# Analysis of Similarities and Differences Between Scientometrics and Informetrics: Postprint

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## Abstract

[Purpose/Significance] Scientometrics and informetrics belong to the science of science and information science, respectively, with overlapping areas in theory, methodology, and technological application. Analyzing their similarities and differences contributes to a deeper understanding and facilitates accurate comprehension of relevant terminology and development directions. [Method/Process] Data samples for scientometrics and informetrics were collected from representative journals and through keyword-based topic searches. The similarities and differences in publication output and collaboration between the two disciplines were compared from national, institutional, and author perspectives. Keyword clustering was employed to analyze the similarities and differences in their research topics and structures. Their citation behaviors and knowledge flows were comparatively analyzed from the perspectives of document co-citation, author co-citation, journal co-citation, and disciplinary overlay mapping. [Results/Conclusion] The findings indicate that although research in scientometrics and informetrics is broadly similar, numerous differences exist in the details.

## Full Text

### Analysis of Similarities and Differences Between Scientometrics and Informetrics

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#### Abstract

[**Purpose/Significance**] Scientometrics and informetrics belong to the science of science and information science respectively, yet they overlap in theory, methods, and technological applications. Analyzing their similarities and differences can deepen understanding and facilitate accurate comprehension of relevant terminology and development directions. [**Method/Process**] We collected data samples for scientometrics and informetrics through two approaches: representative journals and keyword-based topic retrieval. We compared publication patterns and collaboration networks across countries, institutions, and authors; analyzed research themes and structures through keyword clustering; and examined citation behaviors and knowledge flows via literature co-citation, author co-citation, journal co-citation, and disciplinary overlay mapping. [**Result/Conclusion**] While research in scientometrics and informetrics shows overall similarity, numerous differences exist in the details.

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The term "scientometrics" was proposed by Soviet scholars in 1969 [1]. With the deepening of information science research and advances in computer technology, German scholar O. Nacke introduced the term "informetrics" in 1979 [2]. Despite a ten-year gap and different origins, the two terms were quickly used interchangeably by scholars, causing confusion that attracted academic attention. In 1989, B. C. Brookes explored their distinctions and connections, though limited to historical and conceptual aspects [3]. Subsequently, many authors treated them as synonyms, leading to a certain degree of conceptual crisis. Currently, there is no unified international distinction between the two, with diverse and inconsistent definitions that create cognitive difficulties due to their substantial overlaps. L. Egghe argues that informetrics encompasses scientometrics [4], but does this mean scientometrics is entirely contained within informetrics? If not, what are their specific differences? Based on representative journals and keyword retrieval, we compare their similarities and differences in the new environment from three perspectives: disciplinary publication and collaboration, research themes and structures, and citation behavior and knowledge flow.

### 1.1 Development of Scientometrics and Informetrics

Because of their similarities in research objects, methods, and tools, the two fields are often mentioned together—for example, in the International Society for Scientometrics and Informetrics. However, they belong to entirely different disciplines when considering their attributes: scientometrics belongs to the science of science, while informetrics belongs to information science [5-7]. Despite being proposed decades ago, neither has achieved universally recognized definitions. The originators of scientometrics, V. Nalimov and B. Mulchenko, defined it as the quantitative study of various information processes in scientific development [8]. Other scholars view scientometrics as a discipline that uses mathematical methods to quantitatively analyze scientific researchers and outputs, revealing scientific development processes to provide evidence for scientific decision-making and management [5], or as a field that employs bibliometric methods like citation analysis to evaluate scientific research activities and guide science policy [4]. O. Nacke defined informetrics as the application of mathematical methods to information science objects [2], a definition that narrowly limits informetrics within information science. J. Tague-Sutcliffe expanded informetrics to the quantitative study of any form of information, not limited to bibliographic records, social groups, or scientists [9], broadening its scope. Qiu Junping proposes that informetrics should be divided into broad and narrow senses, with the broad sense having an extensive research scope and the narrow sense focusing on quantitative study of information characteristics and laws using mathematics and statistics [10].

