informationresearch

PUBLISHED QUARTERLY BY THE UNIVERSITY OF BORÅS, SWEDEN

VOL. 26 NO. 3, SEPTEMBER, 2021

Mapping trending topics and leading producers in innovation policy research

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Introduction. We investigate the most relevant innovation policy research themes, as well as the authors and journals that produce the most research in this field.
Method. We used bibliometrics combining two main procedures: performance analysis and science mapping.
Analysis. The 2,929 documents under analysis were gathered from the Web of Science Core Collection database considering all years up to and including 2019.
Results. A wide range of bibliometric indicators were used to identify the most cited innovation policy studies, and the most productive and influential authors and journals. Also, bibliometric maps of keyword co-occurrence, authors co-citation and countries co-authorship were depicted to visualize relevant relationships.
Conclusions. This study shows that the combination of bibliometric performance analysis and science mapping offers a tool for evaluators to complement qualitative analyses of a research field. We identified four main findings. First, the main innovation policy research themes are based on three pillars: innovation systems and business, science and knowledge, and governance and sustainability transitions. Second, the leading authors in innovation policy work at institutions in Europe. Third, authors working at institutions in countries with a common or similar language, culture or innovation policy tend to collaborate. Fourth, the top journals in innovation policy reveal an increasing influence of sustainable development and transitions within this field.

DOI: **https://doi.org/10.47989/irpaper905**

Introduction

Over the last few decades, public administrations and the scientific community have increased their focus on innovation research (Martin, 2012; OECD, 2015). The main reason is that research and innovation enhance competitiveness, boost growth and create jobs, whilst improving social well-being, healthcare, transport and digital services and providing countless new products and services (European Commission, 2014). Moreover, innovative economies are more productive, are more resilient, adapt better to change and are able to support higher living standards (Asheim and Moodysson, 2017).

Public administrations are investing heavily in innovation activities and are promoting firms innovation to improve the business environment through the design, implementation and evaluation of innovation policies (Mazzucato and Semieniuk, 2017). Meanwhile, the scientific literature on innovation research has grown substantially in the last few decades. Its rate of growth has outstripped that of other research areas, which suggests that academics from multiple disciplines are investigating how innovation activity and innovation processes influence economies and societies (Cancino et al., 2017). This body of innovation research includes investigations into innovation policy (e.g. Flanagan and Uyarra, 2016; Uyarra and Ramlogan, 2016; Coenen et al., 2017; Edler and Fagerberg, 2017), analyses of innovations addressing important social and global issues such as resource scarcity and climate change (e.g., Ghisellini et al., 2016; Loiseau et al., 2016), and assessments of innovation policies deployed in different regions and countries (e.g. Borrás and Jordana, 2016; Fu et al., 2016; Isaksen et al., 2017).

Innovation policy has emerged as a new field of economic policy in the last few decades. The term is now commonly used given the widespread view that policy plays a role in supporting innovation. Innovation policy attempts to influence innovation activity, often to increase economic growth (Fagerberg, 2017). The origins of the term lie in the intellectual environment that developed around the Science Policy Research Unit at the University of Sussex from the late 1960s onwards (Fagerberg et al., 2011). In particular, Professor Roy Rothwell, of the Unit, did much during the 1980s to increase interest in the topic (Rothwell, 1982). However, the real surge of interest occurred in the 1990s, when national governments and international organisations, such as the OECD, started to pay attention to this phenomenon.

In view of this background, the main objective of this article is to analyse innovation policy research using bibliometrics and focusing primarily on authors and journals. There have been several recent bibliometric studies of innovation focused on the leading countries, regions and universities (Merigó et al., 2016) or the most relevant authors (Cancino et al., 2017). However, to the best of our knowledge, no bibliometric studies have focused specifically on innovation policy research. For innovation policy scholars, the number of academic studies of this topic can obscure a general picture in the search for information. We therefore focus on two research questions:

RQ1. What are the most relevant research themes within innovation policy research?
RQ2. Which authors and journals produce the most innovation policy research?

To answer these questions, we use bibliometric methods such as performance analysis and science mapping (Cobo et al., 2011). The rest of the article is structured as follows: the bibliometric methods and data used in the paper are introduced, the results are presented, and the paper concludes with a summary of the main findings.

Bibliometric methods and data

The analysis presented in this paper uses bibliometrics combining two main procedures: performance analysis and science mapping (Cobo et al., 2011). Bibliometric performance analysis uses a wide range of indicators and techniques. These include total number of studies, total number of citations, publications by country, university or author, the h-index, and word frequency analysis (López-Rubio et al., 2020). The total number of studies is an indicator of absolute productivity. The total number of citations is also an absolute measure. It does not consider the study lifetime (i.e., publication year). The h-index combines the total number of studies and total number of citations into a single measure. If, for a given set of studies, N studies have received at least N citations, then the h-index for that set of studies will be N (Hirsch, 2005).

The h-index also has limitations. For example, a researcher with three heavily cited publications would have the same h-index as a researcher with three publications with only three citations each. Therefore, this indicator does not reflect well on researchers who have highly cited publications but moderate productivity (Egghe, 2006). Other relative bibliometric indicators include the ratio of citations per study, which favours authors with few articles but a high number of citations, and the ratio of citations per year, which accounts for the study publication date (publication lifetime). Both ratios are proxy variables of efficiency.

Overall, a higher number of publications or citations does not necessarily indicate higher research quality. Historically, there has been much discussion about which indicators should be used to accurately measure scientific production and influence. In recent years, the concept of responsible *research and innovation* has gained currency as a framework for research governance. Building on this, Wilsdon et al. (2015) proposes the notion of responsible metrics as a way of framing appropriate uses of quantitative indicators in the governance, management and assessment of research. Furthermore, bibliometric indicators address only one of many aspects of research. Bibliometrics should not be used for evaluation without reference to more in-depth qualitative assessments (Hicks et al., 2015). The present analysis covers all the above-mentioned indicators to provide a comprehensive, multi-faceted overview, and to overcome the limitations of each individual indicator (Mingers and Leydesdorff, 2015).

Science mapping is and interdisciplinary field originated in information science and technology. Science mapping is the development and application of computational techniques to the visualization, analysis, and modelling of a broad range of scientific and technological activities as a whole. This is an interdisciplinary field emerging from traditional library information science in the areas of bibliometrics, citation analysis, and computer sciences in the areas of visualization, visual analytics, data mining and knowledge discovery (Cobo et al., 2011). Bibliometric maps are based on the quantitative analysis of bibliographic data. Therefore, bibliometric mapping can be used to monitor a scientific field to determine its cognitive structure, evolution, and main actors and to visualize the results for specific bibliometric indicators (Noyons et al., 1999). Various software packages can perform bibliographic mapping (Cobo et al., 2011). We use VOSviewer, a free software tool to produce bibliometric maps (Van Eck and Waltman, 2010).

