation system”,

which reveals that these are research concepts in innovation policy during all the years considered in this study (1960-2017).

On the other hand, there are other interesting author keywords that are not included in the rank of 2000-2009 but emerge certainly in 2010-2017. Therefore, such these keywords are newer research concepts that have become trending topics in latest years. This is the case of the following keywords: “Entrepreneurship”, “Patents”, “European Union”, “SMEs”, “Open innovation”, “Innovation performance”, “Science”, “Industrial policy” and “Economic growth”. Besides, the keyword “China” holds the 7th position in 2010-2017 with 29 occurrences, whereas in 2000-2009 was in the 18th position with only 5 occurrences. These author keywords, which have strongly emerged from year 2010, point out the newest trends in innovation policy research.

Firstly, the European Union is one of the most active international organizations in stimulating the innovation processes (Bergek, Jacobsson, Carlsson, Lindmark & Rickne, 2008), especially after the world economic crisis of year 2008 which provoked the EU’s longest-ever recession. The European Commission set out in its Policy Communication of June 2014 (European Commission, 2014b) its priorities for innovation, by means of the Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, which are: support innovation development in priority areas and in SMEs (mainly through its innovation policy Horizon 2020); foster the broad commercialization of innovation in the UE; develop sector policies to modernize the EU’s industrial base and accelerate the market uptake of Key Enabling Technologies; monitor innovation performance and innovation uptake in order to identify developments that require policy changes; improve regulatory conditions for innovation measures for start-ups, entrepreneurship, access to finance, digital transformation, intellectual property and patents; and support the development and cooperation of clusters to boost SME innovation. All these issues are trending topics in innovation policy research in the last years and that is why scholars from all over the world are focusing on analyzing these EU priorities for innovation as well as their effects over the social and economic development. As a consequence of that, academic literature on innovation policy and related research concepts, such as “Entrepreneurship”, “Patents”, “SMEs”, “Open innovation”, “Innovation performance”, “Science”, “Industrial policy”, and “Economic growth”, is increasing over the last years.



Secondly, the innovation systemic approach is nowadays the model generally adopted in developed countries (OECD, 1997). Furthermore, this systemic approach is usually complemented with two other models: the Triple Helix model (Etzkowitz & Leydesdorff, 2000), which considers that the origin point of the innovation process is determined by the relationship between Science, Industry and Public Administrations; and the Open Innovation model (Chesbrough, 2003), which considers firms boundaries permeable to the outside, so firms open new markets and they carry into the current market and also into the new markets innovations generated, both within and outside of the own organization. For this reason, scholars are focusing even more on the research concepts related to these innovation models, increasing the scientific production on these issues.

Lastly, China is an emerging country which is strongly investing in research and innovation for the last few decades with a certain success, so scholars from all over the world are deeply analyzing the Chinese innovation policies and their effects. Due to these innovation policies, China has considerably evolved to an innovation-driven economy. Additionally, in the particular case of China, the Triple Helix model and the Open Innovation model are playing a key role, because they have allowed a fluent interaction between the Chinese government, the multinational enterprises and the universities. Moreover, the well-funded programs to build up innovation infrastructure to increase the absorptive capacity of Chinese firms have achieved a successful foreign technology transfer into Chinese firms (Fu, Wing & Hou, 2016).

	Global (1960-2017)		2010-2017		2000-2009	
R	Keyword	Occurrences	Keyword	Occurrences	Keyword	Occurrences
1	Innovation policy	508	Innovation policy	379	Innovation policy	123
2	Innovation	325	Innovation	253	Innovation	69
3	R&D	64	R&D	48	Policy	17
4	Innovation system	57	Innovation system	40	R&D	16
5	Regional innovation system	50	National innovation system	39	Innovation system	16
6	National innovation system	48	Regional innovation system	34	Regional innovation system	16
7	Policy	46	China	29	National innovation system	9
8	China	34	Entrepreneurship	28	Technological change	7
9	Entrepreneurship	32	Policy	28	Clusters	6
10	Regional development	31	Regional development	26	Technology	6
11	Patents	29	Patents	25	Foresight	6
12	European Union	26	European Union	21	Technology policy	6

13	Foresight	25	Foresight	19	Technology innovation	6
14	SMEs	22	SMEs	19	Regional development	5
15	Technology	21	Open innovation	18	Innovation management	5
16	Industrial policy	21	Innovation performance	18	Knowledge economy	5
17	Regional policy	20	Science	17	Networks	5
18	Technological innovation	20	Industrial policy	17	China	5
19	Innovation performance	20	Region	16	Regional policy	4
20	Science	19	Economic growth	16	Creative industries	4

Table 6. Most common author keywords in innovation policy research.

