Big names in innovation research: a bibliometric overview

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Over the last few years an increasing number of scientific studies related to innovation research has been carried out. The present study analyses innovation research developed between 1989 and 2013. It uses the Web of Science database and provides several author-level bibliometric indicators including the total number of publications and citations, and the h-index. The results indicate that the most influential professors over the last 25 years, according to their highest h-index, are David Audretsch, Michael Hitt, Shaker Zahra, Rajshree Agarwal, Eric Von Hippel, David Teece, Will Mitchell and Robert Cooper. Among these authors, it is possible to demonstrate that they are not necessarily the most productive authors, with the highest number of publications; however, they are the most influential, with the highest number of citations. The incorporation of a larger number of journals to the Web of Science has granted different authors access to publish their work on innovation research.

Keywords: Bibliometrics, innovation research, ranking, Web of Science.

IN the last few decades the number of academic articles on research innovation has grown exponentially[1–3]. Such growth annually exceeds the growth rate of the set of disciplines on other areas of research[4], which allows us to understand that academics from different areas of knowledge are interested in publishing and how activities, processes and results of innovation affect our economies and promoting development, not only of new businesses, but also of greater social and economic well-being. According to Fagerberg *et al.*[5], several thousand academics worldwide are currently researching such issues, which explains the importance of knowing who the leaders in innovation research are.

From an academic point of view, the greatest number of articles, especially in high quality journals, present in the Web of Science (WoS), represents an important effort from different universities and specialized research centres, which seek to significantly influence the development of new knowledge and new applications in the discipline. Despite the above, the increase in the number of articles on innovation research has not necessarily had an impact of equal magnitude in terms of influence and relevance of the results in the scientific community. According to Cancino *et al.*[4], only 1.45% of the academic articles on innovation research published in recent decades exceed 200 citations in other journals of the WoS. In addition, only 4% of the publications exceed 100 citations. If we analyse it from another point of view, 17% of the articles published on innovation research in the WoS have never been cited, and 47.3% have not been cited more than 4 times since their publication, being in general autocites, which shows that they are articles which, although increase scientific production in the discipline, in practice, they do not influence the academic community, which could make us doubt the true quality of those articles. Of the almost 40,000 articles published on innovation research in the last three decades, almost 50% do not necessarily generate impact.

Certainly, the development of academic articles that are responsible for analysing, from a bibliometric point of view, not only the increase in productivity of scientific research on innovation, but also its influence is a relevant matter. In this regard, there are various articles in literature which help us understand which authors are most influential.

For example, Fagerberg *et al.*[5] explore the knowledge base of innovation studies, which is defined as the scholarly study of how innovation takes place and what the important explanatory factors and social and economic consequences are. This paper presents a ranking, using *h*-index, with the 20 most influential authors in the discipline of innovation. In this ranking, four contributors stand out as being particularly influential, namely, Nelson, Freeman, Rosenberg and Schumpeter with their work remaining an important source of inspiration for other researchers.

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On the other hand, Fagerberg and Verspagen[1], using bibliographical evidence, were able to show that core literature in innovation studies centered on a small number of leading academics. In their analysis they divided the most influential authors into four periods. From 1979 to 2006, the most influential work was by Freeman[6], Schumpeter[7,8] and Arrow[9]. From 1979 to 1988 the most influential work was by Schmookler[10], Freeman[6], Rosenberg[11], Nelson and Winter[12] and Freeman *et al.*[13]. From 1989 to 1998 the most influential work was by Pavitt[14], Nelson and Winter[12], Rosenberg[15], Freeman[6] and Teece[16]. Finally, from 1999 to 2006, the most prominent were Nelson and Winter[17], Nelson[18], Cohen and Levinthal[19,20] and Lundvall[21].

Thieme[22] also studied the leading authors in innovation. Using 959 articles reflecting the work of 1,179 scholars, this study ranks the world's top scholars in innovation management on the basis of the number of research articles published across 14 top academic journals in technology and innovation management, between 1990 and 2004. Twenty-three scholars have at least eight articles in this period. Michael Song has the most (31), followed by Robert Cooper, Roger Calantone, William Souder and Elko Kleinschmidt, who have published at least 17 articles in the 15-year period.

Yang and Tao[23] extended Thieme's article[22], with an updated analysis that also included a university ranking. This paper includes data on innovation management from articles published in two leading innovation management journals and eight top management and marketing journals during 1991 to 2010. The empirical data showed that the world's top 10 innovation management scholars were: Michael Song and Mark E. Parry (both of University of Missouri-Kansas City), Roger J. Calantone (Michigan State University), Erik Jan Hultink (Delft University of Technology), Kwaku Atuahene-Gima (China Europe International Business School), Anthony Di Benedetto (Temple University), Abbie Griffin (University of Utah), William E. Souder (Retired), Barry L. Bayus (University of North Carolina at Chapel Hill), and Christoph H. Loch (INSEAD).

Some other authors[24–28] have studied the leading authors, journals and universities in the field and developed different types of rankings according to a wide range of indicators.

The purpose of this paper is to complement previous research and present a bibliometric analysis of the most influential authors in innovation research over the past 25 years, between 1989 and 2013. For this, we not only present an analysis of the main authors in the leading management journals, which are generally the most influential, but also those who are leading authors in journals specialized in innovation, which are not necessarily influential but much more productive. It is important to note that in this work we classify as most influential, those journals, that reach a high number of citations, and by more productive we mean those that present a greater number of publications in innovation research.

Methods

The research method used in this article is bibliometric analysis. According to Broadus[29], bibliometrics is a research field that quantitatively studies the bibliographic material and provides a general overview of a research field according to a wide range of indicators. The most commonly used indicators include[30]: the total number of articles; the total number of citations; and, the *h*-index[31]. While the total number of articles is a proxy variable of productivity, the number of citations and the *h*-index are proxy variables of influence.

There is a discussion in the literature on which indicator could better measure scientific production[32]. Some researchers criticize the use of the indicator for number of articles, because a large number of publications do not imply higher quality of academic research. In fact, many articles by the same researcher may not be cited by another, explaining his/her low influence, or even quality. In addition, other researchers criticize the use of the indicator for the number of citations, because an author having a high number of citations would not imply greater or lesser quality in terms of his/her research. An author, specializing in a particular theme, in which very few researchers work, will surely receive fewer citations, when compared to another working in a popular theme where there are many researchers interested in analysing such topics. Therefore, a greater or lesser number of citations, would not necessarily be directly related with higher quality[33]. Finally, the *h*-index is not free from criticism either, particularly because sometimes an academic with little track record, i.e. with a low number of published articles, but of high influence (many citations) would have the same *h*-index as an academic or researcher with great experience, many published articles, but not all of them cited with high frequency[34,35]. In this sense, the indicator would treat the productivity alike even though it is obviously different.

Regardless of the criticism that occurs to the above listed indicators, in this study we develop a bibliometric analysis by using the three indicators mentioned, ranking authors, leaders in innovation research according to their *h*-index.

As a source of information, we use the articles published in innovation research available in the database of WoS, the most popular database for classifying scientific research worldwide and it includes those journals that are evaluated with the highest quality. Currently, WoS includes more than 50,000,000 articles covering all areas of research and knowledge. Hence, it is necessary to establish classification criteria and filter to specifically analyse what is published only in innovation research.

