STCF Value: A New Metric for Evaluating the Impact of Academic Literature Based on Research Topics (Postprint)

Authors: Li Xiuxia, Song Kai

Date: 2023-08-27T00:00:00+00:00

Abstract

[Purpose/Significance] While evaluation metrics for academic literature impact continue to evolve, there remains a notable deficiency in assessing literature influence at the research topic level. To identify documents with high impact and citation value within distinct research topics, this study proposes a novel literature impact evaluation methodology grounded in research topics. [Method/Process] The study utilizes a sample of 500 highly cited documents in the field of informatics from the Web of Science database spanning 2011-2015. Employing the LDA model for topic modeling of the sample documents, the method integrates topic support for documents with citation frequency to compute the Specific Topic Cited Frequency (STCF). Literature impact is then ranked within each respective topic based on individual documents' STCF values. [Results/Conclusion] The findings indicate that STCF values effectively reflect document thematic content, granularly manifest academic standing, and reveal the multidisciplinarity of research topics in literature. This approach substantially addresses the limitations inherent in traditional citation frequency and Altmetrics indicators.

Full Text

Preamble

Vol. 62 No. 20, October 2018
ChinaXiv Cooperative Journal
STCF Value: A New Index for Evaluating Academic Literature Influence Based on Research Topics
Li Xiuxia, Song Kai
School of Communication, Qufu Normal University, Rizhao 276826

Abstract

[**Purpose/Significance**] While evaluation metrics for academic literature influence continue to emerge, there remains a lack of assessment at the research topic level. To identify highly influential and citable literature within different research topics, this study proposes a literature influence evaluation method based on research topics. [**Method/Process**] Using 500 highly cited documents in the field of information science from the Web of Science database between 2011 and 2015 as samples, the LDA model was employed for topic modeling. The support degree of topics for literature was combined with citation frequency to calculate the Specific Topic Cited Frequency (STCF) for each document, and literature was ranked by influence according to its STCF value within corresponding topics. [**Result/Conclusion**] Results demonstrate that STCF values reflect literature's thematic content, reveal academic status at a granular level, and present the diversity of research topics. This approach effectively compensates for the shortcomings of citation frequency and Altmetrics indicators.

Classification Number: G250.2
Keywords: citation frequency, literature influence, LDA model, STCF value

Introduction

Quantitative evaluation of academic literature influence constitutes a crucial component of research activities, facilitating assessment of individual, institutional, and national research output levels, identifying valuable academic literature, and meeting researchers' information needs. Scholars have explored literature influence from multiple perspectives, with citation frequency being the most common method. For instance, C.C. Kam et al. [1] used threshold citation analysis, selecting marketing research literature with citation frequencies above 18 as key study objects to identify the most influential works. However, citation represents only a small fraction of literature utilization behavior [2], making sole reliance on citation frequency inadequate for comprehensive evaluation.

Subsequently, new methods for assessing literature influence emerged, including impact factor [3], h-index [4], g-index [5], e-index [6], hg-index [7], and the Paper Time Rank Algorithm (PTRA) [8]. These metrics represent improvements and refinements to citation frequency. With the development of networking and digital technologies, scholars such as P. Chen [9] and N. Ma [10] utilized PageRank algorithms to achieve literature ranking based on citation networks. M. Krapivin et al. [11] examined the significance and impact of citation frequency, h-index, and PageRank in scientific citation networks, finding that different ranking methods produced significant differences. As academic outputs increasingly appear on open-access digital platforms, researchers actively engage in diverse academic exchanges within scholarly communities, including commenting, recommending, tagging, forwarding, and downloading, giving rise to Altmetrics indicators based on social networks. T. Kortelainen et al. [12] ar-

gued that behaviors such as recommendations, comments, and link sharing on social media tools can enhance the visibility of scientific literature to the general public and should be incorporated into literature utility evaluation. The rise of Altmetrics indicates that scholars are willing to obtain valuable literature from virtual learning communities of peers, where different communities represent different disciplinary directions and research topics, providing an approach for evaluating literature influence at the research topic level.

Domestic scholars have also conducted improvement work based on citation frequency, such as Jin Bihui's A-index [13] and AR-index [14], Wu Qiang's W-index [15], Xiao Xuebin's x-index [16], and Han Yi's Pt-index [17]. Additionally, Jia Ning [18] analyzed the temporal distribution of literature citations and proposed that "duration of high citation period and peak height" could serve as reference indicators for evaluating literature value. Wang Zhiwei et al. [19] proposed a multi-dimensional literature retrieval ranking method that quantifies literature value through weighting, effectively improving retrieval sorting effectiveness. Li Changling et al. [20] incorporated citation quality into citation analysis, proposing a PageRank-based citation analysis method. Domestic research on Altmetrics indicators also exists, such as Zhai Xiaofang's [21] integrated measurement model combining traditional citation-based metrics with social network-based Altmetrics indicators.