### 1.2 Connections and Differences Between Scientometrics and Informetrics

Brookes previously examined their origins and interrelationships [3, 11]. W. W. Hood and C. S. Wilson conducted a historical survey, analyzing their differences by counting papers and journals from 1968-2000 [12]. Wen Tingxiao and Qiu Junping argued that while they serve different parent disciplines, they share commonalities in research objects, indicators, and methods [3]. Most related research has approached the topic theoretically—through historical development, disciplinary affiliation, methodological indicators, etc.—failing to clearly distinguish scientometrics from informetrics.

### 1.3 Research Based on *Scientometrics* and *Journal of Informetrics*

Due to the high impact and authority of these two journals in the metrics field, many scholars have conducted bibliometric analyses using them. For instance, Wang Lian and Wu Yishan analyzed the citation patterns of *Scientometrics* papers from 1994-2004 to examine the journal' s disciplinary characteristics and connections with other fields [13]. Zhou Haihua and Hua Weina used both journals as data sources to analyze research hotspots, core authors, countries, and institutions from 2008-2012 [14]. A. Abrizah et al. used the journals as data sources for productivity, impact, and collaboration analyses in informetrics [15]. L. Egghe analyzed publication patterns, country distributions, and topics in *Journal of Informetrics* from 2007-2011 [16].

In summary, while many scholars have attempted to analyze the historical development, research objects, and disciplinary affiliations of scientometrics and informetrics, no consensus has emerged. Research on their connections and differences has been largely theoretical, with few quantitative studies examining their similarities and differences in the new environment.

## 2 Methods and Data

We selected two mainstream data sources for disciplinary fields: using representative journals as data sources to analyze both content and metadata, and retrieving samples through representative keywords in databases. We used CiteSpace to analyze collaboration networks, examined disciplinary themes and structures through keyword co-occurrence networks and clustering, and visualized citation behaviors for highly cited authors, journals, and papers using CiteSpace' s journal overlay function to analyze knowledge flows between the two disciplines.

**2.1 Representative Journals Approach** *Scientometrics* focuses on the quantitative features of science and scientific research, emphasizing mathematical and statistical analysis of scientific development and mechanisms [17]. *Journal of Informetrics* publishes high-quality quantitative research on information science [18]. Based on these editorial foci, we selected the former as representative of scientometrics and the latter as representative of informetrics. From 2012-2016, *Scientometrics* published 1,635 documents; we selected 1,546 articles and reviews. During the same period, *Journal of Informetrics* published 459 documents, from which we selected 408 articles and reviews.

**2.2 Keyword Retrieval Approach** Following W. W. Hood and C. S. Wilson' s methodology [12], we searched the WoS database using the query "TS=(scientometric* OR scientometrically OR scientometrician*)" for 2012-2016, retrieving 1,118 documents, of which 920 were articles and reviews. Using the query " TS=(informetric* OR informetrician* OR 'informetion metrology' OR informetry)" for the same period, we retrieved 176 documents, including 144 articles and reviews.

### 3.1 Comparison of Research Subjects

The United States ranks first in publication output for both disciplines, followed by China. Among the top 10 countries in both fields, more than half are European, indicating that Europe is a core region for research in these areas —likely due to being the origin of both fields and the high priority given to them. African and Oceanian countries have relatively few publications in both disciplines, reflecting lower research productivity. Notably, South Africa ranks eighth in informetrics publications, demonstrating strong capabilities in this area, which is inseparable from its economic level and political environment.

Publication volume is one standard for measuring research performance. We regard the top 10 authors by publication count as highly productive authors. The two fields have entirely different groups of productive authors. Scientometrics has formed a productive cohort led by D. A. Groneberg, Y. S. Ho, and L. Bornmann, while R. Rousseau, L. Egghe, and O. B. Onyancha top informetrics. The publication volumes differ dramatically: the 10th-ranked author in scientometrics published at least 13 papers, whereas the 10th-ranked in informetrics published only 3. Since author productivity is not constrained by the total publication volume difference between the fields, we can conclude that scientometrics has established a sizable cohort of productive authors, while informetrics has not yet formed such a group. This may be because scientometrics emerged earlier, has greater research output, and thus reaches more researchers. Although informetrics has a broader scope, its specificity is weaker, its recognition is lower due to its shorter history, and it has relatively fewer researchers.