In order to classify the leading authors in innovation research over the past 25 years, a series of filters were applied to the WoS core collection database to discriminate between the 50,000,000 items. First, only those published in the WoS between 1989 and 2013 were analysed. Second, the study used the keyword innovation in the title, abstract and keywords. The titles of these articles were revised to check that they correspond to themes of innovation research, and not just coincidentally use the innovation concept in a different research context. Third, only articles published in certain specific areas of research were studied, all of which were catalogued in a managerial perspective (business and economics, public administration, operations research and management science, government and law, geography, social sciences and other topics, computer science, sociology, urban studies, social work, social issues, area studies, behavioural sciences, and Asian studies). Finally, only publications classified as articles were considered (reviews letters and notes) leaving out other scientific outputs such as posters, presentations at conferences, among others. In accordance with previous filters, our database to be analysed corresponds to 36,644 published articles in innovation research over the past 25 years.

The previous classification may have some limitations. For example, given the specification of the filters used, some work on innovation research which did not use the concept of innovation in the title, abstract or keywords could have been excluded from the analysis. Another limitation in order to develop our rankings is that the WoS database always gives one unit to any journal, author, university or country involved in an article, which could affect the analysis, knowing that frequently two or more researchers work on the same article. A third limitation in the development of our rankings, given the database used, is that the citations obtained are not weighted by the quality of the journal cited, assigning equal weight to publications of different influence.

Results

This section presents the results of the paper. First, the study develops a ranking of authors who have been leaders in innovation research over the past 25 years. Second, the work develops rankings of leading authors in innovation research according to the journals which published the most in innovation research. Finally, the study presents bibliographic coupling and co-authorship analysis between the most productive and influential authors in innovation research.

Leading authors in innovation research

For the period of time described, 1989 to 2013, research in innovation experienced significant growth that has led to publishing 36,644 articles in journals present in WoS. Some leading authors in innovation research stand out in this discipline, not only because of the large number of publications which they develop but also because of their high influence on the rest of the researchers in the world. Table 1 presents a ranking with 50 leading authors in innovation research, which are classified according to their *h*-index, which allows us to analyse their influence on other researchers.

Along with the *h*-index in innovation (HI) of each author, Table 1 shows more information such as the total number of publications in innovation (TPI) and the total number of citations in innovation (TCI). In addition, indicators of overall number of publications (TP), the total number of citations (TC) and *h*-index (H) in all disciplines, are also presented. It is also possible to identify information about the university that each researcher is affiliated to, and the country that he or she comes from.

The first results shown in Table 1 are that researchers from US lead the ranking of the most influential authors in innovation research. Among the first 10 authors, 60% work in the US universities and from the total of 50 leading authors 28% work in US universities. Following USA, researchers from UK present in our rankings, are the most influential representing 14% of the total number of authors. The Netherlands and China have the same number of most influential researchers, 5 each, followed by Canada and Italy contributing with 4 author leaders in our rankings.

Another important highlight is that the most influential authors come from different universities; the generation of the most influential knowledge on innovation research is not gathered in any particular university. In fact, among US universities, none presents two authors in our rankings. Certain European and Asian universities, such as the Polytechnic University of Milan, KU Leuven, Imperial College London, Shanghai Jiao T. University and the University of Toronto, present two authors or more in the ranking.

When ordering our ranking by *h*-index the 10 most influential innovation research authors are David B. Audretsch (Indiana University), Michael A. Hitt (Texas A&M University), Shaker A. Zahra (University of Minnesota Twin Cities), Rajshree Agarwal (University of Maryland), Eric Von Hippel (MIT-Massachusetts Institute of Technology), David J. Teece (University of California, Berkeley), Will Mitchell (University of Toronto), Robert G Cooper (McMaster University), Bart Verspagen (Maastricht University) and John Bessant (Imperial College London). All these authors are well-known and influential in their discipline, which highlights the importance of measuring the impact and influence of each researcher on other authors who follow a similar line of research.

David B. Audretsch's case is interesting, not only because he is the author with the highest number of publications in innovation research, for the period of 25 years

Table 1. Leading authors in innovation research between 1989 and 2013

Rank	Full name	University	COU	TPI	TCI	HI	TP	TC	H	PI	*p*
1	David B. Audretsch	Indiana U.	USA	63	4510	32	135	6516	39	68,60	68,01
2	Michael A Hitt	Texas A&M U.	USA	28	4511	25	117	10470	53	89,91	97,85
3	Shaker A. Zahra	U. Minnesota TC	USA	35	4682	23	91	8034	43	85,56	89,18
4	Rajshree Agarwal	U. Maryland	USA	36	2708	22	40	1106	17	58,84	31,27
5	Eric Von Hippel	MIT	USA	29	3200	22	39	3284	24	70,68	65,15
6	David J. Teece	U. Calif. Berkeley	USA	31	7988	21	57	9048	26	127,21	112,83
7	Will Mitchell	U. Toronto	CAN	31	1583	20	62	2958	28	43,24	52,06
8	Robert G Cooper	McMaster U.	CAN	26	1784	20	47	3027	30	49,65	57,98
9	Bart Verspagen	Maastricht U.	NLD	29	961	19	47	1393	24	31,70	34,56
10	John Bessant	Imperial C.London	GBR	43	1253	18	85	1585	21	33,18	30,92
11	Philip Nicholas Cooke	Bergen U. College	NOR	40	1549	18	92	1927	22	39,15	34,30
12	Mike Wright	Imperial C. London	GBR	29	1026	18	192	6212	43	33,11	58,58
13	Geert Duysters	Tilburg U.	NLD	28	1070	18	45	1602	23	34,45	38,49
14	Michael Song	U. Missouri – K.C.	USA	44	923	17	77	913	17	26,85	22,12
15	Michael Fritsch	U. Jena	DEU	27	887	17	48	1362	22	30,77	33,81
16	Philippe Aghion	Harvard U.	USA	23	3038	17	81	7048	38	73,76	84,96
17	Reinhilde Veugelers	KU Leuven	BEL	23	1911	17	40	2135	20	54,15	48,48
18	Julian Birkinshaw	London Bus Sch	GBR	22	1837	17	57	4603	33	53,53	71,90
19	Ulrich Lichtenthaler	U. Mannheim	DEU	45	931	16	60	1009	17	26,81	25,70
20	Loet Leydesdorff	U. Amsterdam	NLD	38	1484	16	212	4994	39	38,70	49,00
21	Zoltan J Acs	George Mason U.	USA	27	1622	16	71	2703	27	46,02	46,86
22	Henk W Volberda	Erasmus U. Rott.	NLD	24	1789	16	58	2910	26	51,09	52,66
23	Stephen Roper	U. Warwick	GBR	21	770	16	24	304	11	30,45	15,67
24	Gina Coleralli O'Connor	Rensselaer P. Inst.	USA	28	865	15	34	952	17	29,90	29,87
25	Roberto Verganti	Polytech. U. Milan	ITA	28	677	15	42	921	17	25,39	27,23
26	Varun Grover	Clemson U.	USA	26	1424	15	125	4510	33	42,73	54,59
27	Koenraad Debackere	KU Leuven	BEL	25	756	15	58	1319	21	28,38	31,07
28	Roger J Calantone	Michigan St. U.	USA	34	1348	14	96	2939	26	37,67	44,81
29	Abbie Griffin	U. Utah	USA	28	1123	14	73	2749	16	35,58	46,95
30	Georg Von Krogh	Swiss F.I.T. Zurich	CHE	26	1532	14	51	1939	18	44,86	41,93
31	James H Love	Aston U.	GBR	25	619	14	55	996	17	24,84	26,23
32	Harald Bathelt	U. Toronto	CAN	24	1619	14	44	1837	17	47,80	42,49
33	Yuan Li	Shanghai Jiao T.U.	CHN	36	441	13	47	110	6	17,55	6,36
34	Andres Rodriguez-Pose	London Sch.Eco.	GBR	31	686	13	98	1701	25	24,76	30,91
35	Hariolf Grupp	U. Karlsruhe	DEU	28	527	13	60	921	16	21,49	24,18
36	Eric Jan Hultink	Delft U. Techn.	NLD	27	587	13	38	878	18	23,37	27,27
37	Franco Malerba	Bocconi U.	ITA	26	1317	13	42	1648	17	40,56	40,14
38	Vittorio Chiesa	Polytech. U. Milan	ITA	26	556	13	36	736	14	22,82	24,69
39	Albert N Link	U. North Carolina	USA	30	749	12	69	1170	18	26,54	27,07
40	Dirk Czarnitzki	KU Leuven	BEL	30	504	12	38	598	14	20,38	21,11
41	Guan Jiancheng	U. Chinese Aca. Sc.	CHN	25	376	12	46	710	16	17,82	22,21
42	Cristiano Antonelli	U. Torino	ITA	26	379	11	59	585	12	17,68	17,97
43	Yu-Shan Chen	National Taipei U.	CHN	16	431	11	23	449	7	22,64	20,62
44	Yi Liu	Shanghai Jiao T. U.	CHN	16	301	11	26	51	4	17,82	4,64
45	Chihiro Watanabe	Tokyo Inst. Tech.	JPN	38	324	10	66	499	12	14,03	15,57
46	Oliver Gassmann	U. St. Gallen	CHE	24	641	10	41	1446	16	25,77	37,08
47	David Doloreux	U. Ottawa	CAN	23	241	10	30	270	10	13,62	13,44
48	Chung-Jen Chen	National Taiwan U.	CHN	22	353	10	36	255	6	17,83	12,18
49	Yongtae Park	Seoul National U.	KOR	27	307	9	40	521	14	15,17	18,93
50	Helen Lawton Smith	U. London – Birkbeck	GBR	24	360	9	45	379	10	17,54	14,72