The most common bibliometric mappings are based on bibliographic coupling, co-citations, co-authorship and keyword co-occurrence (Merigó et al., 2016). Bibliographic coupling measures the shared intellectual background amongst documents. A strength value is calculated between each document in the sample based on the references shared by the two documents (Kessler, 1963). The more shared references there are, the stronger the theoretical foundations shared by the two documents are assumed to be. Bibliographic coupling makes it possible to link documents with a similar research focus, thereby revealing the knowledge structure of a field (Jarneving, 2007). Co-citation analysis identifies the shared background of publications in a data set. Two documents are co-cited if one or more documents cite both articles (Small, 1973). The weight of a co-citation is based on the number of articles that co-cite the two documents. It reveals a network of cited documents rather than linking the documents in the data set (Garfield, 2001). Co-authorship identifies research collaboration networks based on the number of co-authored documents (Katz and Martin, 1997). Lastly, keyword co-occurrence identifies links amongst research topics in a particular field based on the frequency of co-occurrence of keywords in documents (Callon et al., 1983).

Data

Our data were gathered from the Web of Science Core Collection database, owned by Clarivate Analytics. This database is one of the most important sources of bibliometric information. It records consistent, standardised information (Adriaanse and Rensleigh, 2013; López-Rubio et al., in press-b). According to the OECD (2018), all types of R&D carried out or paid for by business enterprises are considered by definition innovation activities of those firms. Therefore, we executed the following search in October 2020: `'innovation policy' OR 'innovation policies' OR 'policy of innovation' OR 'policies of innovation' OR 'R&D policy' OR 'R&D policies' OR 'policy of R&D' OR 'policies of R&D'`. We executed the search for the fields *title*, *abstract*; and *keywords* (both author keywords and Keywords Plus generated by the Web of Science) from 1960 to 2019.

We excluded all document types except for articles, reviews, proceedings papers and early access articles. The search returned 2,929 records. Figure 1 depicts the distribution of these documents by research area. The research areas constitute a subject categorization scheme that allows to identify, retrieve and analyse these documents. Besides, journals and books covered by Web of Science are assigned to at least one category and each category is mapped to one research area. Figure 1 shows that innovation policy generally spans one or more research streams across the disciplines of business, public governance and sustainable development.

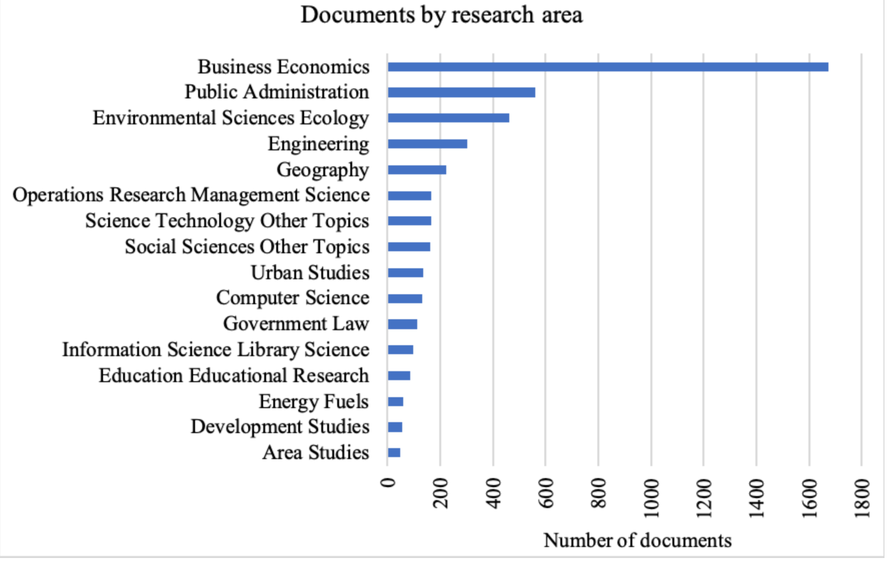

Figure 1: Research areas with at least fifty studies indexed in the Web of Science Core Collection.

Results

This section reports the main bibliometric results for the 2,929 selected documents up to and including the year 2019. These documents consist of 2,255 articles, 704 proceedings papers, 76 reviews and 14 early access articles. Between 1960 and 2019, the number of citations received by this set of studies was 40,560, or 13.8 citations per study.

Figure 2 depicts the total number of publications and citations per year from 1982 to 2019. Between 1960 and 1981, only one study was published on innovation policy research. This study was published in 1969, and it received its first citation in 1983. However, after 1981, documents were published on this topic every year. This trend in publications has continued upwards reaching a maximum number of annual publications of 389 in 2019. Figure 2 also shows that these publications have received a high number of citations. The maximum was achieved in 2019, with 7,768 citations. The thresholds of 1,000, 2,000 and 4,000 annual citations were surpassed in 2010, 2012 and 2016, respectively.

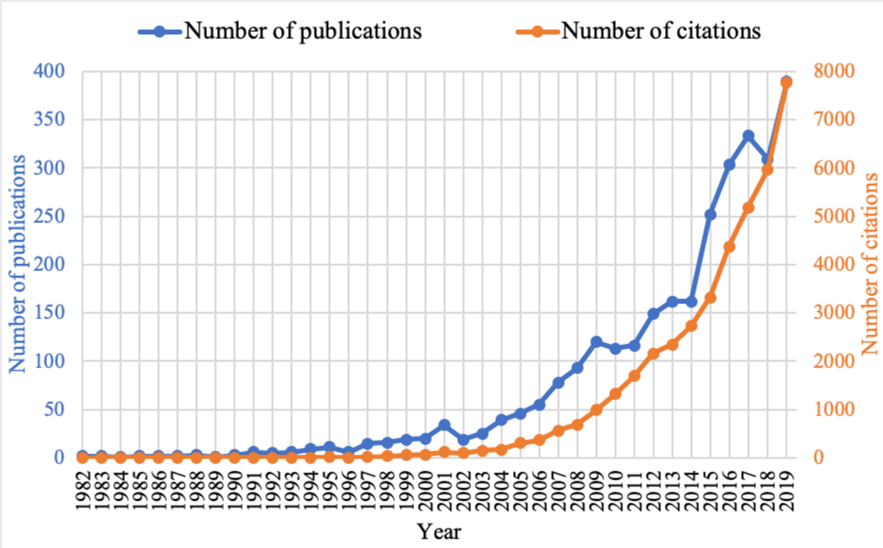

Figure 2: Annual number of publications and citations.

The most cited innovation policy studies indexed in the Web of Science Core Collection.

To identify the most cited innovation policy studies, both in absolute and relative terms, we selected the 1% of studies with the most citations and the 1% with the highest number of citations per year. The Appendix, lists the thirty most cited studies on innovation policy research based on Web of Science Core Collection data. It also shows the thirty studies with the highest number of citations per year. Because of overlap between the two groups of studies, the table contains forty-two studies, ranked by total citations.