### 3.2 Institutional Collaboration Networks

Within the set threshold, scientometrics collaboration institutions form two major clusters (see [Figure 1: see original paper]). In cluster , CSIC, Univ Amsterdam, and Leiden Univ serve as core forces with high centrality values of 0.19, 0.18, and 0.10 respectively, alongside Univ Granada, Max Planck Gesell, and Wolverhampton Univ. In cluster , Chinese Acad Sci is the absolute core with a centrality of 0.39, including members such as Katholieke Univ Leuven (high output), Wuhan Univ, Zhejiang Univ, and Nanjing Univ. Cluster consists mainly of European institutions, while cluster includes numerous Chinese institutions and some Eurasian ones, with Katholieke Univ Leuven maintaining close collaboration with Chinese research institutions.

The main collaborative institutions in informetrics are shown in [Figure 2: see original paper]. Cluster is the largest, with Katholieke Univ Leuven and Univ Atwerp as core institutions (centrality: 0.11 and 0.06), also including Zhejiang Univ and Nanjing Univ. Cluster features Indiana Univ and Chinese Acad Sci as core members (centrality: 0.08 and 0.1), along with Wolverhampton Univ and Yonsei Univ. Cluster centers on Univ Amsterdam and Max Planck Gesell, including Adm Headquarters Max Planck Soc. Cluster is centered on Wuhan Univ, with members such as ETH and Max Planck Inst Solid State Res. Cluster , centered on Univ Roma Tor Vergata, includes Natl Res Council Italy, CNR, and Univ Siena, forming a relatively independent group. Cluster on the left side of the network is also relatively independent, comprising Univ Jaume, Collnet Ctr, and Williams Coll. In cluster , all four collaborating institutions are Italian; only Univ Roma Tor Vergata collaborates with the other three, which have no interconnections among themselves, resulting in weak collaborative relationships. Cluster ' s institutions come from Spain, Germany, and the USA, making it relatively independent.

Overall, both disciplines are dominated by university collaborations, demonstrating that universities are the backbone of research collaboration, while cooperation between different types of institutions remains low. Scientometrics has more concentrated institutional collaboration clusters, whereas informetrics shows more dispersed clusters, even forming independent groups like clusters and that collaborate only internally. This likely results from the substantial difference in data volume between the two journals—larger datasets with more institutions tend to cluster more—so this conclusion holds only when ignoring quantitative differences. Chinese research institutions are distributed differently across the two fields: Chinese Acad Sci, Zhejiang Univ, and Wuhan Univ belong to the same scientometrics cluster with high centrality, but in informetrics they belong to different clusters with lower centrality. Wuhan Univ is an important collaborator in informetrics cluster , while most other Chinese institutions are in cluster , indicating that Chinese institutions' collaboration level in scientometrics is higher than in informetrics.

## 4 Theme Distribution and Structure

We selected paper keywords as the basis for analyzing disciplinary themes. [Figure 3: see original paper] shows five major research themes in scientometrics: exploring trends, patterns, and networks of scientific collaboration based on research outputs; studying research methods (e.g., citation analysis, impact factor) and metrics such as the h-index, including their practical applications; examining the role of scientometric analysis in policy formulation and development planning across scientific fields; conducting scientific evaluation research, including specific assessments of researchers, institutions, articles, and journals; and applying scientometric methods in biology, demonstrating the expanding application of these methods in other disciplines.

[Figure 4: see original paper] reveals six major research themes in informetrics: the rise of webometrics research, focusing on social network analysis and international collaboration patterns in new environments; studying citation behaviors in the network environment, where changing research activity patterns have diversified authors' citation purposes and methods, including article/journal citation analysis and author citation behavior; investigating interdisciplinary integration and fusion using bibliometric methods like citation and co-word analysis; examining digital library development trends and theoretical research on fundamental laws in library and information science; centering on h-index research to study the distribution of highly influential articles, authors, or journals, with a focus on h-index application models; and conducting scientometric evaluation research, particularly assessing research output quality using metric indicators in big data environments.