under analysis (63 in total) but also because he presents a major *h*-index, 32. However, if we look at the number of citations by authors, he would recently be the fourth author with greater influence.

Note that the ranking presented in Table 1 may be ordered by other criteria, which would change the position of each author in the list. If we order by the number of citations that each researcher obtains or by the *p*-index[36,37], David J. Teece, who appears in sixth place in Table 1, with an *h*-index of 21, would be in first place in the ranking. On the other hand, Ulrich Lichtenthaler (19th place) or Michael Song (14th place) would occupy the top positions in ranking if we order by the number of publications in innovation research, and no citations or *h*-index. This allows us to understand that the criteria used to rate leading authors who are more influential in innovation research highly affects the information that arises. Some stand out due to the large number of publications in

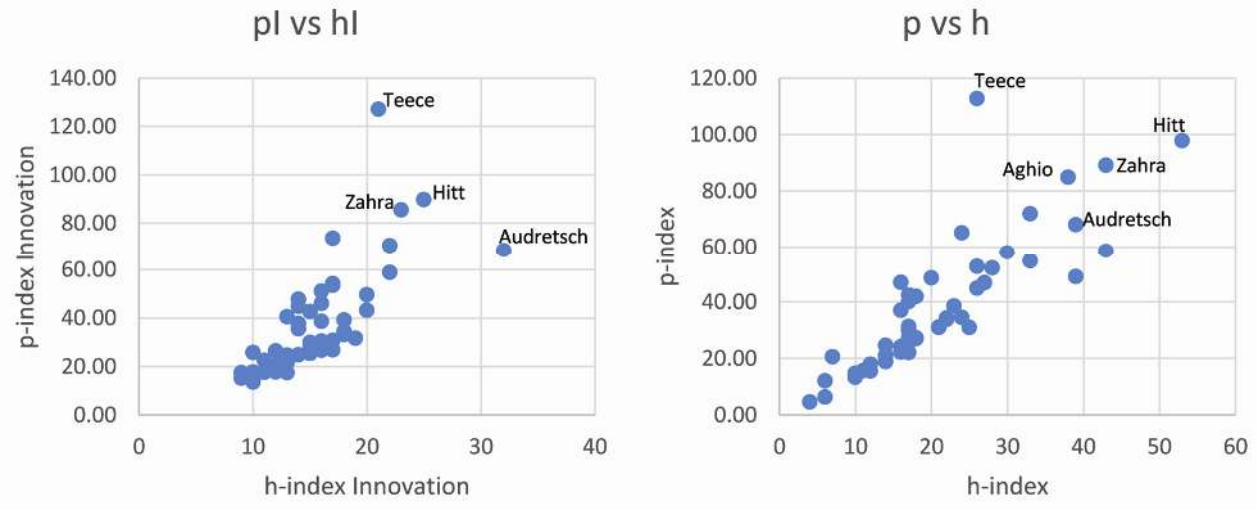

Figure 1. 2-Dimensional comparison between the *h*-index and the *p*-index.

Table 2. Specialized journals in innovation research

Journals	IF	5Y-IF
International Journal of Technology Management	0.492	0.659
Journal of Product Innovation Management	1.379	2.770
R&D Management	1.266	2.635
Research Policy	2.598	3.989
Technological Forecasting and Social Change	1.959	2.405
Technology Analysis and Strategic Management	0.841	1.285
Technovation	2.704	3.251

innovation research, while others stand out for the greater influence that they have on the scientific community, whether measured by the number of citations or *h*-index. Recall that in this context, the aim of the *p*-index is to provide a deeper evaluation in the combination between publications and citations in the same formulation. In order to get a better view of the results, Figure 1 presents a two-dimensional graph that compares the results between the *p*-index and the *h*-index. Note that the results are presented for the top 50 authors not only for their publications on innovation but also considering all their publications.

This is important to understand, because there would be no direct correlation between the most productive authors in innovation research and those most influential in the discipline. There are many specialized journals in innovation in the WoS (Table 2), which do not always have the greatest impact in literature, which may improve the bibliometric indicators of those authors who publish the most in these journals.

Individual specialized journals analysis of the leading authors

According to Cancino *et al.*[4], it is possible to identify a number of journals specializing in innovation research: *International Journal of Technology Management* (*IJTM*), *Journal of Product Innovation Management* (*JPIM*), *R&D Management* (*RDM*), *Research Policy* (*RP*), *Technological Forecasting* and *Social Change* (*TFSC*), *Technology Analysis and Strategic Management* (*TASM*) and *Technovation*. All these journals are highly valued by the discipline with some of them not only being the most cited research papers in innovation, but also the most productive in terms of publishing a greater number of items every year and presenting good impact factors. Some examples: *RP*, *TFSC* and *Technovation* (Table 2).