The first paper is *Regional innovation systems: Institutional and organisational dimensions* (Cooke et al., 1997). This paper suggests that the most severe problems related to the scale and complexity of the national innovation system are mitigated by a subnational focus such as that of regional systems of innovation. The second study, *The learning region: Institutions, innovation and regional renewal* (Morgan, 1997), focuses on an interactive model of innovation for regional development. The paper analyses European Union regional policy measures and studies the regional innovation strategy in Wales. The third study, *One size fits all? Towards a differentiated regional innovation policy approach* (Todtling and Trippl, 2005), examines different types of regions. The aim is to show that there is no ideal innovation policy model and that the type of policy depends on regional features.

The study with the most citations a year is *Constructing regional advantage: platform policies based on related variety and differentiated knowledge bases* (Asheim et al., 2011). This paper presents a regional innovation policy model based on the idea of constructing regional advantage. It categorises knowledge into *analytical* (science based), *synthetic* (engineering based) and *symbolic* (arts based), with different requirements of virtual and real proximity mixes. The implications of this research are the ability to track evolving *platform policies*. These platform policies facilitate economic development within and between regions. The action lines followed are suitable to incorporate the basic principles behind related variety and differentiated knowledge bases. The second document is the study by Todling and Trippl (2005) described previously. The third study, *Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy* (Schot and Geels, 2008), focuses on the strategic niche management approach. According to this approach, sustainable journeys can be facilitated by creating technological niches. These technological niches are protected spaces that allow experimentation with the co-evolution of technology, user practices and regulatory structures. Assuming that if such niches are constructed appropriately, they can act as building blocks for a broader social shift towards sustainable development, the empirical findings show that analysis of the internal dimensions of these niches must be complemented by attention to external processes.

To produce Figure 3, we used the VOSviewer overlay visualisation and the average publication year variable to depict the keyword co-occurrence map. We considered both author keywords and Keywords Plus and a minimum of two occurrences for the forty-two studies previously identified as the most cited papers on innovation policy, resulting in a total of forty-two keywords. The Web of Science Core Collection Keywords Plus field is created by an algorithm that provides expanded terms stemming from the record's cited references or bibliography. The item colour indicates the average publication year. Table 1 presents the twenty most common keywords with the number of occurrences and co-occurrences and the average publication year.

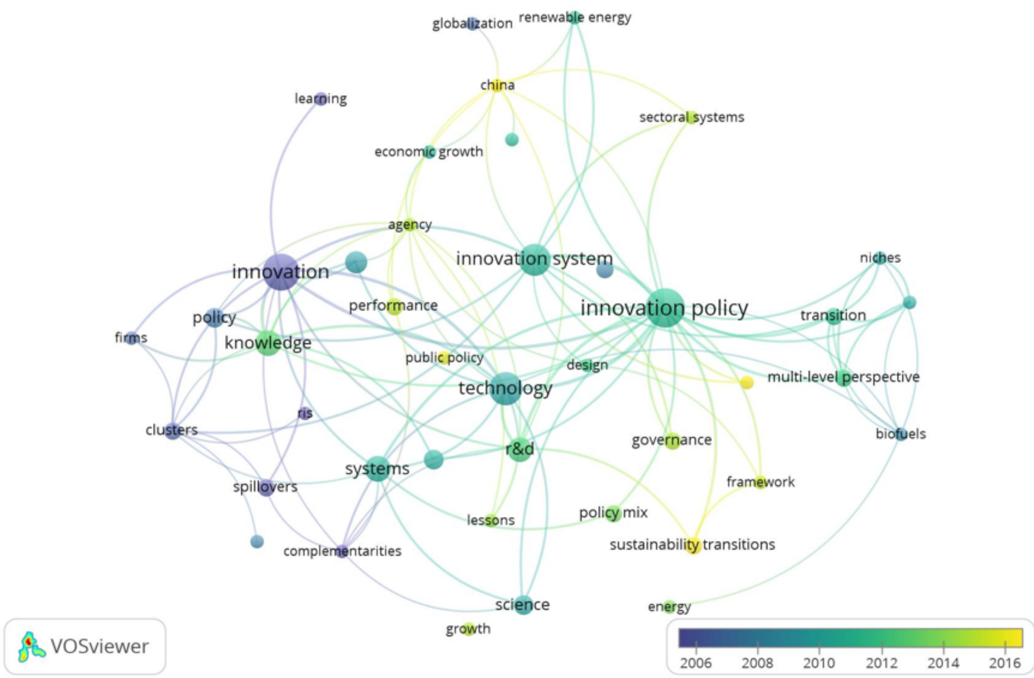

Figure 3: Map of keyword co-occurrence for the most influential studies.

Table 1. The 20 most common keywords for the most influential studies.

Rank	Keyword	Occurrences	Co-occurrences	Average publication year
1	Innovation policy	16	65	2011.19
2	Innovation	14	38	2006.21
3	Technology	11	42	2009.64
4	Innovation system	10	40	2010.7
5	Knowledge	7	25	2012.71
6	Systems	7	24	2010.43
7	R&D	6	28	2012.33
8	Perspective	5	20	2009.2
9	Networks	4	18	2010.25
10	Science	4	16	2009.75
11	Policy	4	14	2007.5
12	Sustainability transitions	3	21	2016
13	Governance	3	20	2014.33
14	Multi-level perspective	3	20	2012
15	Transition	3	20	2011.33
16	Dynamics	3	14	2008
17	Clusters	3	12	2006.67
18	Performance	3	12	2014.67
19	Policy mix	3	12	2013.33
20	Spillovers	3	10	2005.67

We excluded the keywords *innovation policy innovation*, *R&D* and *policy* because these terms were part of the original search query. Besides these search terms, the most common keywords and their co-occurrences indicate that the main topics for authors and journals are based on three pillars:

1. Innovation systems, also including the keywords *dynamics*, *systems* and *performance*.

2. Science and knowledge, also including the keywords *technology*, *networks*, *spill-overs* and *clusters*.
3. Governance and sustainability transitions, also including *policy mix*.

The most productive and influential authors in innovation policy research

Table 3 lists the 34 authors with more than three publications and more than 200 citations in innovation policy research based on data indexed in the WoS Core Collection. The authors are ranked by total citations. The table also shows the total number of studies, the h-index of the documents included in the analysis (not all of a given author's publications), the citations per study and each author's current affiliation (institution and country).

Table 2: The most productive and influential authors in innovation policy research.

