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Sixty-four years of informetrics research: productivity, impact and collaboration

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Abstract This paper analyses the information science research field of informetrics to identify publication strategies that have been important for its successful researchers. The study uses a micro-analysis of informetrics researchers from 5,417 informetrics papers published in 7 core informetrics journals during 1948–2012. The most productive informetrics researchers were analysed in terms of productivity, citation impact, and co-authorship. The 30 most productive informetrics researchers of all time span several generations and seem to be usually the primary authors of their research, highly collaborative, affiliated with one institution at a time, and often affiliated with a few core European centres. Their research usually has a high total citation impact but not the highest citation impact per paper. Perhaps surprisingly, the US does not seem to be good at producing highly productive researchers but is successful at producing high impact researchers. Although there are exceptions to all of the patterns found, researchers wishing to have the best chance of being part of the next generation of highly productive informetricians may wish to emulate some of these characteristics.

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Introduction

Informetrics is one of the older research areas within information science although the term is relatively recent. This area had already been studied for decades by the time information science had coalesced in the late 1950s from elements of many disciplines, including library and information science (LIS), history of science, computer science, communications, sociology and linguistics (Wolfram 2003). It is now over 50 years since this merger and it therefore seems appropriate to analyse informetrics researchers in order to identify strategies that have been successful within this field over its lifetime.

The term informetrics was first used in the late 1970s (Blackert and Siegel 1979, cited in Egghe 2005; Nacke 1979, cited in Wolfram 2003) to describe the area of information science dealing with "the development of information phenomena and the application of mathematical methods to the discipline's problems" (Wilson 1999, p. 111). Egghe (2005) provided a broad definition of informetrics as all metrics studies related to information science, including bibliometrics (bibliographies, libraries), scientometrics (science policy, citation analysis, research evaluation) and webometrics (metrics of the web, the Internet or other social networks such as citation or collaboration networks)" (p. 1311). Björneborn and Ingwersen (2004) argued that the field of informetrics embraced the overlapping fields of bibliometrics and scientometrics following the widely adopted Tague-Sutcliffe (1992) definition which defines informetrics as "the study of the quantitative aspects of information in any form, not just records or bibliographies, and in any social group, not just scientists" (p. 1). The newer area of webometrics also fits within informetrics as "the study of the quantitative aspects of the construction and use of information resources, structures and technologies on the Web drawing on bibliometric and informetric approaches" (Björneborn and Ingwersen 2004). It is therefore appropriate to use the concept of informetrics as a broad term for research into many types of information-related metrics.

This study analyses successful informetrics researchers in terms of research productivity, citation impact and scientific collaboration. Previous studies have found a positive association between productivity and the extent of research collaboration in scientometrics (Egghe et al. 2007) and also between research productivity and citation impact within this field (Wang et al. 2012). Associations between collaboration and citation impact have been widely examined in the literature; the results generally suggest that the higher the number of authors, the higher the citation impact (Beaver 2004). International and inter-institutional collaborative research also positively influences research citation impact (He et al. 2009; cf. Didegah and Thelwall 2013). In Social Network Analysis (SNA)-related research, some studies have also examined the relationship between SNA measures with citation impact and research productivity. In LIS, centrality measures significantly correlated with the citation impact of authors (Yan and Ding 2009; Yan et al. 2010).

Despite the research discussed above, no studies have systematically analysed factors associating with successful informetrics researchers and research over the lifetime of the field. This study fills this gap and focuses on citation impact, collaboration and productivity in order to point to factors associating with successful informetrics research strategies.

Literature review

The study of research productivity, citation impact and collaboration has a long-standing tradition in LIS research, and these three indicators have been employed in many disciplines to measure research success in terms of output. This account focuses on the studies that highlight associations between research productivity, impact and collaboration in the area of informetrics. Milojevic and Leydesdorff (2013) studied the core informetrics researchers based upon comparing four sets of articles from three top journals. They found an accelerated rate of publishing informetrics articles since 2004, with the number of articles in 2010 approximately four times higher than ten years earlier. This reflects the high productivity of the more recent core informetrics researchers. Milojevic and Leydesdorff (2013) also found that most of the authors are more likely to publish in informetrics than in the other Information Science & Library Science areas, indicating that these core authors are specialists rather than general information scientists.