While Table 1 showed a ranking of leading authors in innovation research taking into account all the journals in WoS, specialized or not in innovation research (Tables 3–6) specifically present individualized rankings according to each journal. Table 2 ordered the specialized journals in innovation research. Table 3 presents the leading authors in two specialized innovation research journals: *IJTM* and *JPIM*. In the case of *IJTM* the first 10 authors of the ranking have more than 5 publications on innovation in the same journal. Interestingly, not necessarily the most cited authors lead this ranking. Harry Boer's case is interesting, who with 93 citations and 6 publications, does not appear in the first place in the ranking owing to a lower *h*-index. John Bessant is not only the researcher with the highest *h*-index but also one who has published the greatest number of papers and the most cited.

With respect to *JPIM*, it is possible to see that the number of publications and the number of citations in innovation research are much higher, in relation to the analysed *IJTM*. The first 10 authors of the *JPIM* ranking exceed by more than 10 times the number of citations of the first authors of the *IJTM*. Obviously, *JPIM* publishes articles on innovation research more intensively, and so the influence is far greater. In this journal, authors such as Roger J. Calantone, Elko J. Kleinschmidt and

Table 3. Leading authors in innovation in International *Journal of Technology Management* and *Journal of Product Innovation Management*

	International Journal of Technology Management						*Journal of Product Innovation Management*					
Rank	Author	TP	TC	H	TC/TP	*p*	Author	TP	TC	H	TC/TP	*p*
1	Bessant J	10	115	5	11,50	10,98	Hultink EJ	19	488	12	25,68	23,23
2	Corso M	10	70	5	7,00	7,88	Calantone RJ	25	1459	11	58,36	43,99
3	Lu IY	7	23	4	3,29	4,23	Song M	18	381	10	21,17	20,05
4	Howells J	5	58	4	11,60	8,76	Griffin A	17	726	10	42,71	31,42
5	Cabral R	5	21	4	4,20	4,45	Kleinschmidt EJ	12	1260	10	105,00	50,95
6	Cooke P	4	76	4	19,00	11,30	Song XM	11	799	10	72,64	38,72
7	Smeds R	4	28	4	7,00	5,81	Souder WE	9	528	8	58,67	31,41
8	Hyland P	7	33	3	4,71	5,38	Cooper RG	8	1170	8	146,25	55,52
9	Bowonder B	7	14	3	2,00	3,04	Parry ME	14	350	7	25,00	20,61
10	Herstatt C	5	40	3	8,00	6,84	De Brentani U	10	413	7	41,30	25,74
11	Chanaron JJ	5	28	3	5,60	5,39	Salomo S	10	212	7	21,20	16,50
12	Chiesa V	4	33	3	8,25	6,48	Droge C	8	333	7	41,63	24,02
13	Bart CK	4	27	3	6,75	5,67	O'Connor GC	13	407	6	31,31	23,36
14	Yang J	4	19	3	4,75	4,49	Verganti R	9	207	6	23,00	16,82
15	Wu SH	4	13	3	3,25	3,48	Athaide GA	7	149	6	21,29	14,69
16	Lettl C	3	40	3	13,33	8,11	Schreier M	6	272	6	45,33	23,10
17	Phaal R	3	37	3	12,33	7,70	Barczak G	8	189	5	23,63	16,47
18	Probert DR	3	37	3	12,33	7,70	Robben HSJ	6	255	5	42,50	22,13
19	White S	3	33	3	11,00	7,13	Talke K	6	73	5	12,17	9,61
20	Liu XL	3	30	3	10,00	6,69	Garcia R	5	728	5	145,60	47,33
21	Manzini R	3	28	3	9,33	6,39	Veryzer RW	5	472	5	94,40	35,45
22	Lee J	3	26	3	8,67	6,09	Langerak F	7	160	4	22,86	15,41
23	Salmador MP	3	18	3	6,00	4,76	Kahn KB	7	147	4	21,00	14,56
24	Chiaromonte F	8	11	2	1,38	2,47	Lynn GS	5	175	4	35,00	18,30
25	Boer H	6	93	2	15,50	11,30	Duysters G	5	168	4	33,60	17,81
26	Abetti PA	6	15	2	2,50	3,35	Van Der BIJ	5	166	4	33,20	17,66
27	Tuominen M	6	11	2	1,83	2,72	Akgun AE	5	100	4	20,00	12,60
28	Martini A	5	18	2	3,60	4,02	Ettlie JE	5	90	4	18,00	11,74
29	Ulhoi JP	5	7	2	1,40	2,14	Rijsdijk SA	5	38	4	7,60	6,61
30	Gertsen F	4	50	2	12,50	8,55	Van Looy B	4	252	4	63,00	25,13
31	Paolucci E	4	19	2	4,75	4,49	Markham SK	8	143	3	17,88	13,67
32	Jorgensen F	4	8	2	2,00	2,52	Nakata C	7	78	3	11,14	9,54
33	Lin LH	4	6	2	1,50	2,08	Kawakami T	7	29	3	4,14	4,93
34	Liyanage S	3	27	2	9,00	6,24	McNally RC	6	29	3	4,83	5,19
35	Soosay C	3	25	2	8,33	5,93	Goffin K	5	67	3	13,40	9,65
36	Smits R	3	16	2	5,33	4,40	Van Den Ende	5	24	3	4,80	4,87
37	Wu HL	3	11	2	3,67	3,43	Slater SF	4	484	3	121,00	38,83
38	Kurokawa S	3	10	2	3,33	3,22	Schmidt JB	4	228	3	57,00	23,51
39	Lin CH	3	6	2	2,00	2,29	Reid SE	4	148	3	37,00	17,63
40	Miyake T	3	5	2	1,67	2,03	Paladino A	4	65	3	16,25	10,18

Robert Cooper exceed one thousand citations, which speaks of their high influence in the discipline, particularly amongst those researchers who publish in this journal.

Table 4 presents the leading authors in *RDM* and *RP*. In the case of *RDM* the first 10 authors in the ranking exceed 4 publications on innovation in the same journal. Unlike the information found in *IJTM*, even though there are few papers published by leading authors in *RDM*, the number of citations they have is very high on an average, nearly 230 citations by an author. This shows their high influence. Oliver Gassmann and Roy Rothwell's cases are special because they reach close to 500 citations.

A specific case of analysis is *RP*, one of the most influential and productive innovation research journals. In this case, the 10 most influential authors according to our ranking, sorted by *h*-index are: Eric Von Hippel, Loet Leydesdorff, Daniele Archibugi, Bruce Tether, Richard Nelson, Geert Duysters, Paul Nightingale, Bart Verspagen, Massimo Colombo and Robert Tijssen. The average number of citations from all these authors is 532 citations, which highlights their high influence in the discipline. A particular case of analysis is Henry Etzkowitz, who although does not appear in the first place in the ranking, has reached almost 1400 citations, which also shows high influence for the academic world.