Rank	Author	Institution	Country	Total studies	Total citations	h-index	Citations per study
1	Cooke P	Cardiff Univ	UK	5	1,730	5	346.0
2	Asheim BT	Univ Stavanger	Norway	7	1,652	7	236.0
3	Lundvall BA	Aalborg Univ	Denmark	4	1,505	4	376.3
4	Uyarra E	Univ Manchester	UK	16	1,263	13	78.9
5	Coenen L	Lund Univ	Sweden	13	1,216	10	93.5
6	Morgan K	Cardiff Univ	UK	4	1,062	4	265.5
7	Trippl M	Univ Vienna	Austria	8	981	6	122.6
8	Edler J	Univ Manchester	UK	10	791	9	79.1
9	Flanagan K	Univ Manchester	UK	7	757	6	108.1
10	Klerkx L	Wageningen Univ Research	Netherlands	11	741	9	67.4
11	Edquist C	Lund Univ	Sweden	9	719	8	79.9
12	Georghiou L	Univ Manchester	UK	9	710	8	78.9
13	Czarnitzki D	KU Leuven	Belgium	9	648	7	72.0
14	Hjalager AM	Univ Southern Denmark	Denmark	5	644	2	128.8
15	Laranja M	Univ Lisbon	Portugal	6	536	4	89.3
16	Mohnen P	Maastricht Univ	Netherlands	4	345	4	86.3
17	Weber KM	Austrian Inst Technology	Austria	7	339	6	48.4
18	Hekkert MP	Univ Utrecht	Netherlands	7	334	7	47.7
19	Borras S	Copenhagen Business Sch	Denmark	6	312	5	52.0
20	Etzkowitz H	Stanford Univ	USA	6	312	3	52.0
21	Capello R	Polytechnic Univ Milan	Italy	9	309	7	34.3
22	Hellsmark H	Chalmers Univ Technol	Sweden	7	304	6	43.4
23	Mazzucato M	Univ College London	UK	11	295	7	26.8
24	Anderson D	Arizona State Univ	USA	4	295	3	73.8
25	Kivimaa P	Finnish Environment Inst	Finland	5	286	4	57.2
26	Kuhlmann S	Univ Twente	Netherlands	7	280	5	40.0
27	Archibugi D	CNR	Italy	4	267	4	66.8
28	Filippetti A	CNR	Italy	4	267	4	66.8
29	Jacob M	Lund Univ	Sweden	4	262	3	65.5
30	Rodriguez-Pose A	London Sch Economics	UK	4	261	4	65.3
31	Zabala-Iturriagagoitia JM	Univ Deusto	Spain	9	225	6	25.0
32	Sternberg R	Univ Cologne	Germany	4	223	4	55.8
33	Shyu JZ	Natl Chiao Tung Univ	Taiwan	4	223	3	55.8
34	Lopes-Bento C	KU Leuven	Belgium	4	201	4	50.3

The authors are from a wide range of institutions, most of them in Europe (31 authors of 34). The UK (8), Sweden (4), the Netherlands (4), Denmark (3) and Italy (3) have the strongest presence. Two of the authors are affiliated with institutions in the USA. One is affiliated with an institution in Taiwan.

Five authors have more than 1,200 citations each: P. Cooke, B.T. Asheim, B.A. Lundvall, E. Uyarra and L. Coenen. E. Uyarra has the highest h-index (13), indicating the best combination of productivity and influence, followed by L. Coenen (10), J. Edler and L. Klerkx (9), and C. Edquist and L. Georghiou (8). According to the data indexed in the Web of Science, E. Uyarra is also the most productive author with 16 publications, followed by L. Coenen (13), L. Klerkx and M. Mazzucato (11), and J. Edler (10). Finally, B.A. Lundvall leads the ranking of citations per study (376.3), followed by P. Cooke (346.0) and K. Morgan (265.5).

According to Cole and Cole (1973), there are four categories of scholars based on two dimensions: productivity and citations. Figure 4 depicts the total number of studies (productivity) versus the total number of citations (influence) of the top authors. The relationship between the number of studies and the number of citations is a representation of the ratio citations per study, which is a proxy variable of efficiency. Therefore, Figure 4 shows the efficiency diagram for top authors in innovation policy research. The axes were calibrated according to the average values of the total number of studies (6.9) and the total number of citations (596.9), respectively, in order to classify top authors in the following four quadrants:

1. Highly prolific. Scholars belong to this quadrant if both the number of studies and the number of citations are greater than the average.
2. Perfectionists. Scholars belong to this quadrant if the number of studies is lower than the average but the number of citations is greater than the average.
3. Mass producers. Scholars belong to this quadrant if the number of studies is greater than the average but the number of citations is lower than the average.
4. Less influential. Scholars belong to this quadrant if both the number of studies and the number of citations are below the average.

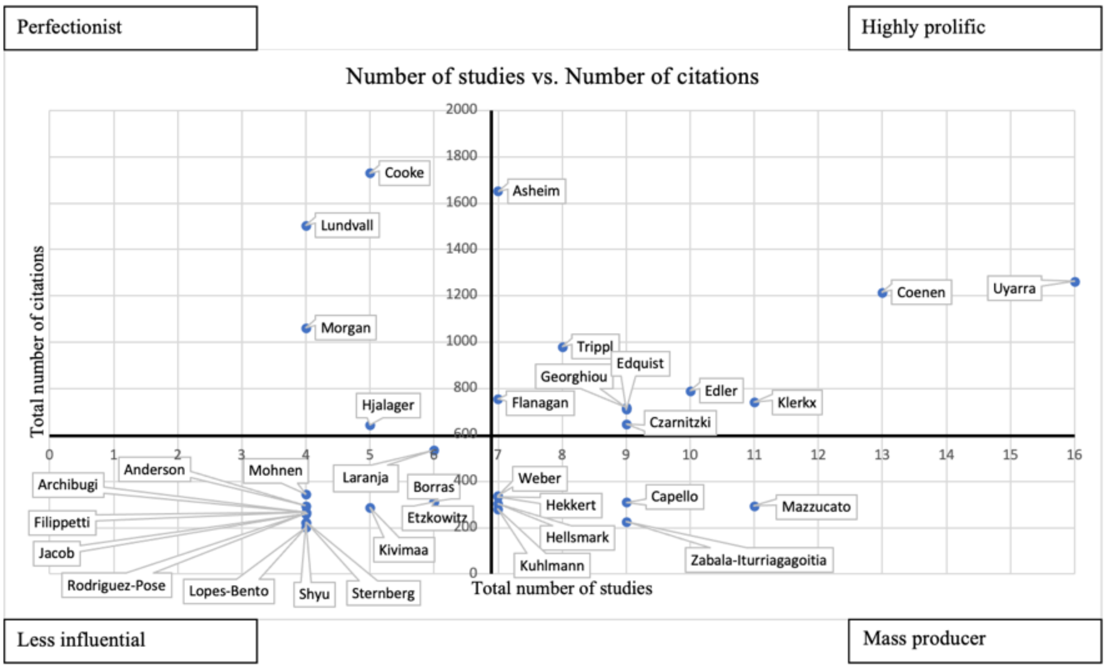

Figure 4: Efficiency diagram for the leading authors.