Research collaboration and productivity

Newman (2001) found that scientists with many collaborators are likely to be productive and influential and the mean number of collaborators for an author is 3.08. Egghe et al. (2007) claimed that for a fixed field, the higher the number of papers of an author, the higher would be his/her fraction of collaborative papers. They gave three explanations for this: (a) authors involved in co-authored papers have more time to write additional papers since part of the work is done by the other co-authors; (b) collaboration could be higher between the "better" researchers, which then leads to higher production; and (c) collaboration is higher in fields with highly productive large research laboratories. Similarly, Borgman and Furner (2002) also claimed that higher rates of collaboration are usually associated with higher productivity. The assertion that collaboration is positively related with research productivity in informetrics research is empirically supported by the results of a meso-level analysis of an informetrics research network COLLNET (Yin et al. 2006); and macro-level analysis of informetricians' geographical diversity (Abbasi and Jaafari 2013). Using the 1995–2004 publication data for scholars from premier information science and library science journals, Liao and Yen (2012) showed that the degree of research collaboration had a strong positive relationship with research productivity.

Research collaboration and citation impact

Internationally co-authored articles are more likely to be cited more by other researchers (Narin et al. 1991; Glänzel and Schubert 2001). Narin et al. (1991) found that internationally co-authored papers were cited twice as often as papers authored by scientists working at a single institution within a single country. Additionally, studying documents recorded in the 1995 volume of the Science Citation Index, Glänzel and Schubert (2001) reported that international co-authorship results in publications with a higher citation impact than purely domestic papers. A positive correlation between the citation frequency of publications and the number of co-authors of the work has also been reported by Beaver (2004) and Levitt and Thelwall (2009). The latter's investigation of collaboration for influential information scientists found that, although collaborative research is conducive to high citation in general, collaboration has apparently not tended to be essential to the success of current and former elite information scientists.

Recent studies have also shown the association between research collaboration and research impact in informetrics research. Liao and Yen's (2012) study of scholars publishing in top information science and library science journals found that the degree of collaboration had the highest coefficient estimates on the average number of citations compared with the collaborative index, collaborative coefficient, revised collaborative coefficient and degree centrality. Similarly, Abbasi and Jaafari (2013) who studied publications in the top ten journals in WoS "Information Science & Library Science" category confirmed that citation impact has an association with collaboration and in fact a stronger association with the numbers of external collaborations at the inter-departmental and inter-institutional level, compared to internal collaborations. Using a combined analysis of citations and collaboration to assess the academic impact of informetricians, Ding et al. (2013) categorized *Scientometrics* researchers into four types: ordinary researchers; ordinary and core researchers; excellent and core researchers; and excellent and lonely researchers.

Centrality measures, research productivity and research impact

There have been studies of the relationship between co-authorship centrality measures and research productivity and impact in the area of informetrics. Using co-authorship data from 16 LIS journals during 1988–2007, Yan and Ding (2009) found that four co-authorship centrality measures [degree centrality (i.e., number of co-authors, as used in the above two subsections), betweenness centrality (the extent to which an author helps to connect otherwise unconnected authors, through co-authorship connections), closeness centrality (the reciprocal of the distance of an author to all other authors, measured through co-authorship connections) and PageRank] statistically significantly associated with citation counts, with betweenness centrality having the strongest association. The same was found for LIS researchers in China (Yan et al. 2010), except that PageRank was not studied.

Guns et al. (2010) found a relatively low degree of international collaboration in informetrics research published in *Scientometrics* and *Journal of Informetrics*, but the top authors had the highest global collaboration network centrality measures. Chen et al. (2012) and Erfanmanesh et al. (2012) both investigated scientometricians through the journal *Scientometrics* (see also: Dutt et al. 2003; Hou et al. 2008; Bar-Ilan 2008). Chen et al. (2012) analysed all 2,541 papers published in *Scientometrics* from 1978 to 2010; whereas Erfanmanesh et al. (2012) used the co-authorship data from 3,125 articles published in *Scientometrics* two years later, from 1980 to 2012. Both studies showed that scientometrics was not dominated by a few key researchers because significant numbers of new authors have also joined the field.