Table 5 presents the leading authors in *TFSC* and *TASM*. As for *TFSC*, it has been observed that the first 10 authors in ranking exceed 5 publications on innovation in the same journal, surpassing 160 citations per researcher

Table 4. Leading authors in innovation in *R&D Management* and *Research Policy*

	R&D Management						*Research Policy*					
Rank	Author	TP	TC	H	TC/TP	*p*	Author	TP	TC	H	TC/TP	*p*
1	Gassmann O	10	516	7	51,60	29,86	Von Hippel E	11	1029	9	93,55	45,83
2	Herstatt C	6	222	6	37,00	20,18	Leydesdorff L	8	1123	8	140,38	54,02
3	Chiesa V	7	138	5	19,71	13,96	Archibugi D	12	213	7	17,75	15,58
4	Ernst H	5	185	5	37,00	18,99	Tether BS	10	528	7	52,80	30,32
5	Lichtenthaler U	6	158	5	26,33	16,08	Nelson RR	9	770	7	85,56	40,39
6	Bessant J	6	67	5	11,17	9,08	Duysters G	8	426	7	53,25	28,31
7	Rothwell R	4	484	4	121,00	38,83	Nightingale P	8	306	7	38,25	22,70
8	Enkel E	4	262	4	65,50	25,79	Verspagen B	8	282	7	35,25	21,50
9	Von Zedtwitz M	4	144	4	36,00	17,31	Colombo MG	7	366	7	52,29	26,75
10	Manzini R	4	112	4	28,00	14,64	Tijssen RJW	7	274	7	39,14	22,05
11	Debackere K	4	96	4	24,00	13,21	Roper S	10	314	6	31,40	21,44
12	Kim Y	4	70	4	17,50	10,70	Gambardella A	8	520	6	65,00	32,33
13	Frattini F	4	55	4	13,75	9,11	Hagedoorn J	8	407	6	50,88	27,46
14	Hobday M	4	45	4	11,25	7,97	Martin BR	8	356	6	44,50	25,12
15	Chang YC	5	93	3	18,60	12,00	Hobday M	7	610	6	87,14	37,60
16	Garnsey E	5	32	3	6,40	5,89	Grupp H	7	301	6	43,00	23,48
17	Brockhoff K	4	45	3	11,25	7,97	Mowery DC	7	228	6	32,57	19,51
18	Howells J	3	132	3	44,00	17,98	Fagerberg J	8	220	5	27,50	18,22
19	Tidd J	3	122	3	40,67	17,06	Geels FW	6	833	5	138,83	48,72
20	Linton JD	3	118	3	39,33	16,68	Link AN	6	365	5	60,83	28,11
21	Hauschildt J	3	100	3	33,33	14,94	Love JH	6	281	5	46,83	23,61
22	Von Krogh G	3	95	3	31,67	14,44	Kenney M	6	211	5	35,17	19,50
23	Lefebvre E	3	70	3	23,33	11,78	Blind K	6	195	5	32,50	18,51
24	Lefebvre LA	3	70	3	23,33	11,78	Etzkowitz H	5	1390	5	278,00	72,84
25	Macpherson A	3	57	3	19,00	10,27	Orsenigo L	5	378	5	75,60	30,57
26	Rush H	3	40	3	13,33	8,11	Fritsch M	5	324	5	64,80	27,59
27	Probert D	4	41	3	10,25	7,49	Kleinknecht A	5	299	5	59,80	26,15
28	Klofsten M	3	123	3	41,00	17,15	D'Este P	5	268	5	53,60	24,31
29	Floricel S	3	32	3	10,67	6,99	Frenken K	5	248	5	49,60	23,08
30	McMillan GS	3	29	3	9,67	6,54	Mangematin V	5	199	5	39,80	19,93
31	Miller R	3	20	3	6,67	5,11	Autio E	5	135	5	27,00	15,39
32	Ball DF	5	15	2	3,00	3,56	Pavitt K	7	386	4	55,14	27,71
33	Malik K	4	112	2	28,00	14,64	Henkel J	6	356	4	59,33	27,64
34	Berggren C	4	28	2	7,00	5,81	Malerba F	5	566	4	113,20	40,01
35	Verganti R	3	80	2	26,67	12,87	Laredo P	5	164	4	32,80	17,52
36	Hung SC	3	51	2	17,00	9,54	Freitas IMB	6	89	3	14,83	10,97
37	Collinson S	3	44	2	14,67	8,64	Stoneman P	6	48	3	8,00	7,27
38	Jones O	3	38	2	12,67	7,84	Iammarino S	5	189	3	37,80	19,26
39	Pearson A	3	26	2	8,67	6,09	Coombs R	5	175	3	35,00	18,30
40	Reger G	3	24	2	8,00	5,77	Freeman C	5	141	2	28,20	15,84

on average. For the total number of researchers in ranking, the average ranking of citations is 100, which shows their high influence. It is important to note the researchers Simona Black and Roald Suurs present a high ratio between citations and number of publications, without being first in the ranking. In other words, they are not the most published in the journal (4 and 3 respectively) but do have many cites with these articles.

TASM is perhaps one of the most interesting journals. The ranking shows that there are few papers published by each academic, 6 being the maximum number presented by two researchers, David Wield and Alan Porter. The interesting point about this case is that the two academics who have published the most have not turned out to be the most influential in the journal. In fact, the number of citations by the two authors mentioned is relatively low, 28 and 16 respectively. If the above is compared to certain researchers, such as Frank Geels, Staffan Jacobsson and Jeremy Howells, all of whom exceed 120 citations, we understand that productivity and influence are not directly related. Hence the importance of studying both aspects of scientific production. The average number of publications of our ranking in *TASM* is 3.3, with a variance of 0.93. Meanwhile, the average number of citations is 43.33 with a variance of 2281.76. Obviously, the greater variability in the number of citations that different researchers present explains the differences in impact and influence of scientific publications on the scientific community.

Finally, Table 6 presents the leading authors in *Technovation*. As in the previous case, *Technovation* is a journal that expresses the problem between productivity and

Table 5. Leading authors in innovation in *Technological Forecasting and Social Change* and *Technology Analysis and Strategic Management*

