Literature Review on Bibliometrics and Its Future Development—Based on Bibliometric Measures

Da-Ying WANG[1,a*],Shan MA[2,b]

[1]Library, Shaanxi Normal University No. 620, West Chang'an Avenue, Chang'an District, Xi'an 710119 , China

[2]School of Foreign Languages, Shaanxi Normal University
No.199, South Chang' an Road, Yanta District, Xi'an 710062, China

[a]wdy_ying@snnu.edu.cn, [b]mashan0509@snnu.edu.cn

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Abstract. Adopting bibliometric measures, based on literature published on bibliometrics from SCI, SSCI, and A&HC in Web of Science, this study makes a quantitative analysis of the time distribution of items published, countries and regions productive authors come from, disciplines the literature belongs to, journal distribution of the literature, as well as research trends and hot spots, aiming at further, diversify, and internationalize the development of bibliometrics in China.

Introduction

Bibliometrics is an important branch in library and information research. First put forward by James Mckeen Cattell, an American psychologist and editor of Science, bibliometrics has been used to extract and analyze the data of a researcher's academic achievements and development. At the same time, adopting scientific measures, bibliometrics also evaluates the researcher's academic achievements and the influence exerted [1] . In recent years, bibliometrics has attracted more and more attention from researchers in library and information as well as librarians at universities and colleges. Especially, with the boost of large analytical databases and the advancement of theoretical and applied research in bibliometics, bibliometrics has spawned new library and information services which aim at evaluating academic performances and predicting future academic development in a certain field. With the aid of bibliometric measures, statistical analysis and research in items published can help us understand specifically the current development and future trends in a certain field.

In order to further understand the status of the research in bibliometrics, using bibliometric measures and comparative methods, this paper makes a quantitative analysis of literature published on bibliometrics, to summarize the time distribution of the literature, the development of productive researchers in this field, the journal distribution of the items published, the disciplines the literature belongs to, and the funding of the research. Then, this paper analyzes and presents research hot spots in bibliometrics and the future trend of it.

Data Sources

This study chooses Web of Science (WOS) as its platform, which is the most important and most popular database for bibliometric analysis. In addition, the study also uses Web of Science Core Collection, with the source data from Sciences Citation Index (SCI), Social Sciences Citation Index (SSCI), and Arts & Humanities Citation Index (A&HCI). The retrieval is done by topic, and the search word is "Bibliometrics OR Bibliometric". The time span is set to be from 2007 to 2016 (Because of the limits, only data after 2007 can be retrieved.). Until June 6, 2016, based on the retrieval conditions, the number of literature published on bibliometrics retrieved is 4307. Then, the author of this paper makes use of two tools in WOS—"Analyze Results" and "Create Citation Report" to analyze the data retrieved.

Data Analysis

Time Distribution of the Literature

Based on the retrieval conditions set above, there are 4307 items published on bibliometrics, and then the data are used as samples to "Create Citation Report". As a result, time distribution of the literature on bibliometrics published is shown in Fig. 1(Published Items in Each Year), and citations of the literature are show in Fig. 2. At the same time, the sum of times cited without self-citations is 19640items, the Citing articles without self-citations12416 items and the average citations per item is 7.5，the h-index is 60.

As is shown in Fig. 1, literature published on bibliometrics is on the rise, and Fig.2 shows that the rising trend of citations is higher than that of the publication, and the average citations per item and the h index are also remarkable. The figures indicate that bibliometrics is still a hot spot in research, the influence of it is far-reaching, and its bright prospects in future development can be anticipated.
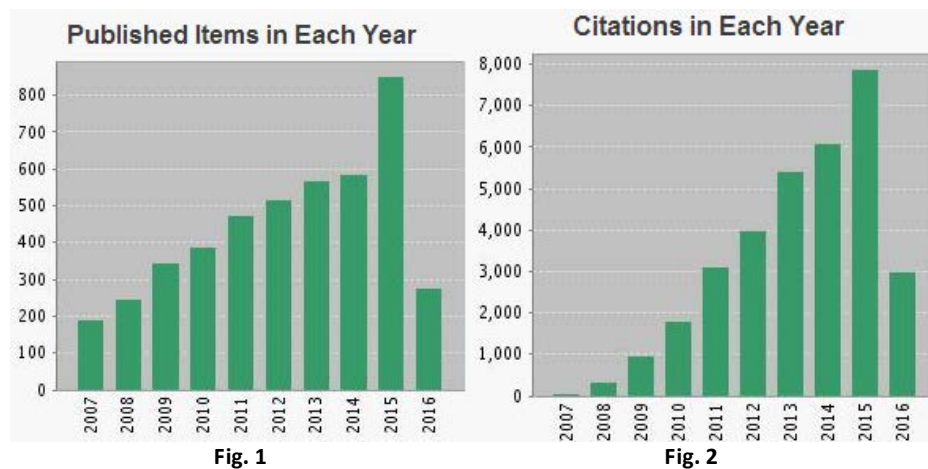