Analysis reveals that existing research primarily uses citation frequency to evaluate literature influence, with improved methods mostly combining temporal factors and social network approaches, rarely considering literature topic factors. Altmetrics, as a new measurement method for analyzing and disseminating academic research based on social networks, has a large online user base and can objectively reflect literature's social influence, yet relevant research has not incorporated research topic differences into academic literature influence evaluation. To address these limitations, this paper proposes an academic literature influence evaluation method based on specific research topics.

2. Scientificity and Rationality of Incorporating Research Topics into Academic Literature Influence Evaluation

Incorporating research topics into academic literature influence evaluation enables fine-grained measurement of influence within topic classifications, yielding more scientific and reasonable evaluation results.

Regarding the evaluation object (the literature itself), documents from different disciplines exhibit significant differences in research objects, content, methods, tools, and presentation forms, with varying numbers of researchers and audience scopes. Therefore, literature from different disciplines cannot be measured by uniform standards. The "Chinese Social Sciences Citation Index (CSSCI)" ranks journals based on disciplinary classification. Since academic journals serve as carriers of academic literature, literature influence evaluation cannot proceed independently of disciplinary classification. Song Liping et al. [22] concluded

that "natural sciences and social sciences show significant differences in scientific evaluation" when examining the effectiveness of peer review, informetrics, and traditional bibliometric indicators. Similarly, literature within the same discipline (e.g., both in information science, one on data mining techniques and another on information evaluation) cannot be evaluated by uniform standards. Only literature within the same discipline and research topic is comparable and can be evaluated by consistent criteria.

Regarding the evaluation subject (evaluators), researchers with identical directions typically evaluate familiar or related topics. Peer review has long been a process for evaluating journals, literature, and institutions domestically and internationally, where "peers" refer to "scientific communities" composed of experts with common goals [23]. J. Liu et al. [24] noted that to rapidly obtain the influence of scientific literature on users in a specific field, one must analyze discussions and exchanges among active users in that field's online communities, as only researchers with identical directions discuss and evaluate topics of common interest. Thus, academic literature influence is closely related to discipline and research topic, making the incorporation of disciplinary topics into literature influence evaluation scientific, reasonable, and necessary.

3. STCF Evaluation Method Overview

This method first extracts literature topics to obtain each topic's support degree for a document, then combines this support degree with citation frequency to derive a document's citation frequency within a specific topic, designated as the STCF value.

The calculation involves three main steps:

(1) **Topic Modeling.** The LDA model extracts topics from the literature collection, generating a document-topic probability matrix containing T topics. Each row represents the probability distribution of T topics in one document, while each column represents the distribution of a particular topic across n documents. A topic's probability of appearing in a document is called its support degree for that document. One document may correspond to multiple research topics, with varying support degrees; higher support indicates greater relevance between the document and topic.

(2) **Calculating Topic-Specific Citation Frequency.** First, for any document Pi (i=1,2,…n), query its current citation frequency, denoted as Ci. Second, for any topic Tj (j=1,2,…,T), determine its support degree for Pi, denoted as TSij (a percentage less than 1). Third, calculate the STCF for document Pi in topic Tj using the formula: STCFi = N × Ci × TSij. Since support degree TSij reduces citation frequency Ci, decreasing STCF sensitivity, a sensitivity coefficient N is added. N ranges from 1-10, with specific values determined by the inverse of the average TSij.

(3) **Topic-Specific Literature Influence Ranking.** Within each topic, literature is ranked by STCF value to identify documents most relevant to that topic. Higher STCF values indicate greater influence within the topic, enabling evaluation of literature influence across different topics.

4. Empirical Research and Results Analysis

4.1 Data Source and Processing

Experimental data were obtained from the Web of Science Core Collection database, which contains over 80 library and information science journals. Based on journal content, six journals with the highest publication volumes in information science between 2011-2015 were selected: *Scientometrics*, *Journal of the American Medical Informatics Association*, *Journal of the American Society for Information Science and Technology*, *Information Processing & Management*, *International Journal of Information Management*, and *Journal of Informetrics*. The 500 most highly cited documents from these journals served as research objects. Title and abstract information for each document were downloaded and numbered 1-500 by citation frequency for identification purposes. The dataset underwent preprocessing using the EnStemmer tool for stopword removal, stemming, and other natural language processing normalization procedures. After removing duplicate words and high-frequency but meaningless terms such as "advice," "journal," "record," and "task," the experimental text corpus was obtained.