	Technological Forecasting and Social Change						*Technology Analysis and Strategic Management*					
Rank	Author	TP	TC	H	TC/TP	*p*	Author	TP	TC	H	TC/TP	*p*
1	Porter AL	9	341	8	37,89	23,47	McAdam R	5	36	4	7,20	6,38
2	Kostoff RN	9	239	7	26,56	18,51	Geels FW	4	249	4	62,25	24,93
3	Watanabe C	8	68	5	8,50	8,33	Jacobsson S	4	122	4	30,50	15,50
4	Hekkert MP	6	337	5	56,17	26,65	Wield D	6	28	3	4,67	5,07
5	Walsh ST	6	194	5	32,33	18,44	Galbraith B	5	29	3	5,80	5,52
6	Park Y	6	128	5	21,33	13,98	Chiesa V	4	52	3	13,00	8,78
7	Salo A	5	131	5	26,20	15,08	Howells J	3	185	3	61,67	22,51
8	Heitor MV	8	54	4	6,75	7,14	Duysters G	3	90	3	30,00	13,92
9	Conceicao P	7	53	4	7,57	7,38	Sanden BA	3	83	3	27,67	13,19
10	Devezas TC	5	102	4	20,40	12,77	Hekkert MP	3	80	3	26,67	12,87
11	Goldenberg J	5	71	4	14,20	10,03	Zawdie G	3	35	3	11,67	7,42
12	Phillips F	5	32	4	6,40	5,89	Tait J	3	34	3	11,33	7,28
13	Negro SO	4	322	4	80,50	29,59	Van Lente H	3	31	3	10,33	6,84
14	Guidolin M	4	48	4	12,00	8,32	Bakker S	3	28	3	9,33	6,39
15	Coccia M	4	45	4	11,25	7,97	Leydesdorff L	3	25	3	8,33	5,93
16	Alkemade F	4	37	4	9,25	6,99	Chataway J	3	24	3	8,00	5,77
17	Linstone HA	8	128	3	16,00	12,70	Porter AL	6	16	2	2,67	3,49
18	Nijkamp P	6	19	3	3,17	3,92	Bessant J	4	29	2	7,25	5,95
19	Phaal R	5	55	3	11,00	8,46	Gemser G	4	24	2	6,00	5,24
20	Smits REHM	4	276	3	69,00	26,70	Guo Y	4	14	2	3,50	3,66
21	Cunningham SW	4	82	3	20,50	11,89	Huang L	4	14	2	3,50	3,66
22	Grupp H	4	73	3	18,25	11,00	Robinson DKR	4	5	2	1,25	1,84
23	Kash DE	4	57	3	14,25	9,33	Clarke K	3	59	2	19,67	10,51
24	Linton JD	4	52	3	13,00	8,78	Hobday M	3	46	2	15,33	8,90
25	Markard J	4	31	3	7,75	6,22	Jacobs D	3	42	2	14,00	8,38
26	Gibson DV	4	28	3	7,00	5,81	Hemphill TA	3	31	2	10,33	6,84
27	Suurs RAA	3	260	3	86,67	28,25	Harborne P	3	23	2	7,67	5,61
28	Smits R	3	153	3	51,00	19,83	Hendry C	3	23	2	7,67	5,61
29	Muller E	3	136	3	45,33	18,34	Magnusson T	3	23	2	7,67	5,61
30	Robinson DKR	3	64	3	21,33	11,09	Hard M	3	22	2	7,33	5,44
31	Weber KM	3	49	3	16,33	9,28	Raven RPJM	3	11	2	3,67	3,43
32	Sirilli G	3	39	3	13,00	7,97	Alegre J	3	10	2	3,33	3,22
33	Shih HY	3	25	3	8,33	5,93	Fontes M	3	10	2	3,33	3,22
34	Van Lente H	3	25	3	8,33	5,93	Le Masson P	3	5	2	1,67	2,03
35	Pistorius CWI	3	21	3	7,00	5,28	Verbong G	2	60	2	30,00	12,16
36	Peine A	3	16	3	5,33	4,40	Wijnberg NM	2	41	2	20,50	9,44
37	Koh WTH	5	20	2	4,00	4,31	Vonortas NS	2	33	2	16,50	8,17
38	Coates JF	4	76	2	19,00	11,30	Vergragt PJ	2	30	2	15,00	7,66
39	Lee S	3	78	2	26,00	12,66	Walsh V	2	20	2	10,00	5,85
40	Meade N	3	62	2	20,67	10,86	Witkamp MJ	2	11	2	5,50	3,93

influence. On an average, the number of articles published by researchers of the ranking is 4.8 with a variance of 11.24. Meanwhile, the number of average citations per researcher is 98.4 with a variance of 4787.22 showing the complexity of the analysis productivity/influence by author. Four cases came to our attention in the ranking. The authors Wim Vanhaverbeke, Joseph Shyu, Nabil Amara and Réjean Landry, all exceeded the value of 48 with respect to the number of citations over the number of publications, which partly explains their greater relative influence over the rest of the researchers in *RDM*.

In order to compare the results with *h*-index and *p*-index, Figure 2 presents a two-dimensional graph showing the results of the leading authors in these journals. As we see, *p*-index tends to penalize an excessive number of papers without sufficient number of citations. Therefore, authors with a significant result in the citations per paper ratio tend to benefit from this index. Usually, highly cited authors appear in this situation with the *p*-index being a better approximation of the real value of key scientific contributions.

Bibliographic coupling and co-citation between the most productive and influential authors

Finally, this study presents an analysis of the citation structure of innovation research by authors through the concepts of bibliographic coupling and co-citation[38] and by using the VOS viewer software[39].

According to Martyn[40], bibliographic coupling appears when two different studies reference a common third

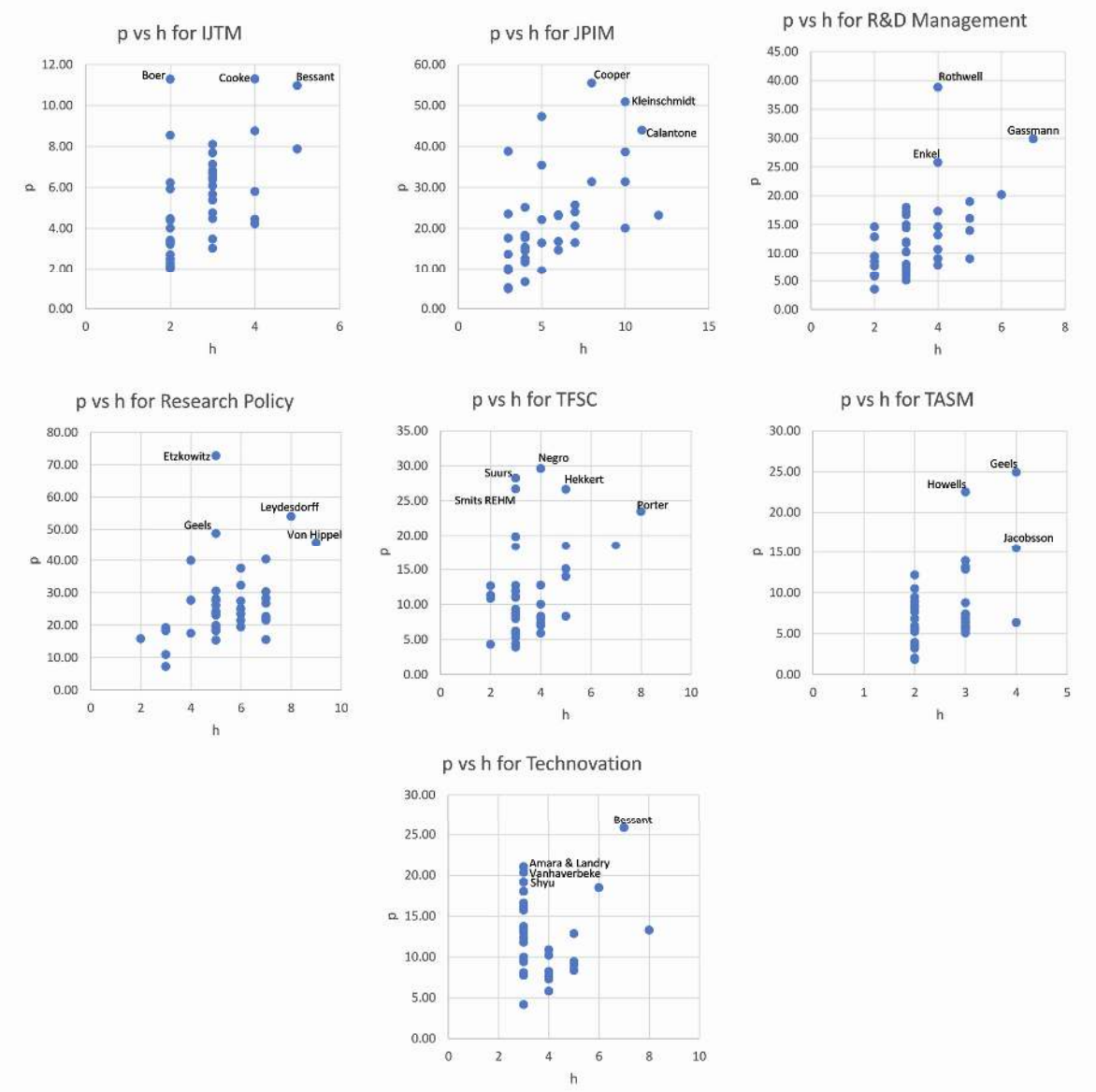

Figure 2. 2-Dimensional comparison between the *h*-index and the *p*-index for individual journals.