Figure 6 presents the bibliometric mapping of the co-occurrence of author keywords in innovation policy research during the whole period of time under study (1960-2017). This mapping shows how the author keywords of these studies are interrelated. Thresholds of VOSviewer tool are configured to display the 50 author keywords with more co-occurrences, and only the 100 strongest links are displayed. This mapping comprises six clusters centered, from largest to smallest, in the following author keywords: “Innovation policy”, “Innovation”, “R&D”, “National innovation system”, “Entrepreneurship” and “Innovation system”.

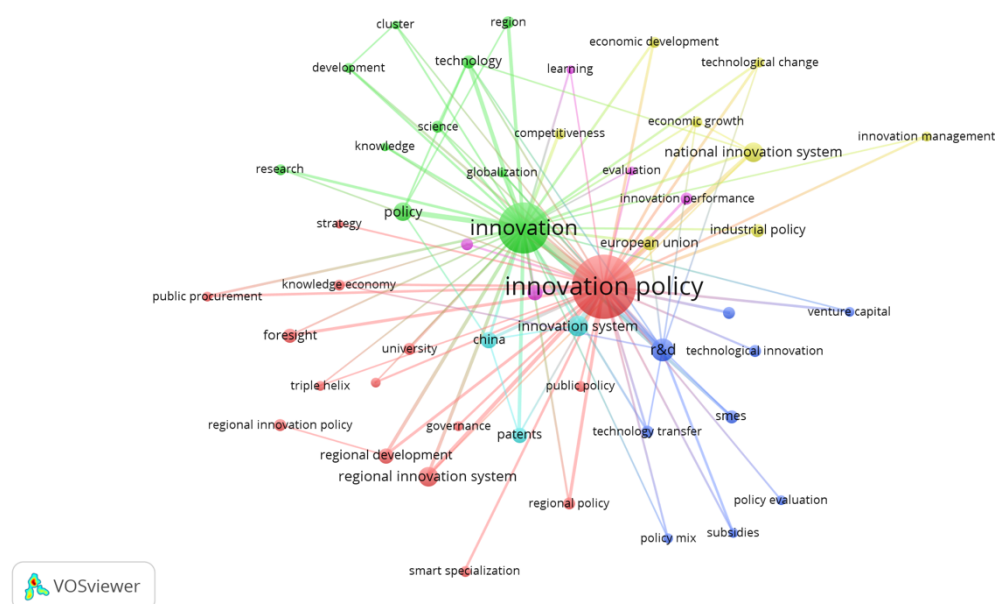


Figure 6. Co-occurrence of author keywords in innovation policy research 1960-2017.

## 4. Conclusions

The main objective of this article is to analyze the academic studies on innovation policy research until the year 2017 using bibliometrics, aiming at mapping top leading regions (countries and institutions/universities) and trending topics in this research field.

This bibliometric study will also help researchers who intend to prepare or submit works on innovation policy research, because it shows a general picture of the topic. WoS Core Collection is used to collect all related data and depict the leading trends of this research field in terms of impact, institutions, countries and topics. Only those research areas focused on innovation policy from a managerial, design, application, or empirical perspective were considered, giving a total of 2056 studies. For doing this analysis, a wide range of bibliometric indicators is presented, and some bibliometric mappings of bibliographic coupling and co-occurrence of keywords are displayed using the VOSviewer tool.

However, this analysis may have some limitations. Obviously, studies on innovation policies, which did not include “innovation policy” or “innovation policies” in the title, abstract or keywords, have not been considered in this analysis. Additionally, one limitation that affects the analysis of the most common author keywords is that, of the 2056 publications, there are 621 studies (30.2%) indexed in WoS database with the author keywords field in blank. Another limitation of WoS is that always gives one unit to any author, university or country involved in a study, regardless of whether the study was written by one researcher or more.