Research questions

The review above shows that the relationship between collaboration and citations has been studied for specific time periods for all of LIS and for both Scientometrics and the Journal of Informetrics. The properties of informetrics research have also been examined in terms of topic focus and distinctness from general information science research. Nevertheless, no previous study has focused on identifying properties of successful informetrics researchers over the full lifespan of this field. To fill this gap, this study reports a micro-level analysis of informetrics research performance in terms of the affiliations, impact and collaboration

of the most prolific individuals in this area. The following specific question drives the research.

How are scholars publishing the most informetrics research characterised in terms of (a) their affiliations, (b) the extent to which they are the primary authors of their papers, (c) their collaboration patterns, (d) the impact of their research, (e) the timespan of their influence, and (e) their impact per paper?

Methods

Seven journals categorized under "Information Science; Library Science" (IS&LS) in the Web of Science (WoS) database were chosen as likely to contain the main contributions of the informetrics community (extending the set used in Milojevic and Leydesdorff 2013): *Journal of Informetrics, Scientometrics, Journal of the American Society for Information Science & Technology* (JASIST and its earlier title, JASIS), *Research Evaluation, Journal of Documentation, Journal of Information Science* and *Information Processing & Management*. This selection will bias the results against authors that publish disproportionately in national journals, journals that are peripheral to scientometrics, or books.

The informetrics articles published in these journals were retrieved from the Thomson-Reuters WoS. All document types were included, such as articles, proceedings paper, book reviews, editorial materials, notes, reviews and letters. This resulted in 17,789 records. Author information not in WoS was identified from the Web. Variants of author names and institutions were also checked with the web. Both *Scientometrics* and *Journal of Informetrics* were considered to be informetric journals and so all of their articles were included. A manual check by two of the authors confirmed that all of the 3,659 articles in both *Scientometrics* and *Journal of Informetrics* related to informetrics research. Milojevic and Leydesdorff's (2013) method was used to identify informetrics articles in the other five journals. Articles from these journals were therefore included if they contained at least one reference to either *Scientometrics* or *Journal of Informetrics* or they contained at least one of the following ten words in their titles or keywords: "scientometric", "bibliometric", "webometric", "informetric", "cybermetric", "citation", "indicator", "productivity", "mapping", "cite" or the prefixes: "h-" or "co-". In this study, articles that contained other words or phrases in their titles or keywords associated with specific concepts, laws or theories used in informetrics research were also included, a manual check by the first author. The final data set consisted of 5,417 informetrics research articles (Table 1). The earliest informetrics paper in this sample was published in 1948 in the *Journal of Documentation* entitled "Bradford's Law of Scattering", which was judged to be about a bibliometric law.

A total of 145 authors were found to publish with different names. There were also 153 inconsistent university names that needed to be edited to bring all the papers affiliated with a specific institution together. After data verification, there were 4,779 unique authors affiliated to 2,434 parent institutions from 75 countries.

To quantify the importance of an author in the informetrics research collaboration network, for each author their number of collaborators, collaborations and betweenness centrality were also calculated. Betweenness centrality is the probability that a particular author appears on the shortest path between any pair of authors in the collaboration network (Prell 2011; Yan et al. 2010) and is an indicator of the importance of an author for the connectedness of a network.

Table 1 Articles extracted from the selected journals

Journal title	Years (volumes, issues)	Total no. of documents	Informetrics documents	% of the total informetrics documents
Scientometrics	1978 (1,1) –Dec 2012 (93,3)	3,342	3,342	61.7
Journal of Informetrics	Jan 2007(1,1)–Oct 2012 (6,4)	317	317	5.9
Journal of the American Society for Information Science (JASIS) and Journal of the American Society for Information Science & Technology (JASIST)[a]	Jan 1970 (21,1)–Dec 2000 (51,14) (JASIS)[a]	5,300	820	15.1
	Jan 2001 (52, 1)–Nov 2012 (63,11) (JASIST)			
Research Evaluation	Apr 2000 (9,1)–Sep 2012 (21,3)	352	290	5.4
Journal of Documentation	Jan 1945 (1,1)–Nov 2012 (68,5)	3,729	206	3.8
Journal of Information Science	Jan 1979 (1,1)–Oct 2012 (38,5)	1,805	213	3.9
Information Processing & Management[b]	Jan 1975 (11,1)–Nov 2012 (48,6)	2,944	229	4.2
Total		17,789	5,417	100.0