Based on Figure 4, E. Uyarra, L Coenen, B. T. Asheim, L. Klerkx, J. Edler, M. Trippl, C. Edquist, L. Georghiou, K. Flanagan and D. Czarnitzki are highly prolific. P. Cooke, B. A. Lundvall, K. Morgan and A. M. Hjalager are perfectionists. M. Mazzucato, R. Capello, J. M. Zabala-Iturriagagoitia, K. M. Weber, M. P. Hekkert, H. Hellsmark and S. Kuhlmann are mass producers. The remaining authors are less influential.

Another interesting issue is that of author co-citations. Author co-citation analysis shows the structure of connections between authors who are frequently cited together (White and Griffith, 1981). Co-citation analysis considers the references cited in the documents under study. This approach broadens the focus of the analysis because the cited documents may not be indexed in the Web of Science. Figure 5 presents the results of this analysis using a threshold of more than 100 citations and the 100 most representative links. Figure 5 corroborates the relevance of Lundvall, Edquist, Cooke and Asheim. However, this map also shows other important authors, such as the European Commission, the OECD, R.R. Nelson and C. Freeman.

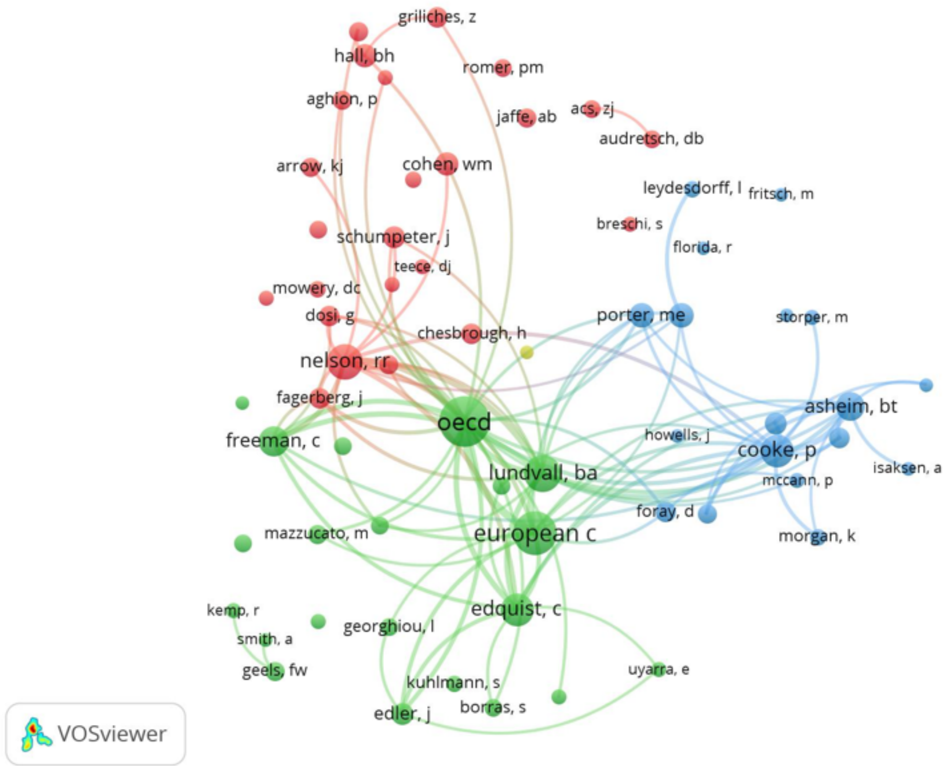

Figure 5: Co-citations of authors in innovation policy research.

Co-authorship analysis allows us to analyse research collaboration networks. Figure 6 depicts co-authorship between countries with at least thirty documents. The figure is based on VOSviewer network visualisation. In a network representation, the size of a node or label is proportional to that item's relevance, and the network connections closely identify linked items. The location and colour of an item are determined by its cluster. Only the 100 strongest links are displayed. Table 3 presents the distribution of these twenty-seven countries according to the clusters generated by VOSviewer. Within each cluster, countries are ranked by total citations.

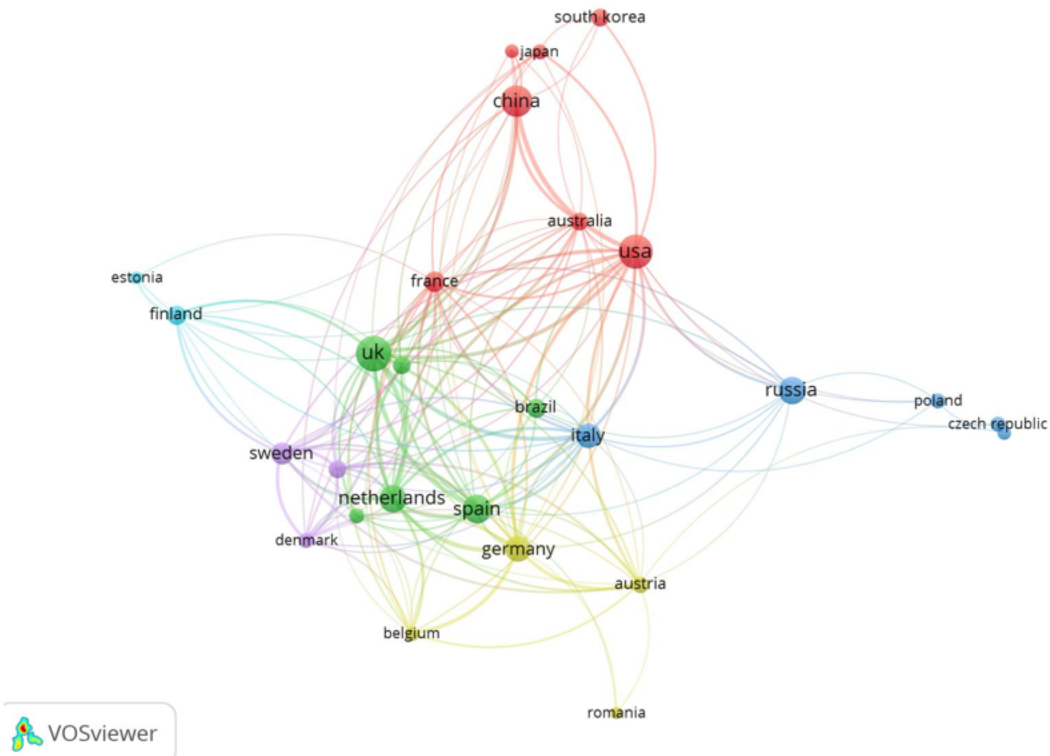

Figure 6: Co-authorship of countries in innovation policy research.

Table 3: Co-authorship of countries in innovation policy research according to VOSviewer clusters.