study in their bibliographies. Figure 3 shows the bibliographic coupling between the most productive and influential authors in innovation research. It is possible to observe several groups of authors who are bibliographically coupled, presenting a huge bibliographic network. For example, Michael Hitt, Shaker Zahra and Robert Hoskisson can be called a good network of American authors. Another group of authors who are bibliographically coupled are represented by the Italians Giovanni Dosi and Franco Malerba. In addition, there is a more diverse group of authors from countries like Germany, United States, United Kingdom and Netherlands, authors such as Philip Cooke, Michael Fritsch, Andrés Rodríguez-Pose, and Loet Leydesdorff. All these groups analyse literature in common and often cite specific documents similar to their lines of research on innovation. The previous analysis allows us to identify common study groups, with highly correlated literature.

On the other hand, according to Small[41], co-citation measures the frequency with which two documents are cited together by other documents. Figure 4 presents the co-citation structure of the most productive and influential authors in innovation research. In this case, leading authors in innovation research from our ranking (see Table 1), and other classic authors who are highly recognized for their contributions to innovation research, appear to have the highest influence in the co-citation analysis. According to this analysis, David Teece, Wesley Cohen and Richard Nelson would be the authors who receive the most citations compared to other authors in the world. It is remarkable that the earlier names are receiving even more citations than classic names such as that of Joseph

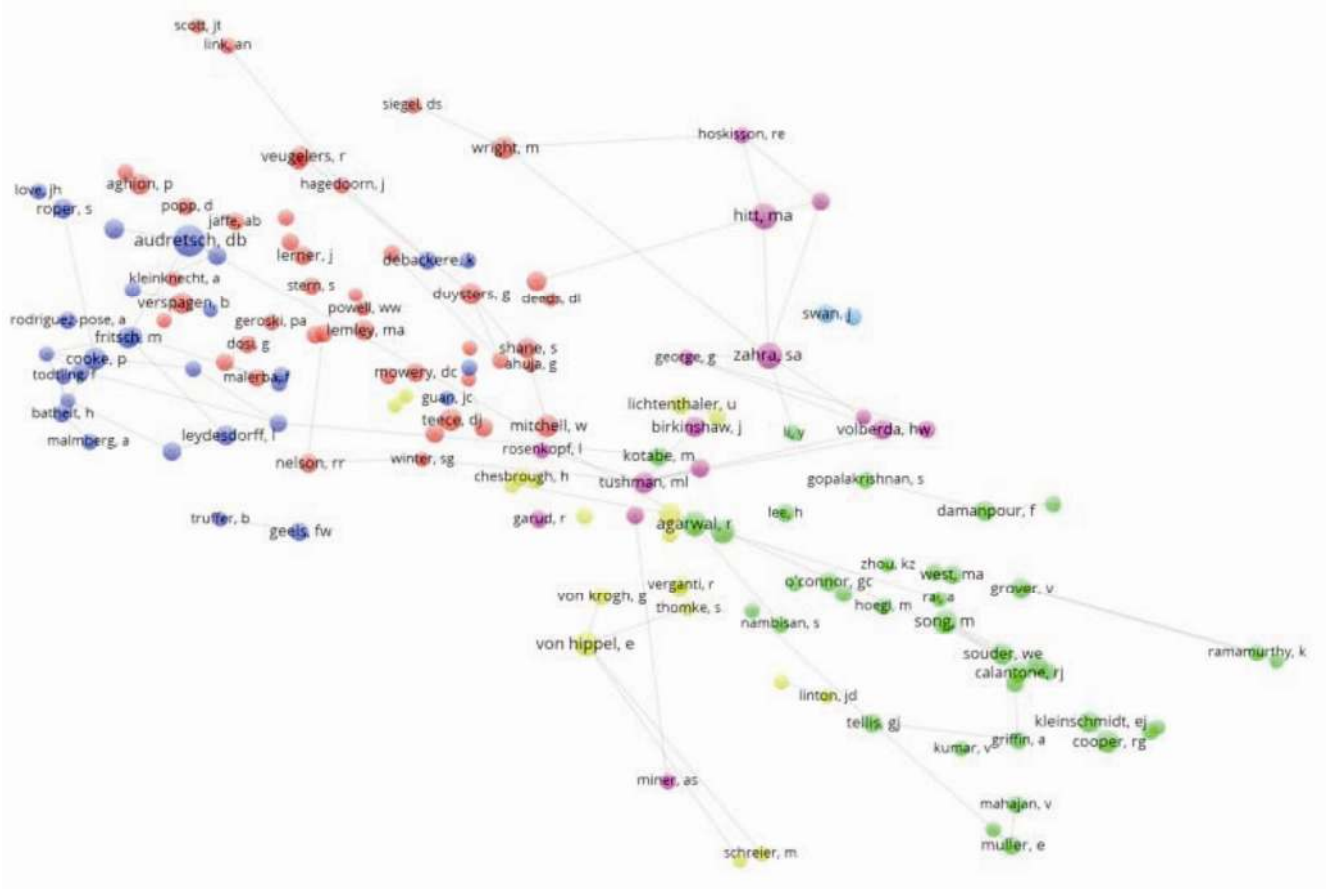

Figure 3. Bibliographic coupling analysis.