4.2 STCF Value Calculation

When applying the LDA model to the experimental corpus, the number of topics was determined based on the average inter-topic similarity proposed in reference [25]. Experiments revealed that when topic number T=7, average topic structure similarity was minimized, yielding the optimal model. Thus, the 500 sample documents covered seven research topics. Through topic extraction, a document-topic matrix was formed (see Table 1), from which each topic Tj's support degree TSij for document Pi was determined.

Citation frequency Ci for each document Pi was queried in the Web of Science database, and STCF values were calculated using the STCF formula. To demonstrate STCF's advantages, values were compared with total citation frequency and Altmetrics indicators. Liu Xiaojuan et al. [26] found that Mendeley and Twitter have greater reference value for evaluating library and information science papers. Therefore, this study used the number of registered Mendeley users who added the article to their My Library as the Altmetrics indicator. Comparison results are shown in Table 2 .

The inverse of average TSij values (ranging from 2.143-4.903) determined the sensitivity coefficient. Following the principle of selecting the integer nearest to the minimum value (2.143), N=2 was chosen. Topics were then labeled based

on their most relevant terms, yielding seven research topics: information evaluation, medical information analysis, e-commerce and decision support, open data, bibliometrics, new media research, and social network analysis.

4.3 Results Analysis

4.3.1 Correlation Between STCF Values and Citation Frequency/Altmetrics Correlation analysis between STCF values and citation frequency/Altmetrics across seven topics produced seven correlation coefficient sets (see Table 3).

Table 3 shows that in most topics, correlation coefficients between STCF values and citation frequency range from 0.496-0.619, with lower correlations in individual topics (-0.092 in topic 6). Overall, STCF values correlate relatively highly with citation frequency, indicating consistency with citation-based evaluation results. This occurs because STCF does not negate citation frequency's role but treats it as a factor in the calculation, adding social attention factors while affirming academic value. STCF values correlate lower with Altmetrics, with coefficients ranging from 0.125-0.370 in most topics and -0.092 in some topics (e.g., topic 6). This demonstrates that different evaluation methods yield substantially different results. While STCF considers both academic status and social attention, it relatively emphasizes academic value.

4.3.2 Advantages of STCF Values Compared with citation frequency and Altmetrics indicators, STCF values offer distinct advantages in academic literature influence evaluation:

(1) **STCF values reflect academic value from thematic content.** Citation frequency evaluates influence purely from the perspective of being cited, reflecting academic impact and value but not research themes or content. Altmetrics primarily measure reader counts and interactive behaviors (recommendations, comments) in online social media, emphasizing social influence and attention. While community characteristics can reflect thematic content, they rarely involve academic value related to paper quality [27]. STCF integrates topic support degree TSij (reflecting thematic content) with citation frequency Ci (reflecting academic value), thus representing academic value through thematic content.

(2) **STCF values reflect academic status within similar research topics.** Citation frequency and Altmetrics values should directly reflect research strength within a document's corresponding topic, as different research directions have varying numbers of researchers and enthusiasts. Even equally excellent literature will differ in citations and Altmetrics values. Conversely, identical citation/Altmetrics values do not guarantee equal academic quality. STCF can identify literature with relatively weak research strength and low social influence but high academic quality. For example, in Table 2, document 4-1 in "open data" has STCF=60, lower

than document 1-3's STCF=76.23 in "information evaluation"; document 6-1 in "new media research" has STCF=68.74, lower than document 3-3's STCF=78.37 in "e-commerce and decision support." Yet the lower-STCF documents rank first in topics 4 and 6, while higher-STCF documents rank third in topics 1 and 3. Thus, STCF compares literature influence within similar topics, reflecting reasonable academic status.

(3) **STCF values demonstrate literature's thematic diversity and tendencies.** A document often involves multiple research topics and may be classified into different topic clusters. Based on Table 2 and definitions of citation frequency/Altmetrics, even when literature is pre-classified by topic, citation frequency and Altmetrics values remain identical across topics. For example, document 3-4 ("Negative results are disappearing from most disciplines and countries") has citation frequency 175 and Altmetrics value 453. Ranked by citation frequency, it's first in all topics; by Altmetrics, it's 11th in all topics. However, a document's relevance varies across topics—identical evaluation values across all topics are unrealistic. STCF values, derived from topic support degrees, differ across topics for the same document, reflecting varying academic status. As shown in Table 4 , document 3-4 ranks 15th, 7th, 4th, 11th, 5th, 2nd, and 15th across topics 1-7. Thus, STCF values not only demonstrate thematic diversity but also reflect differential emphasis across topics.