Cluster	Countries
1	USA, France, China, South Korea, Australia, Japan and Taiwan
2	UK, Netherlands, Spain, Canada, Portugal and Brazil
3	Italy, Russia, Czech Republic, Slovakia and Poland
4	Germany, Austria, Belgium and Romania
5	Sweden, Denmark and Norway
6	Finland and Estonia

Clusters 3, 4, 5 and 6 are formed by European countries. Cluster 3 comprises Eastern European countries and Italy, Cluster 4 comprises Central European countries plus Romania, and Clusters 5 and 6 comprise Nordic European countries and Estonia. Cluster 1 is formed by Asian countries and the United States, France and Australia. Cluster 2 comprises several European countries, Canada and Brazil. These results show that clusters tend to be formed by countries that share the same or a similar language, culture or innovation policy. Sharing a language and/or culture should be expected to facilitate communication and understanding, whilst having similar innovation strategies and common goals promotes joint efforts.

The most productive and influential journals in innovation policy research

Table 4 presents the most productive journals in innovation policy research considering all the journal Web of Science categories and the fourteen journals with more than twenty studies indexed in the Web of Science. For each journal, Table 4 includes the total number of studies, the total number of citations, the h-index, the citations per study and the journal impact factor for the year 2019.

Table 4: The most productive and influential journals in innovation policy research.

Rank	Journal	Total studies	Total citations	h-index	Citations per study	Impact factor 2019
1	Research Policy	168	12,104	53	72.0	5.351
2	Technological Forecasting and Social Change	103	2,090	22	20.3	5.846
3	Science and Public Policy	98	1,204	17	12.3	1.730
4	European Planning Studies	93	1,340	20	14.4	2.226
5	Regional Studies	45	2,303	17	51.2	3.312
6	Technovation	43	1,704	21	39.6	5.729
7	International Journal of Technology Management	41	407	8	9.9	1.348
8	Technology Analysis & Strategic Management	40	1,394	15	34.9	1.867
9	Journal of Technology Transfer	37	535	14	14.5	4.147
10	Scientometrics	33	667	13	20.2	2.867
11	Sustainability	28	143	7	5.1	2.576
12	Environment and Planning C*	27	883	13	32.7	2.601
13	Energy Policy	26	766	14	29.5	5.042
14	Economics of Innovation and New Technology	23	140	7	6.1	1.563

* Environment and Planning C-Government and Policy was relaunched in 2017 as Environment and Planning C-Politics and Space, so both names were considered for the calculations.

Research Policy is the leading journal by total number of studies, total number of citations, h-index and citations per study. This journal is followed by *Technological Forecasting and Social Change, Regional Studies* and *European Planning Studies*, depending on the indicator. *Technological Forecasting and Social Change* has the highest impact factor for the year 2019, with a value of 5.846. This journal is followed by *Research Policy* and *Energy Policy*. All these journals are high impact journals, which highlights the increasing importance of this research field in the last decade. This fact also shows that these journals have received a high number of citations and suggests that they are influential amongst the scientific community.

Based on the approach provided by Cole and Cole (1973), Figure 7 shows the efficiency diagram for top journals. The axes were calibrated according to the average values of total number of studies (61.9) and total citations (1,975.4), which allowed us to classify top journals into four categories: highly prolific, specialists, mass producers and less influential. Based on Figure 7, *Research Policy* and *Technological Forecasting and Social Change* are highly prolific journals, whereas *Regional Studies* is a specialist journal. *Science and Public Policy* and *European Planning Studies* are mass producers. The other journals are less influential.

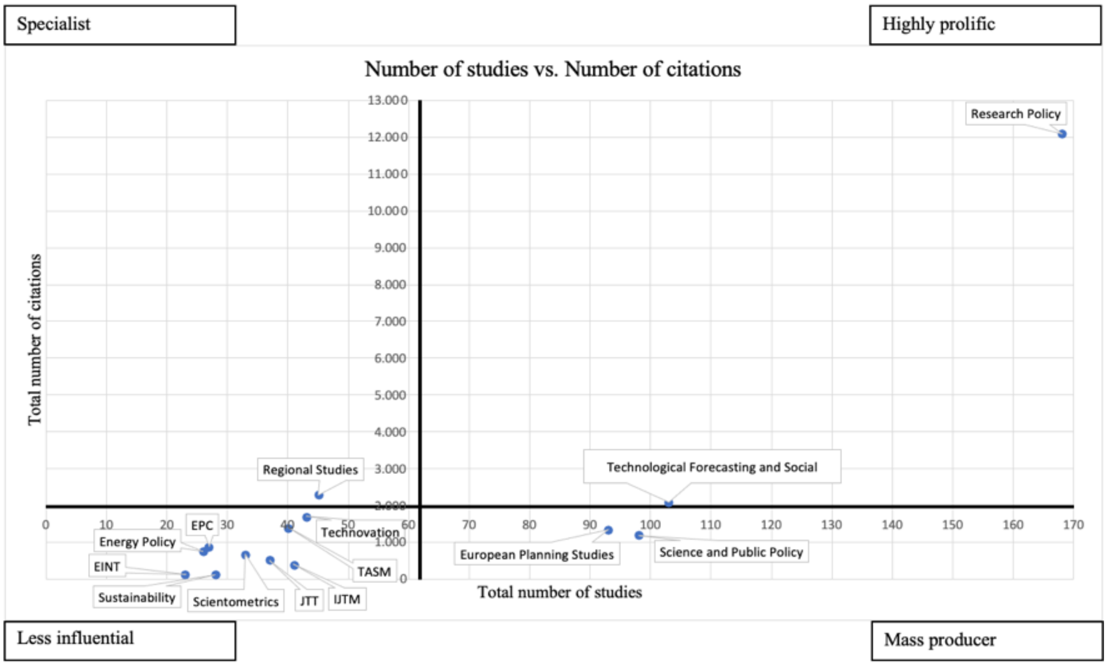

Figure 7: Efficiency diagram for leading journals.
Notes: EINT = Economics of Innovation and New Technology; EPC = Environment and Planning C; IJTM = International Journal of Technology Management; JTT = Journal of Technology Transfer; TASM = Technology Analysis Strategic Management.

The articles published in a given research area and journal tend to influence future studies submitted to that journal. Therefore, by analysing study citers, we can identify other journals focused on innovation policy research. We identified 25,703 citing studies from the Web of Science, excluding all document types except for articles, reviews, proceedings papers and early access articles.

Table 5 presents the ten journals with the most citing studies. Interestingly, one of the journals included in this ranking, *Journal of Cleaner Production*, does not appear in the list of the most productive and influential journals in Table 5. *Journal of Cleaner Production* is ranked fourth, with 565 citing studies. *Sustainability* occupies the second position in this ranking, with 790 citing studies. *Journal of Cleaner Production* is a cross-disciplinary journal that publishes research on cleaner production and environmental and sustainability research and practice. It is aimed at helping societies to become more sustainable. *Sustainability* focuses on the environmental, cultural, economic and social sustainability of human beings. These results highlight the increasing influence of sustainable development and transitions within innovation policy research in recent years (Schot and Geels, 2008; Kivimaa and Kern, 2016).