Over the last few years, the number of studies on innovation policies has significantly increased. Until 1980, there is only one study published in 1962 and another one in 1978, but from 1980 on the production of documents is continuous. The 50 and 100 studies thresholds are overcome in 2005 and 2009, respectively, reaching its maximum of 294 studies in 2017. Therefore, the significant and constant increase of innovation policy studies begins in year 2005.

The present study depicts the following insights. First, the leading research area in innovation policy research is “Business Economics” with 1291 studies, followed by “Public Administration” (576 studies) and “Environmental Sciences Ecology” (251 studies). These research areas are a logical consequence of the adoption of the systemic innovation model in most of developed countries (which is especially focused on the relationships between business, Public Administrations and universities), as well as of the increasing interest in achieving more social and sustainable economic models.

Second, the analysis of the most productive and influential institutions show that the University of Manchester in the UK leads the total publication index with 53 publications, as well as the h-index ranking with a value of 16, while the Lund

University in Sweden leads the total citations rank with 1502 citations, and the Wageningen University in Netherlands leads the citations per study rank with 39.20 citations per study. According to Cancino et al. (2017a), the ranking of more productive and influential institutions is highly dominated by institutions from the USA, followed by institutions from the UK, France, Netherlands, Canada, Denmark or Belgium among others. However, in the particular case of innovation policy research, institutions from the UK, Sweden and Netherlands are ahead of those from the USA. Actually, there are only three institutions from the USA in the innovation policy research ranking (the Georgia Institute of Technology in the 4th position, the Massachusetts Institute of Technology in the 26th position, and the University of California Berkeley in the 29th position). This indicates that innovation policy is a research topic much more popular in the UK and Europe than in the USA, being institutions from the UK and these European countries more productive and influential in innovation policy research than those from the USA. The reason behind is that the USA government generally adopts more liberal policies, hence its Public Administrations are less interventionist than the European countries'. Consequently, innovation policy research is a less popular topic in the USA than in the UK and the continental Europe. Additionally, the strong focus of the European Union on innovation policies reinforces this issue.

Third, the analysis of the most productive and influential countries show that UK is the leading country in innovation policy research, followed by Netherlands, the USA, Germany, Spain, Sweden, Denmark, Austria, France or China depending on the variable used to rank. Remark that China obtain much better results in productivity than in influence variables rankings. However, according to Merigó et al. (2016), the USA is the leading country in innovation research in general, with a substantial difference over the other leading countries, such as the UK, Canada, Netherlands, Germany or France. Again, the strong focus of the European Union, the UK and China on innovation policies and the less interventionist policies of the USA play a crucial role in these results, making the UK the leading country in innovation policy research.

Finally, the analysis of most common author keywords allows us to identify the main research topics and concepts within innovation policy research. There are some keywords that are always top regardless of the period of time considered, such as "Innovation policy", "Innovation", "Policy", "R&D", "Innovation system", "Regional Innovation System" and "National Innovation System", which means that these are

research concepts in innovation policy since the beginning until now. Conversely, some other keywords emerge powerfully in the last period of time considered (2010-2017), such as “Entrepreneurship”, “Patents”, “European Union”, “SMEs”, “Open innovation”, “Innovation performance”, “Science”, “Industrial policy”, “Economic growth” and “China”, revealing the trending research topics in the last few years.

## References

- Adriaanse, L. S. & Rensleigh, C. (2013). Web of Science, Scopus and Google Scholar: A content comprehensiveness comparison. *The Electronic Library*, Vol. 31, Issue: 6, pp. 727-744.
- Alonso, S., Cabrerizo, F. J., Herrera-Viedma, E., & Herrera, F. (2009). H-index: A review focused on its variants, computation, and standardization for different scientific fields. *Journal of Informetrics*, 3, 273-289.
- Asheim, B., & Moodysson, J. (2017). *Innovation policy for economic resilience: The case of Sweden (No. 2017/5)*. Lund University, CIRCLE-Center for Innovation, Research and Competences in the Learning Economy.
- Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the functional dynamics of technological innovation systems: A scheme of analysis. *Research Policy*, 37, 407-429.
- Bettencourt, L.M., & Kaur J. (2011). Evolution and structure of sustainability science. *Proc. Natl. Acad. Sci. USA* 108(49):19540–5.
- Broadus, R. N. (1987). Toward a definition of “Bibliometrics”. *Scientometrics*, 12, 373–379.
- Cajaiba-Santana, G. (2014). Social innovation: Moving the field forward. A conceptual framework. *Technological Forecasting and Social Change*, 82, 42–51.
- Callon, M., Courtial, J. P., Turner, W. A., & Bauin, S. (1983). From translations to problematic networks: An introduction to co-word analysis. *Social Science Information*, 22(2), 191–235.
- Cancino, C., Merigó, J. M., & Coronado, F. (2017a). A bibliometric analysis of leading universities in innovation research. *Journal of Innovation & Knowledge*, 2, 106–124.
- Cancino, C., Merigó, J. M., & Coronado, F. (2017b). Big names in innovation research: a bibliometric overview. *Current Science*, 113(8), 1507–1518.