Fig. 1   **Fig. 2**

Analysis of Fruitful Yielding

Geographic Distribution of the Authors

Applying "Analyze Results" to the 4307 items retrieved, the countries and territories where the authors are from can be seen clearly. This study chooses the top-ten countries and territories and makes a further analysis and gets the h index and the Average Citations per Item (as is shown in table 1). The statistics shows that the US ranks the first in the publication of items on bibliomtetrics, way ahead of Spain and China that rank the second and third. The h index of the items from the US is the highest of all, and their average citations are only second to those of Taiwan. The US excels in the research in bibliometrics judging from its yielding, quality and influence. China ranks the third in the publication of literature on bibliometrics, forth in the h index, and ninth in the average citations per item, which shows that although the academic achievement of China in this field has become one among the world's highest, the influence is still weak, in need of further hard work to exert more influence internationally. In the last three years, literature published by Chinese authors has exceeded that of Spain.

Table 1: Geographical Distribution of the Authors

Countries/Territories	Items	Percentage in Total Items Published	h Index	Average Citations per Item
USA	812	18.853%	41	10.76
SPAIN	589	13.675%	23	5.96
PEOPLES R CHINA	453	10.518%	26	5.9
ENGLAND	347	8.057%	27	9.42
GERMANY	297	6.896%	23	7.11
ITALY	252	5.851%	25	9.62
NETHERLANDS	229	5.317%	32	14.8
BRAZIL	210	4.876%	11	2.92
CANADA	189	4.388%	21	8.76
TAIWAN	188	4.365%	25	11.28

Analysis of Productive Authors

Table 2 is reflects the authors of the literature on bibliometrics. This study chooses the top-ten authors with high h indexes according to their academic yielding on bibliometrics. The authors are divided into two groups. Those with more than 70 items fall into the first group and the rest fall into the second group. Analysis shows that ABRAMO G and D'ANGELO CA are in the same research team and they share quite a lot academic achievements. They are dedicated to the application of bibliometrics in the evaluation of academic performances, including the evaluation of the Italy's national academic performance, the evaluation of the researchers, and the evaluation of academic institutions. Their academic yielding is stable and its average citations are comparatively higher too, which reveals the high quality and wide influence of their works.

BORNMANN L is a notable scholar who focuses on the application of new methodologies in bibliomertics. Items published by him are on the rise year by year, indicating that he is getting to the peak of his academic life, and the average citations of his works are on the rise too. HO YS focuses on the application of bibliometrics in other disciplines, including environment, medicine, resources, physics and chemistry. His research has a wide coverage and his works are cited a lot. ALEIXANDRE-BENAVENT R and GONZALEZ-ALCAIDE G are also team members, whose research interests lie in bibliometric analysis of agricultural literature (especially in grape-planting and wine-making) and medical literature. However, due to limited coverage, average citations of their works are low. Specialized in the study of bibliometric theories and methodology, GLANZEL W and WALTMAN L published most of their works in years between 2008 and 2013, and average citations of their works are high, but without much change over time, which indicates that their research used to produce a continuous influence on bibliometrics, but it does not draw more attention in the recent three years and it is not a research hot spot any more.

Table 2: Top-ten Overseas Authors in Bibliometrics

Name of the Author	Items Published	Percentage in Total Items Published	h Index	Average Citations per Item	Countries/Regions
ABRAMO G	75	1.741%	17	11.36	Italy
BORNMANN L	75	1.741%	18	15.81	German
HO YS	75	1.741%	23	17.53	Taiwan
D'ANGELO CA	74	1.718%	17	11.3	Italy
ALEIXANDRE-BENAVENT R	46	1.068%	6	3.96	Spain
GLANZEL W	34	0.789%	15	13.79	Belgium
GONZALEZ-ALCAIDE G	32	0.743%	7	5.21	Spain
LARIVIERE V	30	0.697%	11	14.5	Canada
PRATHAP G	30	0.697%	6	4.7	India
WALTMAN L	29	0.673%	18	33.72	Northern Ireland

Analysis on Productive Organizations

An analysis on organizations from which authors of bibliometric literature are from yields the result in Table 3. The top-three organizations are Universidad de Granada in Spain, Leiden University in the Netherlands, and CSIC in Spain. Peking University ranks the sixth, and Chinese Academy of Sciences ranks the eleventh. Among the top-ten organizations, three are from Spain and two are from the US, which shows that although the US has published the most items on bibliometrics, yet no organization in the US has a better performance than the three Spain organizations in the top-ten list, presumably due to the fact that organizations doing research in bibliometrics are scattered in the US. The same is also true of organizations in China, thus researchers in bibliomterics need to make more communication and cooperation to promote the development of the discipline.