Comparing the research themes, both fields focus on metric indicator applications and innovations, citation behavior studies, and evaluation of research outputs and authors. However, scientometrics particularly emphasizes research collaboration trends, patterns, and networks; its role in policy formulation across scientific fields; and specific applications in other disciplines. Informetrics pays more attention to webometrics analysis in new environments, interdisciplinary fusion studies, and theoretical research on digital libraries and fundamental laws in library and information science.

### 5.1.1 Literature Co-Citation–Knowledge Base Comparison

As shown in [Figure 5: see original paper] and [Figure 6: see original paper], scientometrics' knowledge base comprises seven major components, while informetrics' comprises six. In the figures, connections between nodes represent citation relationships, nodes with purple rings are important cited documents with high centrality, and node size represents citation frequency. Based on [Figure 5: see original paper], we compiled a list of foundational literature for scientometrics (see ) containing 18 key documents. From [Figure 6: see original paper], we compiled informetrics' foundational literature list (see ) with 15 documents, seven of which (marked in red) are shared between the two fields.

Comparing the foundational literature reveals that shared documents may belong to different knowledge components, indicating different application contexts across the two fields. For example, F. Radicchi' s article on H index in scientometrics component #0 appears as foundational literature for scientific impact in informetrics component #0. S. Alonso' s article on web-based scholarly impact in scientometrics component #4 belongs to the H-index research component in informetrics.

Comparing and shows that two-thirds of the foundational literature in scientometrics component #0 and informetrics component #2 are identical, both focusing on H-index research. J. E. Hirsch' s 2005 proposal of the h-index as a metric for evaluating researchers' academic output and impact pioneered this subfield [19]. L. Egghe' s 2006 introduction of the g-index compensated for the h-index' s limitations by measuring global citation performance of article sets [20]. Subsequent research in both fields has deepened h-index applications while developing extensions like the A-index and M-index, establishing a shared knowledge base.

As shown in [Figure 5: see original paper] and , interdisciplinary research, triple helix model studies, and scientific collaboration research constitute unique knowledge foundations for scientometrics. Interdisciplinary research (component #1) primarily uses visualization techniques and software to analyze disciplinary integration in research activities. The triple helix model (component #5) features two key articles by H. W. Park examining university-industry-government interactions in South Korea [21-22], which later researchers built upon to study complex social information systems. Scientific collaboration research (component #6) is grounded in J. Hoekman's 2010 study on long-distance research collaboration patterns in Europe [23] and A. Abbasi' s 2012 research on betweenness centrality in collaboration network evolution [24], laying foundations for innovation in collaboration models and methodologies.

According to [Figure 6: see original paper] and , humanities and social sciences, percentile rank classes, and crown indicators form unique knowledge foundations for informetrics. In component #3 (humanities and social sciences), L. Waltman innovated scientific classification systems [25], providing experience for subsequent social network analysis in informetrics. In component #4 (percentile rank classes), researchers studied the advantages, disadvantages, and applications of percentile ranks in bibliometrics [27], representing a successful application of mathematical models to metrics. In component #5 (crown indicators), foundational literature innovated citation metrics and calculation methods, stimulating research on citation analysis limitations and new evaluation indicators.

#### 5.1.2 Author Co-Citation and Journal Co-Citation

Nine of the top 10 most-cited authors are shared between the two disciplines, but high-impact authors differ between fields. In scientometrics, L. Leydesdorff (centrality: 0.43, citations: 332), W. Glanzel (centrality: 0.33, citations: 343), and M. E. J. Newman (centrality: 0.34, citations: 155) are highly influential. In informetrics, L. Leydesdorff (centrality: 0.34, citations: 128), L. Waltman (centrality: 0.33, citations: 124), and L. Bornmann (centrality: 0.24, citations: 141) are highly influential. L. Leydesdorff is a high-impact author in both fields, with high centrality and citation counts. As the 2003 Derek de Solla Price Award winner, his research interests span metric indicators, citation analysis, social network analysis, and interdisciplinary collaboration.