- Cancino, C., Merigó, J. M., & Palacios-Marqués, D. (2015). A bibliometric analysis of innovation research. *CID Working Papers, 2015-02*, University of Chile, Santiago, 2015.
- Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Harvard Business School Press.
- Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology*, 62(7), 1382–1402.
- Coenen, L., Asheim, B., Bugge, M. M., & Herstad, S. J. (2017). Advancing regional innovation systems: What does evolutionary economic geography bring to the policy table? *Environment and Planning C: Politics and Space*, 35(4), 600–620.
- Ding, Y., Gobinda, G. C., & Schubert, F. (2001). Bibliometric cartography of information retrieval research by using co-word analysis. *Information Processing and Management*, 37, 817–842.
- Edler, J., Cameron, H. & Hajhashem, M. (2015). *The intersection of Intellectual Property Rights and Innovation Policy Making – A literature review*. Prepared by the Manchester Institute of Innovation Research, University of Manchester United Kingdom for the Innovation Policy Section, Department for Transition and Developed Countries of the World Intellectual Property Organization.
- Edler, J., & Fagerberg, J. (2017). Innovation policy: what, why, and how. *Oxford Review of Economic Policy*, 33(1), 2–23.
- Etzkowitz, H., & Leydesdorff, L. (2000). The dynamics of innovation: from National Systems and “Mode 2” to a Triple Helix of university-industry-government relations. *Research Policy* 29, 109–123.
- European Commission (2014a). *The European Union Explained: Research and Innovation*. Luxembourg, Publications Office of the European Union, 2014.
- European Commission (2014b). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Industrial Policy Communication: For a European Industrial Renaissance*.
- Fagerberg, J., & Verspagen, B. (2009). Innovation studies: the emerging structure of a new scientific field. *Research Policy*, 38, 218–233.

- Flanagan, K., & Uyarra, E. (2016). Four dangers in innovation policy studies-and how to avoid them. *Industry and Innovation*, 23(2), 177–188.
- Fu, X., Wing, T.W. & Hou, J. (2016). Technological innovation policy in China: the lessons, and the necessary changes ahead. *Econ Change Restruct*, 49, 139-157.
- Garfield, E. (2001). *From bibliographic Coupling to Co-Citation Analysis via Algorithmic Historio-Bibliography*. Presented at: Drexel University, Philadelphia, PA.
- Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. In: *Proceedings of the National Academy of Sciences of the United States of America*, 102, 16569–16572.
- Igarashi, Y., & Okada, M. (2015). Social innovation through a dementia Project using innovation architecture. *Technological Forecasting and Social Change*, 97, 193–204.
- Isaksen, A., Normann, R. H., & Spilling, O. R. (2017). Do general innovation policy tools fit all? Analysis of the regional impact of the Norwegian Skattefunn scheme. *Journal of Innovation and Entrepreneurship*, 6(1), 6.
- Kessler, M. M. (1963). Bibliographic coupling between scientific papers. *American Documentation*, 14, 10–25.
- Linton, J.D. (2004). Perspective: Ranking Business Schools on the management of technology. *Journal of Product Innovation Management*, 21: 416–430.
- Marshakova, I. (1973). System of Document Connections Based on References. *Scientific and Technical Information Serial of VINITI*, 6(2), 3–8.
- Martin, B. R. (2012). The evolution of science policy and innovation studies. *Research Policy*, 41, 1219–1239.
- Mazzucato, Mariana (2013). *The entrepreneurial state: debunking private vs. public sector myths*. Anthem Press, London, UK.
- Mazzucato, M., & Semieniuk, G. (2017). Public financing of innovation: new questions. *Oxford Review of Economic Policy*, 33(1), 24-48.
- McCarthy, D. J., Puffer, S. M., Graham, L. R., & Satinsky, D. M. (2014). Emerging innovation in emerging economies: Can institutional reforms help Russia break through its historical barriers? *Thunderbird International Business Review*, 56(3), 243–260.
- Merigó, J. M., Cancino, C., Coronado, F., & Urbano, D. (2016). Academic research in innovation: A country analysis. *Scientometrics*, 108, 559–593.