[a] *JASIST* began as *American Documentation* with its first issue in 1950 but is not covered in this study before 1970 as the journal is not covered in WoS

[b] IP&M began as Information Storage and Retrieval with its first issue in 1963 but is not covered in this study before 1975, when it was covered in WoS

Results and discussion

In the dataset of 4,779 unique authors, only 148 (2.82 %) had contributed to 10 or more articles and these could reasonably be considered to be successful researchers. Table 2 shows the 30 most productive researchers, as indicated by the total number of articles in the data set. Given that journal editorial board members are sometimes considered to be among the most prestigious scientists (Campanario 1998), it is not surprising that 19 out of the top 30 most productive informetricians are current editorial board members in at least one of the journals studied. This set also includes just under half of the current De Solla Price Award winners: 11 out of 25. Since this award presumably reflects the judgement of the field about which are its best researchers, just under half of the top informetrics researchers are highly productive in informetrics. Others have perhaps driven the field in more applied ways (e.g., Martin, Irvine) or have contributed particularly important or pioneering strands of research (e.g., Merton, Nalimov). Apart from Oppenheim, Bar-Ilan, Bordons, Small and Garfield, the other top informetricians have more than 60 % of their WoS publications in the seven journals on which this study focuses. Thus, most top informetricians published mostly in the 7 core journals.

Affiliation

Almost half (13) of the 30 most productive authors have been affiliated with a few institutions: the Hungarian Academy of Science (Glänzel, Schubert, Braun, Vinkler and Thijs), Leiden University (van Raan, Moed, van Leeuwen and Tijssen), University of Leuven (Glänzel, Rousseau, Thijs and Meyer), and the University of Antwerp (Rousseau and Egghe). Only 4 out of the top 30 most productive authors are affiliated with American institutions (Cronin, Small, Moravcsik (deceased but formerly with Oregon) and Garfield). This is surprising since the United States ranks 1st among the top most productive countries in the area of informetrics with its global share of 33.75 % (1,768 papers). Thus the US seems to be more successful at producing informetrics research than at producing successful informetrics researchers. Informetricians sometimes have multiple affiliations, and 613 papers contain at least one author who indicated more than one institutional affiliation (i.e. different departments in the same institution or different institutions). Four out of the top 30 authors had, on average, at least two concurrent affiliations: Rousseau, Egghe, Meyer and Glänzel. Nevertheless, almost two-thirds of the most productive authors (19) have a single affiliation.

Primary authorship

Successful informetrics researchers are predominantly first authors of their papers and hence probably the main contributors (Table 2—but note that some authors, such as Egghe and Rousseau, frequently use alphabetical order and so order does not necessarily indicate contribution) and this difference is statistically significant (one-way ANOVA $F = 28.84$, $p = 0.000$). This probably contrasts with areas within medicine, computing and science in which senior researchers are often at the end of author lists. The 30 most productive authors rarely contribute to papers in the 4th or later position (3.6 %). There is a great range, however, from 3 % of articles as the first author (D'Angelo) to 100 % (Vinkler—due to not collaborating). Hence, it seems that successful informetrics researchers tend to be primary contributors to research rather than research supervisors.

Table 2 The 30 authors publishing the most informetrics articles in the main seven journals for informetrics (1945–2012)