Table 3: Top-ten Overseas Organizations

Organizations	Items Published	Percentage in Total Items Published	Organizations	Items Published	Percentage in Total Items Published
UNIV GRANADA (Spain)	117	2.717%	ASIA UNIV (Taiwan)	69	1.602%
LEIDEN UNIV (The Netherlands)	100	2.322%	PEKING UNIV (China)	68	1.579%
CSIC (Spain)	79	1.834%	INDIANA UNIV (US)	63	1.463%
UNIV ROMA TOR VERGATA (Italy)	77	1.788%	KATHOLIEKE UNIV LEUVEN (Belgium)	60	1.393%
UNIV VALENCIA (Spain)	75	1.741%	GEORGIA INST TECHNOL(US)	48	1.114%

Characteristics of Literature Distribution

Journals Publishing Literature on Bibliometrics

Table 4 is a list of the top-ten source journals that publish items on bibliometrics. As can be seen

from the figures, among all the journals included in WOS, Scientometrics and Journal of Informetrics are major ones that publish items on bibliometrics. Application studies of bibliometrics in other disciplines are mainly published in Scientometrics, with far more items than in other journals, accounting for 17% of the literature on bibliometrics. Therefore, researchers in bibliometrics can pay close attention to Scientometrics for the latest development in the discipline.

Table 4: Overseas Journals that Publish Literature on Bibliometrics (top-ten)

Source Titles	Items	Percentage in Total Items Published
SCIENTOMETRICS	750	17.414%
JOURNAL OF INFORMETRICS	199	4.620%
JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE AND TECHNOLOGY	148	3.436%
PLOS ONE	73	1.695%
JOURNAL OF THE ASSOCIATION FOR INFORMATION SCIENCE AND TECHNOLOGY	71	1.648%
RESEARCH EVALUATION	64	1.486%
REVISTA ESPANOLA DE DOCUMENTACION CIENTIFICA	58	1.347%
TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	48	1.114%
MALAYSIAN JOURNAL OF LIBRARY INFORMATION SCIENCE	39	0.906%
PROFESIONAL DE LA INFORMACION	36	0.836%

Distribution of Research Areas

An analysis of research areas in bibliometrics generated Table 5. Currently, information science and library science are the major focus of bibliometric studies, with 39.517% in the total literature. Ranking the second in research areas is computer science, with 28.001% in the total literature. At the same time, studies on bibliometrics often overlap with studies on economics, science and technology, environment, occupational health, ecology, engineering, psychology, neurosciences and internal medicine, with each accounting for more than two percentages of the total literature published. It can be seen from Table 5 that bibliometrics is applied more and more widely in other disciplines and its value has been recognized.

Table 5: Research Areas Overseas in Bibliometrics

Research Areas	Items	Percentage in Total Items Published
INFORMATION SCIENCE LIBRARY SCIENCE	1702	39.517%
COMPUTER SCIENCE	1206	28.001%
BUSINESS ECONOMICS	332	7.708%
SCIENCE TECHNOLOGY OTHER TOPICS	212	4.922%
PUBLIC ENVIRONMENTAL OCCUPATIONAL HEALTH	164	3.808%
ENVIRONMENTAL SCIENCES ECOLOGY	152	3.529%
ENGINEERING	142	3.297%
PSYCHOLOGY	121	2.809%
NEUROSCIENCES NEUROLOGY	120	2.786%
GENERAL INTERNAL MEDICINE	115	2.67%

Analysis on Funding Agencies

Funding is an indicator of the importance a country attaches to the overall research. Table 6 shows funding agencies based on the analysis of data retrieved. Top on the list is National Natural

Science Foundation of China, supporting 1.834% of the literature published on bibliometrics, a proportion far greater than papers funded by other agencies. Meanwhile, there are another 44 items funded by other agencies in China, proving the fact that China attaches significantly more importance to the research in bibliometrics than developed countries and regions.