Table 5: The ten journals with the most studies citing the set of documents on innovation policy research.

Rank	**Journal**	**Total studies**	**Impact factor 2019**
1	Research Policy	796	5.351
2	Sustainability	790	2.576
3	Technological Forecasting and Social Change	763	5.846
4	Journal of Cleaner Production	565	7.246
5	European Plannig Studies	491	2.226
6	Energy Policy	362	5.042
7	Scientomentrics	346	2.867
8	Regional Studies	345	3.312
9	Journal of Technology Transfer	282	4.147
10	Science and Public Policy	281	1.204

Discussion and conclusions

This study provides an overview of the most cited documents and the most relevant topics in innovation policy research, as well as of the authors and journals that produce the most research in this field. We used Web of Science Core Collection data from 1960 to 2019, excluding all document types except for articles, reviews, proceedings papers and early access articles.

There are other recent bibliometrics studies that carry out deep analyses on innovation research. Merigó et al. (2016) focuses on the most productive and influential countries in innovation research between 1989 and 2013 classifying the results in periods of five years. This study also analyses the research developed in several supranational regions. The leading journals in the field are also studied individually identifying the most productive countries in each of the journals. Cancino et al. (2017) analyses the most productive and influential authors in innovation research developed between 1989 and 2013 by calculating several author-level bibliometric indicators such as the total number of publications and citations, and the h-index. The results demonstrate that the most influential authors are not necessarily the most productive researchers. The study also analyses the most productive and influential authors in the leading journals in the field.

Our article provides diverse and significant contributions to the bibliometric literature on innovation compared with the aforementioned studies. First, we specifically focused on innovation policy within the innovation research field, and considered all years up to and including 2019. The principal Web of Science research areas covered by the documents under analysis and the keyword co-occurrence in the forty-two most influential studies show that the most relevant topics for authors and journals are based on three pillars: innovation systems and business, science and knowledge, and governance and sustainability transitions.

The concept of innovation systems originated between the end of the 1980s and the middle of the 1990s. The concept emerged in the context of the European industrial economies' transformation into knowledge-based economies. A national innovation system consists of a network of economic agents together with the institutions and policies that influence these agents' innovation behaviour and performance (Freeman, 1987; Lundvall, 1992; Nelson 1993). The idea of applying the national innovation system framework to a smaller geographical area (regional or even local) was later proposed by Cooke (1992).

The subsequent triple helix model (Etzkowitz and Leydesdorff, 2000) complements the innovation system approach. Whereas business is the central actor for innovation in the innovation systems model, in the Triple Helix model, innovation processes are considered to arise from multiple sources, namely the relationships between three main agents: the government (public administration), universities (science) and industry (business). This model has now evolved into the quadruple helix, the quintuple helix and even the sextuple helix model (government, university, industry, knowledge society, sustainability and entrepreneurship). The quadruple helix emphasises the importance of the knowledge society and knowledge democracy for knowledge production and innovation (Campbell et al., 2015), while the quintuple helix stresses the need for the socioecological transition of society and the economy to address, for example, global warming (Carayannis et al., 2012), and the sextuple helix adds entrepreneurship as a sixth dimension (López-Rubio et al., in press-a).

Secondly, P. Cooke has the highest total number of citations, followed by B.T. Asheim, B.A. Lundvall, E. Uyarra and L. Coenen. According to the data indexed in the Web of Science, E. Uyarra is the most productive author and has the highest h-index. J. Edler, L. Klerkx, C. Edquist, L. Georghiou, M. Mazzucato, K. Morgan, M. Trippl, K. Flanagan, D. Czarnitzki, and A. M. Hjalager are also ranked highly by total number of studies, total number of citations, h-index or citations per study. According to Cancino et al. (2017), the ranking of the most productive and influential authors in innovation research is dominated by U.S. authors. However, in the particular case of innovation policy research, the most influential authors are based at institutions in European countries. This spread may result from the strong focus of the European Union and the UK on innovation policies, especially since the 2008 global economic crisis, and is in line with the fact that the EU and the UK actively promote innovation processes and activities (Bergek et al., 2008).

For example, Horizon Europe (European Commission, 2018), the new EU innovation policy framework for the period 2021 to 2027 that will replace Horizon 2020, is based on three pillars: excellent science, global challenges and European industrial competitiveness, and innovative Europe. Furthermore, the authors' co-citations corroborate the relevance of Lundvall, Edquist, Cooke and Asheim, and also shows other important authors, such as the European Commission, the OECD, R.R. Nelson and C. Freeman. These results highlight the relevance of the pioneering researchers in national innovation systems (Lundvall, Freeman and Nelson) and regional innovation systems (Cooke), as well as other authors and institutions that have also actively promoted the innovation system approach (e.g. Edquist, the OECD and the European Commission).

Third, the mapping of co-authorship across countries based on authors' affiliations suggests that research collaboration networks usually include scholars working at institutions in countries with the same or a similar language, culture or innovation policy. A similar language or culture aids communication and understanding, whilst having similar innovation goals encourages joint efforts.

Fourth, *Research Policy* is the leading journal in terms of the total number of studies, total number of citations, h-index and citations per study. *Technological Forecasting and Social Change* heads the journal impact factor ranking for 2019. The *Journal of Cleaner Production*, one of the ten journals with the most studies citing innovation policy research, is not included in the innovation policy rankings. Sustainability is the second biggest citer of innovation policy studies. Both journals focus on sustainability research. Therefore, these results reflect the major role of sustainable development and growth, renewable and clean energy, smart specialisation, and the circular economy within innovation policy in the last few years (Staffas et al., 2013; McCann and Ortega-Argilés, 2015; Loiseau et al., 2016; Geissdoerfer et al., 2017; McDowall et al., 2017).

Finally, this analysis has some limitations. First, innovation policy research documents not indexed in the Web of Science were not included in the analysis. However, our study also includes co-citation analysis of authors to help overcome this limitation. For the co-citation analysis, the cited references did not need to be indexed in the Web of Science. Second, innovation policy studies indexed in the Web of Science but not contained in the selected research areas were not included in the analysis. Third, we used the full counting method, so each author was awarded one unit, regardless of whether the article had one or multiple authors. Fourth, in relation to journals, the citations obtained from the Web of Science data are not weighted. Therefore, all citations are considered equally, regardless of journal quality. Despite these limitations, this paper identifies the most cited and relevant documents and their main topics, as well as the most cited and influential authors and journals in innovation policy research. Furthermore, this paper shows that the combination of bibliometric performance analysis and bibliometric science mapping offers a tool for evaluators to complement qualitative analyses of a research field.