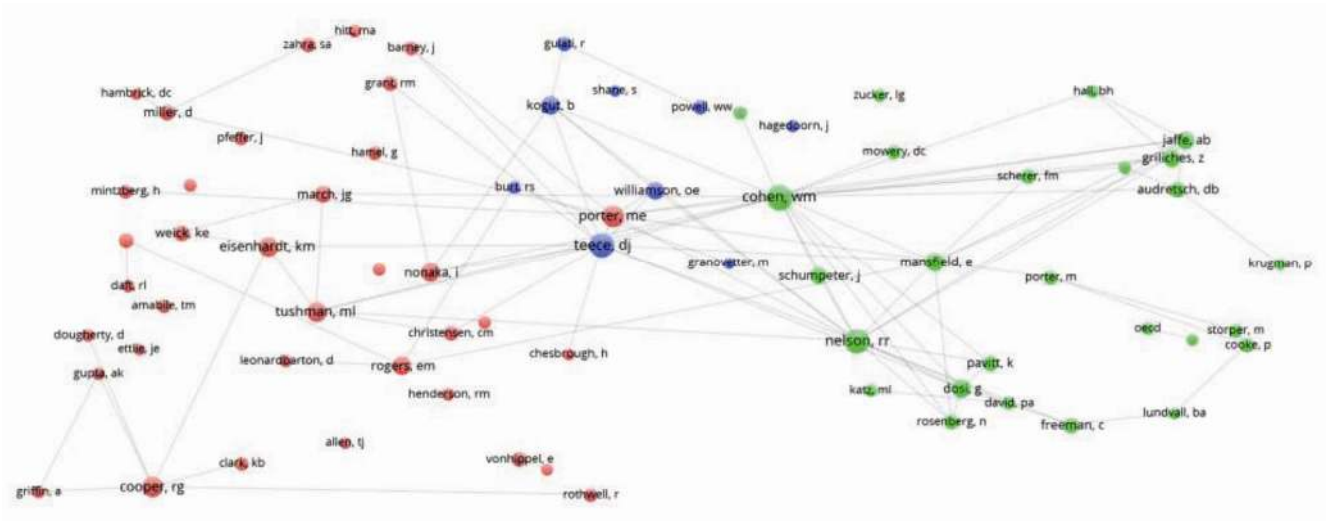

Figure 4. Co-citation analysis.

Schumpeter, typically cited in any scientific work on innovation. As in the case of bibliographic coupling, in co-citation analysis there are academics who are cited the most. These groups include David Audretsch, Zvi Griliches and Adam Jaffe who are highly cited by joint work, or also the group consisting of Michael Hitt, Shaker Zahra and Danny Miller, who are also highly cited by other similar work. David Teece, Wesley Cohen and Richard Nelson's cases are remarkable for receiving citations transversely by different authors from all over the world.

Table 6. Leading authors in innovation in *Technovation*

Rank	Author	*Technovation*				
		TP	TC	H	TC/TP	*p*
1	Watanabe C	22	227	8	10,32	13,28
2	Bessant J	9	394	7	43,78	25,84
3	Carayannis EG	7	210	6	30,00	18,47
4	Linton JD	12	98	5	8,17	9,28
5	Foxall GR	7	72	5	10,29	9,05
6	Griffy-Brown C	6	71	5	11,83	9,44
7	McAdam R	5	103	5	20,60	12,85
8	Kodama M	5	54	5	10,80	8,35
9	Wonglimpiyarat J	7	52	4	7,43	7,28
10	Lindelof P	5	80	4	16,00	10,86
11	Lofsten H	5	80	4	16,00	10,86
12	Hameri AP	5	47	4	9,40	7,62
13	Roper S	4	65	4	16,25	10,18
14	Dooley L	4	47	4	11,75	8,20
15	Brown S	4	28	4	7,00	5,81
16	Amara N	4	193	3	48,25	21,04
17	Landry R	4	193	3	48,25	21,04
18	Rothwell R	4	153	3	38,25	18,02
19	Kumar V	4	98	3	24,50	13,39
20	Roy R	4	81	3	20,25	11,79
21	Ottosson S	4	63	3	15,75	9,97
22	Lee J	4	46	3	11,50	8,09
23	Lichtenthaler U	4	44	3	11,00	7,85
24	Fontes M	4	43	3	10,75	7,73
25	Ilori MO	4	17	3	4,25	4,16
26	Vanhaverbeke W	3	159	3	53,00	20,35
27	Shyu JZ	3	145	3	48,33	19,14
28	Tzeng GH	3	117	3	39,00	16,59
29	Nieto M	3	112	3	37,33	16,11
30	Sohal AS	3	108	3	36,00	15,72
31	Islam N	3	88	3	29,33	13,72
32	Miyazaki K	3	88	3	29,33	13,72
33	Spithoven A	3	85	3	28,33	13,40
34	Love JH	3	83	3	27,67	13,19
35	O'Regan N	3	82	3	27,33	13,09
36	Trott P	3	81	3	27,00	12,98
37	O'Sullivan D	3	75	3	25,00	12,33
38	Phaal R	3	52	3	17,33	9,66
39	Probert D	3	52	3	17,33	9,66
40	Wang CH	3	50	3	16,67	9,41

Conclusions

This study presents a general overview of the leading authors in innovation research between 1989 and 2013. Different analyses were performed, both at a general level for the described period, and also at the level of specialized journals and by quinquennia.

First, the analysis focused on studying a ranking of 50 leading authors that present a greater *h*-index in the discipline. In this ranking, it is possible to observe an interesting discussion that reveals that the most productive researchers, i.e. those who have a greater quantity of published work, are not necessarily the most influential, i.e. those who have a greater number of citations by the scientific community. There are several authors who despite presenting fewer publications, are frequently cited by other researchers. Perhaps one of the most interesting cases is David Teece, a researcher who is noted for having the largest number of citations, almost 8000 citations, with only 31 articles in innovation research published for the period of analysis, with an average of 257.7 citations per article. Other authors, such as Ulrich Lichtenthaler, Michael Song, John Bessant, Philip Nicholas Cooke, among others, present a large number of publications, over 40 items for the period under analysis, but with fewer number of citations by article between 20 and 40 articles on average by author. Obviously, greater productivity does not imply greater influence. Except in the case of David Audretsch, present in our ranking, who with more than 4500 citations and 63 articles, presents the highest *h*-index.

Second, taking into account the seven most specialized and recognized journals in innovation research – *IJTM*, *JPIM*, *RDM*, *RP*, *TFSC* and *TASMT* – it was possible to develop a particular analysis of authors with higher *h*-index in innovation. Regarding individual journals, it is corroborated again that researchers presenting greater productivity do not necessarily become the most influential. The above is also true for specialized journals. However, *RP*, *JPIM*, *RDM* and *TFSC* stand out. They are journals where authors who appear at the top of each ranking are noticeable due to the high number of citations exceeding even over a thousand citations per researcher, such as the cases of Henry Etzkowitz, Loet Leydesdorff and Eric Von Hippel on *RP*, with 5, 8 and 11 publications respectively. In this case, it is possible to note more clearly the influence that an author can have depends strongly on the quality, novelty and attraction of the article by a researcher, rather than the number of publications that he/she possesses in the discipline.

While the results of this study are valuable, it is necessary to deepen and complement the information presented with new studies that allow understanding on how innovation research publications in different journals (specialized and general) in the Web of Science have increased and see what the ratio of citations among these journals is. This would allow us to recognize if the largest number of publications and citations of certain authors, were linked to the network of contacts that is generated within the group of authors concentrated around a journal, rather than by influence in the scientific world, given the quality and appeal of their work. In this sense, we still see the need to further develop studies to complement the analysis of what the most influential countries and universities in innovation research are and which journals have greater impact and influence on the material.

The results of this study are particularly different from previous studies[1,22,23]. Fagerberg and Verspagen[1] presented an analysis of the most influential authors in innovation research taking into account all the years of history, which leads to highlight the classic papers[6–9]. In the focus is on the most influential authors of the past

25 years instead, recognizing those who have allowed the frontiers of knowledge to extend in recent years. This study Thieme[22] and Yang and Tao[23] based their analysis primarily on measuring productivity, and to a lesser extent on measuring influence. The present study allows us to activate the discussion on whether only a greater volume of scientific production is desirable, or if the impact and influence of each academic work is what is actually valuable.

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