Conclusion

This study proposes a new topic-based academic literature influence evaluation index—STCF value—and conducts empirical research using 500 highly cited documents in information science. Comparative analysis reveals STCF's unique advantages.

Key findings: (1) LDA modeling of 500 highly cited documents identified seven research topics: information evaluation, medical information analysis, e-commerce and decision support, open data, bibliometrics, new media research, and social network analysis. (2) STCF values were calculated for each document across topics, enabling influence ranking within topics. Compared with citation frequency and Altmetrics, STCF correlates highly with citation frequency but lower with Altmetrics, indicating that while considering both academic status and social attention, STCF relatively emphasizes academic value. (3) Advantage comparison shows that topic-based STCF evaluation simultaneously reflects thematic content and social attention, aligning with peer review principles, while also capturing literature's multi-topic attributes.

In summary, STCF improves upon traditional citation-based evaluation methods, offering new perspectives for identifying highly influential and citable literature across research topics.

STCF limitations include: (1) For literature covering many topics (e.g., review articles) with low support across all topics, STCF values may be relatively

low, potentially underestimating influence. (2) Citation frequencies change over time, and literature half-life varies across disciplines. Ignoring temporal variables may bias evaluation results.

Future research will consider principal component extraction for all topics, weighting component factors by variance contribution ratios, integrating weighted support degrees with citation frequency, and incorporating temporal variables for more objective and fair evaluation.

References

[1] KAM CC, PIKKI L, KARTONO L. A threshold citation analysis in marketing research[J]. European journal of marketing, 2012, 46(1): 134-156.

[2] Liu Xiaojuan, Zhou Jianhua, You Bin. A study on the correlation between altmetrics indicators based on Mendeley and WoS and traditional scientometric indicators[J]. Library and Information Service, 2015, 59(3): 112-118.

[3] Xu Qi. A method for calculating literature impact factor based on citation network[J]. Information Studies: Theory & Application, 2011, 34(7): 98-102.

[4] HIRSCH JE. An index to quantify an individual's research output[J]. Proceedings of National Academy of Sciences, 2005, 102(46): 16569-16572.

[5] EGGHE L. An improvement of the h-index: the g-index[J]. ISSI newsletter, 2006, 2(1): 8-9.

[6] ZHANG C. The e-index, complementing the h-index for excess citations[J]. Plos One, 2009, 4(5): 1-4.

[7] ALONSO S, CABRERIZO FJ, HERRERA-VIEDMA E, et al. Hg-index: a new index to characterize the scientific output of researchers based on the h- and g-indices[J]. Scientometrics, 2010, 82(2): 391-400.

[8] MUSHTAQ AH, LU SF, BASHEERA A. Scientific research paper ranking algorithm PTRA: a tradeoff between time and citation network[J]. Applied mechanics and materials, 2014, 551(8): 603-611.

[9] CHEN P, XIE H, MASLOV S, et al. Finding scientific gems with Google's PageRank algorithm[J]. Journal of informetrics, 2007, 1(1): 8-15.

[10] MA N. Bringing PageRank to the citation analysis[J]. Information processing & management, 2008, 44(2): 800-810.

[11] KRAPIVIN M, MARCHESE M, CASATI F. Exploring and Understanding Scientific Metrics in Citation Networks[J]. Complex sciences, 2009(5): 1550-1563.

[12] KORTELAINEN T. "Everything is plentiful—except attention". Attention data of scientific journals on social web tools[J]. Journal of informetrics, 2012, 6(4): 661-668.

[13] JIN BH, LIANG LM, ROUSSEAU R, et al. The R- and AR-indices: complementing the h-index[J]. Chinese science bulletin, 2007, 52(6): 855-863.

[14] Jin Bihui, Rousseau R. R-index and AR-index: supplementary indicators for extending the function of h-index[J]. Science Focus, 2007, 2(3): 1-8.

[15] WU Q. The w-index: a measure to assess scientific impact by focusing on widely cited papers[J]. Journal of the American Society for Information Science and Technology, 2010, 61(3): 690-614.

[16] Xiao Xuebin. x-index: a new bibliometric index describing researchers' paper level[J]. Document, Information & Knowledge, 2015(2): 93-99.