Journal co-citation network analysis reveals that nine of the top 10 most-cited journals are shared between the two fields, including *Scientometrics*, *J Am Soc Inf Sci Tec*, *J Informetr*, *Res Policy*, *P Natl Acad Sci Usa*, *Science*, *Nature*, *J Am Soc Inform Sci*, and *Inform Process Manag*, indicating these are primary source journals publishing high-quality, frontier-leading research. In scientometrics, *Res Policy* (centrality: 0.59, citations: 568), *Scientometrics* (centrality: 0.34, citations: 1,429), and *J Am Soc Inf Sci Tec* (centrality: 0.31, citations: 801) are core cited journals. In informetrics, *Res Policy* (centrality: 0.29, citations: 125), *P Natl Acad Sci Usa* (centrality: 0.15, citations: 184), and *Science* (centrality: 0.12, citations: 149) are core cited journals. *Res Policy* is a core journal in both fields, reflecting its importance in research management and close relationship with both disciplines.

### 5.2 Knowledge Flow

Using CiteSpace' s "Overlay Maps" function, we created dual overlay maps for both disciplines [28] to compare their knowledge flows with other fields. The results show that scientometrics primarily cites literature from Plant, Ecology, Zoology; Chemistry, Materials, Physics; Systems, Computing, Computer; Molecular, Biology, Genetics; and Health, demonstrating broad citation across many disciplines and extensive borrowing of methods and theories. Scientometrics articles are mainly published in journals from ecology, Earth, Marine; Veterinary, Animal, Science; Molecular, Biology, Immunology; and Medicine, Medical categories, indicating wide-ranging knowledge flows and extensive application in other disciplines.

Informetrics primarily cites knowledge from Systems, Computing, Computer and Economics, Economic, Political, with minimal citations from other disciplines. Its articles appear mainly in journals from Psychology, Education, Health and Physics, Materials, Chemistry categories. Thus, informetrics' knowledge flow range is much narrower than scientometrics' , involving fewer disciplines.

The comparison reveals that scientometrics has broad knowledge flows across many disciplines, both borrowing from and being widely applied by other fields. Informetrics' knowledge flow is relatively narrow, involving fewer disciplines. Although informetrics is often considered to have broader research scope, its recognition is actually lower, as evidenced by publication volumes.

## 6 Conclusion

Based on WoS database data from 2012-2016 for *Scientometrics*, *Journal of Informetrics*, and related keyword retrieval results, we compared the two disciplines across three dimensions: publication and collaboration, theme distribution and structure, and citation behavior and knowledge flow. We found that while their general research directions align, differences exist in the details.

The recognition levels of scientometrics and informetrics differ significantly. The total data volume from relevant retrieval queries shows a large disparity. Scientometrics has established a sizable cohort of productive authors, while informetrics' productive author cohort is still developing. Scientometrics has broad knowledge flows across many disciplines, whereas informetrics' knowledge flow is much narrower. As scientometrics gained acceptance, informetrics emerged later, leading researchers to prefer "scientometrics." The extensive application of scientometrics in other disciplines has indirectly enhanced its recognition, while informetrics' relatively limited connections with other disciplines have resulted in lower recognition.

Research themes are largely similar but differ in emphasis. Both focus on metric indicator applications and innovations, performance evaluation of research outputs, and citation behavior studies. However, scientometrics particularly emphasizes research on scientific collaboration across all fields and applications in other disciplines, while informetrics focuses more on new indicators and collaboration models in network environments and interdisciplinary fusion studies. This suggests scientometrics is grounded in the entire scientific domain, whereas informetrics is closely linked to network technology development.

While many foundational documents are shared, they belong to different knowledge components, indicating different application contexts. Interdisciplinary research, triple helix model studies, and scientific collaboration research constitute unique knowledge foundations for scientometrics, while humanities and social sciences, percentile rank classes, and crown indicators are unique to informetrics. The high-impact authors differ between fields, with scientometrics having a larger cohort. L. Leydesdorff, W. Glanzel, and M. E. J. Newman represent high-impact authors in scientometrics, while L. Leydesdorff, L. Bornmann, and L. Waltman are representative in informetrics.

Our comparison has limitations. We only analyzed data from 2012-2016, providing an incomplete sample. Retrieval terms may have been insufficient, causing incomplete data collection. Additionally, our limited knowledge breadth and depth may have resulted in insufficiently thorough analysis. Future research should consult domain experts, expand time ranges, and conduct deeper content analyses for more comprehensive comparisons.

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