Acknowledgements

Norat Roig-Tierno wishes to thank Project [GV/2019/063], funded by the Generalitat Valenciana, and the "Agencia Estatal de Investigación y el Fondo de Desarrollo Regional (FEDER)" - RTI2018- 093791-B-C22 (MCI, AEI/FEDER, UE) for supporting this research.

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Note: A link from the title is to an open access document. A link from the DOI is to the publisher's page for the document.

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How to cite this paper

López-Rubio, P., Roig-Tierno, N., & Mas-Tur, A. (2021). Mapping trending topics and leading producers in innovation policy research. *Information Research, 26*(3), paper 905. Retrieved from http://InformationR.net/ir/26-3/paper905.html (Archived by the Internet Archive at https://bit.ly/3lkGHB7) https://doi.org/10.47989/irpaper905

Appendix: The thirty most cited studies on innovation policy research based on Web of Science Core Collection data

Rank	RCY	Authors	Title	Year	Total citations	Citations per year
1	9	Cooke, P; Uranga, MG; Etxebarria, G	Regional innovation systems: institutional and organisational dimensions	1997	998	43.4
2	10	Morgan, K	The learning region: Institutions, innovation and regional renewal	1997	975	42.4
3	2	Todtling, F; Trippl, M	One size fits all? Towards a differentiated regional innovation policy approach	2005	909	60.6
4	11	Rennings, K	Redefining innovation - eco-innovation research and the contribution from ecological economics	2000	821	41.1
5	3	Schot, J; Geels, FW	Strategic niche management and sustainable innovation journeys: theory, findings, research agenda, and policy	2008	722	60.2
6	6	Jensen, MB; Johnson, B; Lorenz, E; Lundvall, BA	Forms of knowledge and modes of innovation	2007	711	54.7
7	8	Asheim, BT; Coenen, L	Knowledge bases and regional innovation systems: comparing Nordic clusters	2005	671	44.7
8	1	Asheim, BT; Boschma, R; Cooke, P	Constructing Regional Advantage: Platform Policies Based on Related Variety and Differentiated Knowledge Bases	2011	622	69.1
9	4	Hjalager, AM	A review of innovation research in tourism	2010	579	57.9
10	17	Lundvall, BA; Johnson, B; Andersen, ES; Dalum, B	National systems of production, innovation and competence building	2002	555	30.8
11	18	Cowan, R; Jonard, N	Network structure and the diffusion of knowledge	2004	456	28.5
12	12	Flanagan, K; Uyarra, E; Laranja, M	Reconceptualising the 'policy mix' for innovation	2011	367	40.8
13	20	Edler, J; Georghiou, L	Public procurement and innovation - Resurrecting the demand side	2007	354	27.2
14	33	Woolthuis, RK; Lankhuizen, M; Gilsing, V	A system failure framework for innovation policy design	2005	325	21.7
15	16	Klerkx, L; Aarts, N; Leeuwis, C	Adaptive management in agricultural innovation systems: the interactions between innovation networks and their environment	2010	313	31.3
16	29	Asheim, B; Coenen, L; Vang, J	Face-to-face, buzz, and knowledge bases: sociospatial implications for learning, innovation, and innovation	2007	294	22.6

			policy			
17	32	Fleming, L; King, C; Juda, A	Small worlds and regional innovation	2007	289	22.2
18	49	Foxon, TJ; Gross, R; Chase, A; Howes, J; Arnall, A; Anderson, D	UK innovation systems for new and renewable energy technologies: drivers, barriers and systems failures	2005	275	18.3
19	14	Weber, KM; Rohracher, H	Legitimizing research, technology and innovation policies for transformative change Combining insights from innovation systems and multi-level perspective in a comprehensive 'failures' framework	2012	273	34.1
20	62	Almus, M; Czarnitzki, D	The effects of public R&D subsidies on firms' innovation activities: The case of Eastern Germany	2003	267	15.7
21	55	Mohnen, P; Roller, LH	Complementarities in innovation policy	2005	248	16.5
22	56	Etzkowitz, H; Klofsten, M	The innovating region: toward a theory of knowledge-based regional development	2005	248	16.5
23	5	Kivimaa, P; Kern, F	Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions	2016	231	57.8
24	15	Borras, S; Edquist, C	The choice of innovation policy instruments	2013	229	32.7
25	63	Beise, M; Rennings, K	Lead markets and regulation: a framework for analyzing the international diffusion of environmental innovations	2005	229	15.3
26	99	Johnson, B; Lorenz, E; Lundvall, BA	Why all this fuss about codified and tacit knowledge?	2002	222	12.3
27	98	Jacob, M; Lundqvist, M; Hellsmark, H	Entrepreneurial transformations in the Swedish University system: the case of Chalmers University of Technology	2003	210	12.4
28	125	Martin, S; Scott, JT	The nature of innovation market failure and the design of public support for private innovation	2000	208	10.4
29	80	Leiponen, A	Skills and innovation	2005	203	13.5
30	50	Hoekman, SK	Biofuels in the US - Challenges and Opportunities	2009	201	18.3
32	22	Wieczorek, AJ; Hekkert, MP	Systemic instruments for systemic innovation problems: A framework for policy makers and innovation scholars	2012	193	24.1
53	25	Smith, A; Fressoli, M; Thomas, H	Grassroots innovation movements: challenges and contributions	2014	139	23.2
55	28	Hoppmann, J; Huenteler, J; Girod, B	Compulsive policy-making-The evolution of the German feed-in tariff system for solar photovoltaic power	2014	137	22.8
58	30	Li, GC; Lai, R; D'Amour, A; Doolin, DM; Sun, Y; Torvik, VI; Yu, AZ; Fleming, L	Disambiguation and co-authorship networks of the US patent inventor database (1975-2010)	2014	134	22.3
70	7	Schot, J; Steinmueller, WE	Three frames for innovation policy: R&D, systems of innovation and transformative change	2018	109	54.5
89	26	Mazzucato, M	From market fixing to market-creating: a new framework for innovation policy	2016	92	23.0
96	19	Binz, C; Truffer, B	Global Innovation Systems-A conceptual framework for innovation dynamics in transnational contexts	2017	85	28.3
107	13	Bogers, M; Chesbrough, H; Moedas, C	Open Innovation: Research, practicies, and policies	2018	74	37.0
175		23 Gault, F	Defining and measuring innovation in all sectors of the economy	2018	48	24.0
185	24	Carayannis, EG; Grigoroudis, E; Campbell, DFJ; Meissner, D; Stamati, D	The ecosystem as helix: an exploratory theory-building study of regional co-opetitive entrepreneurial ecosystems as Quadruple/Quintuple Helix Innovation Models	2018	47	23.5
361	21	Eder, J	Innovation in the Periphery: A Critical Survey and	2019	27	27.0

			Research Agenda			
415	27	Jia, N; Huang, KG; Zhang, CM	Public governance, corporate governance, and firm innovation: an examination of state-owned enterprises	2019	23	23.0

Note: RCY = rank by citations per year.

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