	Author	Informetrics papers	IS&LS papers in WoS	Informetrics/ IS&LIS papers (%)	Average affiliations	Papers as 1st author	Papers as 2nd author	Papers as 3rd author	Papers as 4th or later author	% first author	Fractional count
1[a]	***Glänzel, W***	148	170	87	1.5	68	61	10	9	46	104.0
2[a]	***Egghe, L***	132	172	68	2.0	131	1	0	0	99	131.5
3[a]	***Rousseau, R***	128	187	63	2.1	51	60	15	2	40	86.4
4[a]	***Leydesdorff, L***	120	149	79	1.0	86	25	7	2	72	101.3
5[a]	***Schubert, A***	114	120	94	1.0	62	27	19	6	54	83.3
6	***Thelwall, M***	102	167	61	1.0	58	39	3	2	57	79.0
7[a]	***vanRaan, A. F. J***	77	77	94	1.0	30	18	15	14	39	47.0
8[a]	***Braun, T***	75	83	89	1.2	60	7	7	1	80	66.1
9	***Bornmann, L***	65	79	82	1.0	55	10	0	0	85	60.0
10[a]	***Moed, H. F***	63	67	87	1.0	28	22	9	4	44	42.9
11	***vanLeeuwen, T. N***	46	47	98	1.0	18	19	8	1	39	30.4
12	*Daniel, HD*	44	54	82	1.0	3	20	16	5	7	19.5
13	**Burrell, Q**	41	59	70	1.1	40	1	0	0	98	40.5
14	Moya-Anegon, F	40	56	71	1.0	7	15	9	9	18	19.7
15[a]	***Cronin, B***	40	262	15	1.1	34	5	1	0	85	36.8
16	***Vinkler, P***	39	46	85	1.0	39	0	0	0	100	39.0
17	***Bar-Ilan, J***	38	83	43	1.0	33	3	2	0	87	35.2
18	*Oppenheim, C*	37	293	12	1.0	18	10	8	1	49	25.9
19[a]	Moravcsik, M. J	36	37	95	1.0	32	3	1	0	89	33.8
20[a]	***Small, H***	36	54	57	1.0	32	4	0	0	89	34.0

Table 2 continued

	Author	Informetrics papers	IS&LS papers in WoS	Informetrics/ IS&LIS papers (%)	Average affiliations	Papers as 1st author	Papers as 2nd author	Papers as 3rd author	Papers as 4th or later author	% first author	Fractional count
21	Lewison, G	33	47	70	1.1	30	1	1	1	91	31.0
22	**Kretschmer, H**	33	37	89	1.3	25	7	1	0	76	28.9
23	D'Angelo, C. A	31	36	86	1.0	1	22	8	0	3	14.7
24	Abramo, G	31	37	84	1.4	30	0	1	0	97	30.3
25	***Tijssen, R***	30	38	76	1.0	16	7	5	2	53	21.7
26	Gupta, B. M	29	43	67	1.0	21	8	0	0	72	25.0
27	*Meyer, M*	27	27	100	1.7	15	9	3	0	56	20.5
28[a]	***Garfield, E***	27	223	12	1.0	20	6	0	1	74	23.2
29	Thijs, B	26	32	81	1.1	7	10	7	2	27	14.8
30	Garg, K. C	26	28	93	1.0	14	9	3	0	54	19.5

Italic authors are also in the top 30 most highly cited. Bold authors are editorial board members in the journals studied

[a] De Solla Price Award winner. Others were Nalimov (1987), F. Narin (1989), B.C. Brookes, J. Vlachy (1991), R. Merton (1995), B. Martin, J Irvine, B. Griffith (1997), P. Ingwersen, H. White (2005), K. McCain (2009), P Vinkler, M. Zitt (2009), O Persson (2011)

Collaboration

In general, the most publishing authors also tend to have the most informetrics collaborators and collaborations (Table 3), even though some (Vinkler) don't collaborate. Authors with a high betweenness centrality tend to connect, through co-authorship, authors that are otherwise not well connected to the informetrics community, including new researchers (e.g., PhD students). The most productive researchers are well represented in the top 30 for betweenness centrality and hence seem to play this role or perhaps also collaborate with

Table 3 The 30 authors with the highest collaboration scores based upon informetrics articles in the main seven journals for informetrics (1945–2012)