- Merigó, J. M., Gil-Lafuente, A. M., & Yager, R. R. (2015). An overview of fuzzy research with bibliometric indicators. *Applied Soft Computing*, 27, 420–433.
- Moed, H.F., Burger, W.J.M., Frankfort, J.G., & Van Raan, A.F. (1985). The use of bibliometric data for the measurement of university research performance. *Research Policy*, 14(3): 131-149.
- Nacke, O. (1979). Informetrie: Ein neuer Name für eine neue Disziplin. *Nachrichten für Dokumentation*, 20, 212–226.
- Nalimov, V. V., & Mulchenko, Z. M. (1969). *Naukometriya. Izuchenie Razvitiya Nauki kak Informatsionnogo Protsessa*. [Scientometrics. Study of the Development of Science as an Information Process], Nauka, Moscow, (English translation: 1971. Washington, D.C.: Foreign Technology Division. U.S. Air Force Systems Command, Wright-Patterson AFB, Ohio. (NTIS Report No.AD735-634).
- Neumeier, S. (2012). Why do social innovations in rural development matter and should they be considered more seriously in rural development research? *Sociologia Ruralis*, 52(1).
- Noyons, E. C. M., Moed, H. F. & Van Raan, A. F. J. (1999). Integrating research performance analysis and science mapping. *Scientometrics*, 46(3), 591-604.
- OECD (1997). *National Innovation Systems*. OECD Publishing, Paris.
- OECD (2011). *Regions and Innovation Policy*. OECD Reviews of Regional Innovation. OECD Publishing, Paris.
- OECD (2015). *The Innovation Imperative: Contributing to Productivity, Growth and Well-Being*. OECD Publishing, Paris.
- Podsakoff, P. M., MacKenzie, S. B., Podsakoff, N. P., & Bachrach, D. G. (2008). Scholarly influence in the field of management: A bibliometric analysis of the determinants of university and author impact in the management literature in the past quarter century. *Journal of Management*, 34, 641–720.
- Pritchard, A. (1969). Statistical Bibliographic or Bibliometrics? *Journal of Documentation*, 25(4), 348–349.
- Sengupta, I. N. (1992). Bibliometrics, Informetrics, Scientometrics and Librametrics: An Overview. *Libri*, 42(2), 75–98. Munksgaard, Copenhagen.
- Shafique, M. (2013). Thinking inside the box: Intellectual structure of the knowledge base of innovation research (1988-2008). *Strategic Management Journal*, 34, 62–93.



- Small, H. (1973). Co-citation in the scientific literature: a new measure of relationship between two documents. *Journal of the American Society for Information Science*, 24, 265–269.
- Small, H. (1999). Visualizing Science by Citation Mapping. *Journal of the American Society for Information Science*, 50(9), 799–813.
- UNIDO (2013). *Business, Investment and Technology Services Branch. Enhancing the contribution of the private sector to sustainable industrial development and poverty reduction*. Vienna International Centre, Austria.
- Uyarra, E., & Ramlogan, R. (2016). The Effects of Cluster Policy on Innovation. In Edler, J., Cunningham P., Gok, A. and Shapira, P. (Eds.). *Handbook of innovation policy impact*. Edward Elgar.
- Van Eck, N. J., & Waltman, L. (2010). Software survey: Vosviewer, a computer program for bibliometric mapping. *Scientometrics*, 84(2), 523–538.
- Van Leeuwen, T. (2006). The application of bibliometric analyses in the evaluation of social science research. Who benefits from it, and why it is still feasible. *Scientometrics*, 66(1):133–54.
- White, H. D., & Griffith, B. C. (1981). Author co-citation: A literature measure of intellectual structure. *Journal of the American Society for Information Science*, 21, 163–172.
- Yang, L., Chen, Z., Liu, T., Gong, Z., Yu, Y., & Wang, J. (2013). Global trends of solid waste research from 1997 to 2011 by using bibliometric analysis. *Scientometrics*, 96: 133–146.