Table 6: Funding of the Research in Bibliometrics

Funding Agencies（Country/region）	Items	Percentage in Total Items Published
NATIONAL NATURAL SCIENCE FOUNDATION OF CHINA（China）	79	1.834
NATIONAL SCIENCE FOUNDATION（The US）	17	0.395
SPANISH MINISTRY OF SCIENCE AND INNOVATION（Spain）	14	0.325
CNPQ（Brazil）	14	0.325
NATIONAL SOCIAL SCIENCE FOUNDATION OF CHINA（China）	13	0.302
FUNDAMENTAL RESEARCH FUNDS FOR THE CENTRAL UNIVERSITIES（China）	13	0.302
EUROPEAN UNION（European Union）	11	0.255
EUROPEAN COMMISSION（European Union）	11	0.255
NSFC（China）	10	0.232
NATURAL SCIENCE FOUNDATION OF CHINA（China）	8	0.186

Document Types

Analysis based on the understanding of document types in the literature retrieved helps to learn about the creativity, maturity, systematicness, and practicability of the research[2]. From Table 7, we can see the major document types on bibliometrics are articles and reviews, with articles accounting for 85% of the items published. There are 294 reviews, ranking the second in the list. Table 7 shows that research in bibliometrics has now formed a mature system, but there is still much room for improvement in creativity. Relating the figures in Table 7 to the figures in Table 6 help the author of this paper to predict that application of new methodology and theories into other disciplines will be the future trend in bibliomertric research.

Table 7: Document Types in Bibliometric Literature

Document Types	Items	Percentage in Total Items Published
ARTICLE	3687	85.605
REVIEW	294	6.826
EDITORIAL MATERIAL	149	3.459
PROCEEDINGS PAPER	81	1.881
LETTER	76	1.765
MEETING ABSTRACT	61	1.416
BOOK REVIEW	22	0.511
CORRECTION	10	0.232
BIOGRAPHICAL ITEM	4	0.093
BOOK CHAPTER	2	0.046

Research Trends and Hot Spots

The study uses WOS as its platform and chooses SCI, SSCI, and A&HCI as data sources. The retrieval is done by topic and the search word is"Bibliometrics OR Bibliometric". The time span of

the retrieval is set to be from 2013 to 2015, and 1902 items are retrieved. Refining the results by selecting ESI Top Papers and 4 hot papers are found (A hot paper was published in the past two years and received enough citations in January/February 2016 to place it in the top 0.1% of papers in the academic field of Social Sciences, general.) . "Clustering by fast search and find of density peaks" and "Growth rates of modern science: A bibliometric analysis based on the number of publications and cited references" represent the latest achievements in the application of bibliometrics in literature analysis. The third article in Table 8is about a new bibliometric measure called "altmetrics". The forth one is about the application of bibliometrics in talent management. Hot papers represent research hot spots in bibliometrics in the last three years and a further examination of the citing articles in the hot papers shows the future trends of the research in this field, namely, cluster analysis and management, the application of bibliometrics, the application of Altmetrics, and the application of bibliometrics in talent management.

Table 8: Hot Papers in Bibliometrics

Title	Author	Journal
Clustering by fast search and find of density peaks	Rodriguez, Alex; Laio, Alessandro	SCIENCE
Growth rates of modern science: A bibliometricanalysis based on the number of publications and cited references	Bornmann, Lutz; Mutz, Ruediger	JOURNAL OF THE ASSOCIATION FOR INFORMATION SCIENCE AND TECHNOLOGY
Do "altmetrics" correlate with citations? Extensive comparison of altmetric indicators with citations from a multidisciplinary perspective	Costas, Rodrigo; Zahedi, Zohreh; Wouters, Paul	JOURNAL OF THE ASSOCIATION FOR INFORMATION SCIENCE AND TECHNOLOGY
Towards an understanding of talent management as a phenomenon-driven field using bibliometric and content analysis	Gallardo-Gallardo, Eva; Nijs, Sanne; Dries, Nicky, etc.	HUMAN RESOURCE MANAGEMENT REVIEW

Conclusion

From the above statistics of and analysis on academic achievements in bibliometrics, we can see that research in bibliometrics draws the attention of scholars worldwide. The focus is on its application in areas like computer science, economics, environmental engineering, and medicine. Some new bibliometric measures, for example, altmetrics, has become a research hotspot. Obviously, as the devepoment of science and technology, bibliometrics develops too. Researchers have made use of new algorithms and affecting factors in bibliometric research, and have applied them widely in other disciplines.

China has become the top-one in the funding of bibliometric studies, which has greatly boosted the development of bibliometrics both at home and abroad. However, there is still much room for improvement. We need to make more efforts in promoting the quality and international influence of our academic performance, enhancing the cooperatiom with leading institutions and productive authors. In the recent three years, China has moved from the third to the second in items published on bibliometrics, giving much confidence that it will develop vigorously and will eventually be a leading research force in the world.

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