Collaborators		Collaborations		Betweenness centrality	
Author	#	Author	#	Author	($\times 10^{-3}$)
Rousseau, R[a]	67	*Glänzel, W*[a]	236	*Glänzel, W*[a]	83
Glänzel, W[a]	58	*Schubert, A*[a]	131	*Rousseau, R*[a]	64
Leydesdorff, L[a]	52	*Rousseau, R*[a]	130	*Leydesdorff, L*[a]	58
Thelwall, M	47	*Thelwall, M*	123	*Kretschmer, H*	31
Moya-Anegon, F	43	*Braun, T*[a]	110	Liang, L. M	26
Moed, H. F[a]	39	Moya-Anegon, F	106	*Moed, H. F*[a]	26
Borner, K	30	*Leydesdorff, L*[a]	100	*Thelwall, M*	23
vanLeeuwen, T. N	29	*Bornmann, L*	97	Moya-Anegon, F	21
Debackere, K	29	*Moed, H. F*[a]	96	Zitt, M[a]	19
Bornmann, L	28	*vanLeeuwen, T. N*	94	*Egghe, L*[a]	17
Gomez, I	27	*vanRaan, A.. F. J*[a]	85	Qiu, J. P	17
Oppenheim, C	27	*Daniel, H. D*	73	Leta, J	16
Kretschmer, H	27	Debackere, K	69	Park, H. W	15
Tijssen, R	26	Huang, M. H	67	Wang, Z	14
Lewison, G	26	Chen, D. Z	59	Debackere, K	14
vanRaan, A. F. J[a]	25	Abramo, G	59	*Meyer, M*	14
Huang, M. H	25	D'Angelo, C. A	59	*Oppenheim, C*	13
Ho, Y. S	25	Gomez, I	57	Borner, K	13
Liang, L. M	24	Thijs, B	54	*Vaughan, L. W*	12
Lepori, B	24	*Tijssen, R*	49	Chen, C. M	12
Klingsporn, B	24	Bordons, M	49	Okubo, Y	11
Schubert, A[a]	23	Courtial, J. P	47	Katz,J. S	10
Courtial, J. P	23	Gupta, B. M	45	Hicks, D	10
Wu, Y. S	23	Spink, A	45	Gupta, B. M	10
Kostoff, R. N	23	*Oppenheim, C*	43	*vanLeeuwen, T. N*	10
Chen, D. Z	22	Liang, L. M	42	Zhang, X	10
Gupta, B. M	22	Visser, M. S	42	Sugimoto, C. R	10
Pan, Y. T	22	*Egghe, L*[a]	42	*Ho, Y. S*	9
Trochim, W. M	21	Lariviere, V	41	Aguillo, I. F	9
Spink, A	20	Waltman, L	41	*Bornmann, L*	8

Bold authors are also in the productivity top 30 and italic authors are also in the total citation impact top 30

[a] De Solla Price Award winner

researchers in more peripheral countries. This part of Table 3 includes some that successfully co-author with others in countries that have historically been outside of the core of informetrics, such as China (Liang, Qiu, Wang), France (Zitt), Brazil (Leta) and South Korea (Park), even though they are not in the top 30 for productivity.

Impact

The most cited authors (Table 4) also tend to be the most productive authors: 20 of the 30 most cited authors are also in the most productive 30. The prominent exceptions of White, Narin and McCain show that it is possible to have a significant citation impact on the field without being the most prolific. Derek de Solla Price, Robert Merton and Eugene Garfield are additional influential exceptions, but their main contributions were published books or articles outside the journals included here. The inclusion of 17 de Solla Price Award winners in Table 4 also confirms that total impact is a better influence metric than total publications.

Influence span

The most cited informetricians started to have their influence at a range of different points in time and are all still relevant today, although the influence of one, Bornmann, started in the latest period, 2005–2009 (Table 4). The citation impact of all authors has increased over time, almost without exception. This is probably due to the increase in the size of the informetrics field over time, as measured by its total publications (e.g., the most specialist publication, the Journal of Informetrics, started in 2007). Possibly because of this increase, previously influential informetricians that are not as relevant today are unlikely to be in the top cited list. Nevertheless, a career starting before 1984 (29 years from the data collection) does not preclude current influence.

Impact per paper

Based on the number of citations per paper for authors with at least six papers (to exclude occasional contributors), it is clear that the most productive informetricians do *not* have unusually high citation impact per paper because only 4 of the most productive informetricians are in Table 3. Although more of the highly cited informetricians (12) are in Table 5, it is still less than half. Presumably either some of their articles are highly cited and others are not, or they produce many moderately cited articles. When normalized based on the journal impact factor of the journal that each of the 515 articles (publications) was published in, the citations of the Price de Solla award winners (carrying more than 1,000 citations respectively) surpassed the rest of the authors.