[17] Han Yi, Xia Hui. Research on Pt-index for evaluating researchers from the perspective of time factor[J]. Journal of Library Science in China, 2015, 41(6): 73-85.

[18] Jia Ning. The significance of the temporal distribution of literature citations for cited literature evaluation: taking physics as an example[J]. Library Journal, 2016, 35(12): 55-62.

[19] Wang Zhiwei, Zou Yanni, Wu Shuxia. Research and improvement on applying PageRank algorithm in literature retrieval ranking[J]. Information Studies: Theory & Application, 2016(11): 126-130, 144.

[20] Li Changling, Zhai Xuemei. Discussion on citation analysis method based on PageRank[J]. Information Studies: Theory & Application, 2007, 30(1): 122-124.

[21] Zhai Xiaofang, Liu Quanming, Cheng Yaodong, et al. An integrated bibliometric model combining social networks[J]. Computer Engineering, 2016, 42(6): 21-26.

[22] Song Liping, Wang Jianfang, Wang Shuyi. Comparison of F1000, Mendeley and traditional bibliometric indicators from the perspective of scientific evaluation[J]. Journal of Library Science in China, 2014, 40(4): 48-54.

[23] Wang Guoyu, Zhu Xiaolin. Peer review and "layman" review[J]. Studies in Science of Science, 2015, 33(8): 1121-1126, 1133.

[24] LIU J, ADIE E. New perspectives on article-level metrics: developing ways to assess research uptake and impact online[J]. Insights, 2013, 27(2): 153-158.

[25] Cao Juan, Zhang Yongdong, Li Jintao, et al. An adaptive optimal LDA model selection method based on density[J]. Chinese Journal of Computers, 2008, 31(10): 1780-1787.

[26] Liu Xiaojuan, Zai Bingxin. Analysis of Altmetrics indicators for literature in library and information science[J]. Library and Information Service, 2015, 59(18): 108-116.

[27] Zhao Rongying, Guo Fengjiao, Tan Jie. Research on evaluation of academic paper impact based on Altmetrics: taking Chinese language and literature as

an example[J]. Journal of Library Science in China, 2016, 42(1): 96-108.

Author Contributions: Li Xiuxia: research design, methodology, paper writing and revision; Song Kai: data collection and program debugging.

Academic Integrity Statement

Upholding research ethics is a fundamental principle of scientific work and essential for fulfilling the mission of scientific innovation entrusted by the Party and people. The Academic Ethics Committee of the Chinese Academy of Sciences, based on prominent issues identified in daily research misconduct reports, summarizes common problems and errors in academic paper authorship to raise awareness and advocate for integrity in research practice.

Reminder 1: Incomplete or gift authorship. Authorship should be limited to scholars who made substantial contributions to the research process, following academic conventions and journal requirements. Honorific, gift, or quid pro quo authorship is prohibited.

Reminder 2: Improper authorship ordering. Authorship order should be determined collectively by authors based on substantive contributions, reflecting academic publishing conventions or journal requirements. Arbitrary changes to authorship order after peer review are opposed.

Reminder 3: Excessive first or corresponding authors. The number of first or corresponding authors should be based on substantive contributions to avoid excessive numbers that may cause ambiguity among peers.

Reminder 4: Unauthorized authorship. Using scholars' names as authors without their knowledge is prohibited. All authors should provide informed consent before publication and endorse the paper's fundamental academic viewpoints.

Reminder 5: Failure to disclose conflicts of interest. Relevant conflicts (e.g., funding sources, research-related associations) should be declared following international standards.

Reminder 6: Inadequate acknowledgment of contributions. Insufficient use of acknowledgments for other participating researchers may cause intellectual property and ethics disputes.

Reminder 7: Incorrect institutional affiliation. Author affiliations should reflect the primary institution where the work was completed. Inappropriate changes due to author mobility are opposed.

Reminder 8: Use of personal instead of institutional contact information. Public email and social communication methods are not recommended as author contact information.

Reminder 9: Failure to cite important literature. Authors should comprehensively understand predecessor work and directly relevant literature, ensuring no

representative literature is omitted.

Reminder 10: Post-publication issues. Authors should proactively declare corrections or request retractions upon discovering defects or research standard violations.

Institutions should provide necessary education and training based on these reminders, combined with disciplinary characteristics and academic conventions, to ensure every researcher maintains high responsibility in authorship, cherishes academic honor, resists misconduct, and upholds research integrity throughout their career.

Source: Chinese Academy of Sciences Supervision and Audit Bureau

Note: Figure translations are in progress. See original paper for figures.