Limitations

This study examined selected characteristics of the most productive informetricians ever based upon informetrics articles published in seven journals, a subset of informetrics research that is reasonably comprehensive but not complete. The results are limited by the scope and may be misleading for authors that published books or who published significantly outside of the seven journals selected. For example, the inclusion of influential

Table 4 The 30 authors receiving the most citations to informetrics articles in the main seven journals for informetrics (1945–2012)

	Author	Total citations	Citations <1984	Citations 1985–1989	Citations 1990–1994	Citations1995–1999	Citations 2000–2004	Citations 2005–2009	Citations >2010
1[a]	**Glänzel, W**	3,262	1	85	206	278	312	1190	1190
2[a]	**vanRaan, A. F. J**	2,380	0	25	91	216	359	807	882
3[a]	**Schubert, A**	2,144	15	131	251	255	240	595	657
4[a]	**Moed, H. F**	2,012	0	21	60	184	287	675	785
5[a]	**Small, H**	1,934	113	197	174	160	256	494	540
6[a]	**Leydesdorff, L**	1,918	0	19	65	92	156	692	894
7[a]	Narin, F	1,883	282	182	150	188	254	395	432
8[a]	White, H. D	1,841	68	100	49	131	391	569	533
9[a]	**Egghe, L**	1,828	0	61	108	136	237	627	659
10	**Thelwall, M**	1,803	0	0	0	0	311	834	658
11[a]	**Rousseau, R**	1,718	0	3	28	91	212	629	755
12[a]	**Braun, T**	1,573	13	103	214	254	198	419	372
13	**Bornmann, L**	1,098	0	0	0	0	0	285	813
14	**vanLeeuwen, T. N**	1,080	0	0	0	70	167	350	493
15[a]	McCain, K. W	1,057	3	21	61	112	246	351	263
16[a]	**Cronin, B**	994	14	21	37	127	193	330	272
17	**Daniel, H. D**	931	0	0	1	6	3	306	615
18	MacRoberts, B. R	845	0	34	77	132	122	232	248
19	MacRoberts, M. H	845	0	34	77	132	122	232	248
20	**Meyer, M**	798	0	0	0	1	67	328	402
21	Griffith, B. C	748	82	110	76	78	101	172	129
22	**Bar-Ilan,J**	729	0	0	0	9	82	303	335

Table 4 continued

	Author	Total citations	Citations <1984	Citations 1985–1989	Citations 1990–1994	Citations1995–1999	Citations 2000–2004	Citations 2005–2009	Citations >2010
23[a]	Ingwersen, P	761	0	0	0	35	255	278	193
24[a]	**Vinkler, P**	670	0	11	46	88	94	152	279
25	**Oppenheim, C**	653	9	16	9	10	95	206	308
26[a]	Persson, O	616	0	7	6	33	82	241	247
27	Ho, Y. S	597	0	0	0	0	5	198	394
28	**Tijssen, R**	588	0	1	23	51	76	189	248
29[a]	**Garfield, E**	585	38	48	56	50	60	145	188
30	Vaughan, L	563	0	0	0	0	34	322	207

Bold authors are also in the productivity top 30

[a] De Solla Price Award winner

Table 5 The 30 authors receiving the most *CPP* Citations Per Paper to informetrics articles in the main seven journals for informetrics (1945–2012), excluding authors with 5 or less publications 30

	Author	CPP	Citations	Publications	Total normalized citations
1[a]	*Narin, F*	78.5	1,883	24	2,101.6
2	*MacRoberts, B. R*	76.8	845	11	678.1
3	*MacRoberts, M. H*	76.8	845	11	678.1
4[a]	*White, H. D*	76.7	1,841	24	1,386.6
5	Meho, L. I	60.1	421	7	285.8
6[a]	***Small, H***	53.7	1,934	36	1,925.6
7*	*McCain, K. W*	42.2	1,057	25	1,323.0
8	Beaver, D. D	41.1	329	8	438.4
9	Leimkuhler, F. F	41.0	246	6	511.8
10[a]	*Griffith, B. C*	37.4	748	20	1,101.7
11	Boyack, K. W	37.2	522	14	265.8
12	Bjorneborn, L	36.8	184	5	173.3
13	Klavans, R	35.8	358	10	196.3
14	Snyder, H. W	34.6	208	6	628.0
15	Shaw, D	34.1	273	8	210.0
16	Reedijk, J	33.3	200	6	327.1
17[a]	*Ingwersen, P*	33.1	761	23	1470.4
18[a]	***Moed, H. F***	32.0	2,012	63	2,882.1
19	*Ho, Y. S*	31.4	597	19	429.2
20	Melin, G	31.1	218	7	357.4
21[a]	***van Raan, A. F. J***	31.0	2,380	77	2,562.0
22	Visser, M. S	30.5	397	13	302.6
23	Aksnes, D. W	30.4	365	12	236.6
24	Rodriguez, M. A	30.2	151	5	102.1
25	VanDeSompel, H	29.6	148	5	192.2
26	***Meyer, M***	29.5	798	27	729.7
27	Hicks, D	29.4	206	7	227.2
28	Callon, M	28.0	168	6	345.0
29[a]	*Persson, O*	28.0	616	22	1,072.8
30	Katz, J. S	27.6	221	8	385.9

Bold authors are in the productivity top 30 and italic authors are in the total citation impact top

[a] De Solla Price Award winner

books from Merton, Garfield, Egghe and Rousseau or Moed or journals from China may have significantly changed the findings. The results are also limited to traditional scholarly influence and publication and do not take into account other activities, such as producing scientometric reports or scientometric databases. This is an important omission, given that scientometrics in particular is an applied subject with many active practitioners, and may have particularly affected Garfield, Narin, Martin and Irvine, amongst others. Also, the method for selecting articles from the general journals will have missed some relevant papers as well as the highly cited books of Garfield, Cronin, Moed and others, and hence

the results should be taken as indicative rather than definitive. The results are also limited to the top IS&LS journals in WoS, and many articles were missed by not including other journals that may publish metrics research less frequently, such as PLOS ONE. Moreover, six of the seven journals included, although international in scope, are based in Europe, and so non-European researchers could be under-represented in the sample and this may influence the conclusions drawn. Finally, academic productivity changes over time, for example due to the ease with which articles can be written and processed using electronic technologies, and so comparisons between authors starting their research in different eras is somewhat unfair.

Conclusions

Subject to the limitations above, the results suggest that the most productive researchers in the history of informetrics so far have been often affiliated with a few core informetric groups (although most were not), mostly affiliated with a single institution, and mostly the primary authors of their informetrics papers. They are disproportionately represented in lists of the most collaborative researchers in three different way of measuring this (Table 3). In terms of citation impact, they are disproportionately the most cited (including 20 out of the 30 most cited) but do *not* dominate the list of those with the highest citation impact per paper. Hence the cumulative impact of the most productive researchers tends not to be on the basis of producing uniformly high impact research. The citation impact of individuals in the list started from the first period examined (before 1984) to the penultimate period (2005–2009), showing that they represent several different generations of researchers. A surprising finding is that the US seems to produce relatively few highly productive information scientists for the amount of informetrics research that it conducts. American informetrics researchers may have a broader research agenda so that some of their research efforts may target other research areas in information science. Another plausible explanation is that there is relatively little funding to carry out informetrics research in the US.

In terms of the implications for current and future informetrics researchers, it seems that it is important to be a research practitioner rather than a research manager but to collaborate extensively when conducting informetrics research. It seems that it will also be useful to work in one of the core institutions for informetrics research, all of which are in Europe. Although Europe is the most active center for metrics-based research, without looking at working conditions, the expectations of scholars, and funding opportunities for scholars in other parts of the world, it is difficult to draw a definitive conclusion about where the best place to be a successful metrics researcher is. It may also be beneficial to avoid moving to the US to be highly productive, although Cronin has been highly productive there and Cronin, Griffith, MacRoberts, B.R., MacRoberts, M.H., McCain, Narin, Small, White and Garfield have all generated a high total citation impact, so for this aim the US would be a good choice. A perhaps controversial implication is that researchers may not need to focus on ensuring that all of their work has the highest possible impact because informetricians have been successful in terms of both productivity and overall citation impact (and de Solla Price Award winning) without achieving this.

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