



RESEARCH ARTICLE

# An analysis of the development of Chinese STM journals in the past 30 years

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## ABSTRACT

China publishes 5,052 academic journals in science, technology, and medicine. It ranks third in terms of the number of publications, behind the United States and the United Kingdom. In recent years, English-language journals have increased annually in China, but there are only just over 300 English journals published, accounting for about 6.5% of all published journals, whereas Chinese journals account for about 93.5%. Using 30 years' data from the Chinese science citation database (CSCD), I compiled statistics on the average number of papers, the average number of references, the language of references, the distribution of author age, etc. I also analyzed the role of Chinese STM journals in terms of their academic significance. It is observed that the average number of journal papers and references per paper has been on the rise in the past 30 years. English literature accounts for a large proportion of the references, and the authors are young. The conclusion is that Chinese journals are important for young scholars to publish their papers, and Chinese scholars widely use international research results for reference in their research.

## 1. INTRODUCTION

The importance of academic journals in the scientific community is self-evident. Currently, about 42,000 (Ulrichsweb Global Serials Directory, n.d.) STM academic journals are published worldwide. Among them 5,052 (China Association for Science and Technology, 2019) are published in China (more than 3,300 of which are in Ulrichsweb), behind only the United States and the United Kingdom. The history of Chinese STM journals is not long, with around 43% of them founded after 1990. *National Medical Journal of China* (available in Chinese and English), the earliest published STM journal, was founded in 1915. In the past 30 years, the number of STM journals in China has increased rapidly. More than 330 journals published in the last 5 years are available in English, accounting for 6.7% of all Chinese STM journals (C-STMJs). C-STMJs are developing, not only in terms of the number of journals published, but also in their characteristics. I studied Chinese Science Citation Index (CSCD) data and used quantitative methods to delineate the development of C-STMJs over the past 30 years.

CSCD was created by the National Science Library of the Chinese Academy of Sciences in 1989 and was China's first citation database. The mechanism of the CSCD database is very similar to the Science Citations Index (SCI), which draws citation networks to reveal the context of scientific research. It also establishes criteria to select outstanding academic journals and sets data processing standards to standardize the data of key contents. It currently has three databases, namely CSCD, CSCD-JCR, and CSCD-ESI. CSCD makes full use of citation relationships

to provide a document database for document retrieval and information discovery. CSCD-JCR is an annual statistical report of journals based on CSCD data, including CSCD-sourced journal citation frequency, impact factor, citation/cited half-life, mutual journal citations, feature factors, number of published papers, and other quantitative indices. It also provides the frequency of citations for all non-CSCD-sourced journals in 60 categories. CSCD-ESI is a statistical report of annualized paper publication and influence based on CSCD and SCI data. It includes published papers by various institutes and provincial and municipal governments, indexed by citation of all papers in the past 5 years and the number of highly cited papers, among others. Despite having an independent domain name (<http://cscd.ac.cn>), CSCD also operates on the Web of Science (WoS) platform, which makes it the first non-English citation database on WoS. As of February 2020, CSCD has 1,229 journals, 5.39 million papers, more than 75.1 million records of citation data, about 250,000 new papers, and more than 6 million records of citations.

CSCD selects from all Chinese and English STM journals published in China. In 2019, 1,229 journals passed the selection criteria of CSCD, accounting for 24.32% of all C-STMJs. The selection uses a combination of quantitative and qualitative methods. Quantitative calculation is the main method for selecting journals, and qualitative evaluation involves the participation of peer experts. CSCD, through extensive data analysis and trend monitoring, optimized its selection metric from a type-focused one at the beginning to an impact-focused one now. Impact is considered on the level of both individual papers and journals. The ratio between the frequency of citations and the number of cited papers is also taken into account. A journal's citation of its own papers is excluded, and only citation by papers from other journals is registered. Overall, there are eight indicators, including 5-year cited impact factors, eigenfactor scores, ratio of citing journals, ratio of cited papers to published papers, mutual citations of journals, and average level of journal in the discipline. After calculating the comprehensive score of the eight indicators, Bradford's Law is applied to delineate the thresholds for journal selection in each discipline. The key to journal selection is to define the disciplinary attributes (Zhang, Liu, & Wu, 2016) and conduct intradiscipline comparisons among journals. To this end, the influence of a certain journal in different disciplines is calculated to determine its discipline. Journals that fail to reach the CSCD quantitative threshold are eliminated. Publications with severe postponements or violations of publication ethics are also dropped.

In 1989, there were only 312 CSCD journals. Applying Bradford's Law, it is found that the ratio of the number of CSCD journals to the total number of C-STMJs fluctuated around 0.23. With the increase in number of Chinese STM journals, the number of CSCD journals has also risen accordingly. There were 312 CSCD journals in 1989, 594 in 1995, and 990 in 1999. In 2003, 1,040 journals were collected in CSCD and the number has since been relatively stable, with only small increases. In 2019, there were 1,229 CSCD journals. They are archived by CSCD in the language of publication, the majority in Chinese. Of the 315 journals included in CSCD in 1989, 14 were in English; by 2019, 225 of them were in English.

By studying CSCD data in the recent three decades, I captured the development of C-STMJ core journals and features of leading Chinese journals.

## **2. DATA AND ANALYSIS**

The statistics in this article are based on research papers and literature reviews published on CSCD journals. The features of Chinese journals are described from paper publication, paper citations, and author's age. As the data for 2019 are not yet complete, the data for published papers in 2019 is not calculated. In addition, the granularity of data processing is different in

different times. The data in this article on paper publication come from 1989–2018, and the data related to references are from 2002–2018.

According to statistics from 1989 to 2018, the number of published articles per journal (CSCD-A/J) increased rapidly from 1989 to 2010. CSCD-A/J was 87.79 (articles) in 1989, and 200.32 in 2018. The 2018 number is 2.28 times that of 1989. The highest value of CSCD-A/J appeared in 2010 at 255.46 articles. From 2009 to 2013, the number of published articles per journal remained above 250, and began to decrease in 2014 (Figure 1).

Based on the JCR data from SCI (Clarivate Analytics Journal Citation Reports, 1997–2018), the number of articles published in SCI per journal in 1997–C-STMJ2018 was calculated. The SCI-A/J value increased slightly amid a generally steady trend. In 1997, SCI-A/J was 107.2 articles. It increased 1.5 times to 171 articles in 2018.

Since 1997, CSCD-A/J values have been consistently larger than SCI-A/J. In 1997, CSCD-A/J was 116.52 articles, and in the same period SCI-A/J was 107.2 articles. The year 2010 saw the largest gap between the two with a difference of 121.7 (CSCD-A/J = 255.46, SCI-A/J = 133.8). The number of papers published in CSCD-J journals has exploded, and the number of papers published by SCI journals has increased slightly in a steady trend. The indicator of CSCD-A/J can reveal the trend of papers in Chinese STM journals. The decline in CSCD-A/J has been less sharp since 2015. The decline does not mean a weakening of demand for published papers, but rather that journals and periodicals stepped up their emphasis on paper quality. For a period before 2015, to adapt to the rapid increase in the demand for published papers, journal content was blindly enlarged. But this expansion quickly showed negative effects. The decline in the quality of journals was criticized by scholars, which forced some journals to stop publishing as many papers as possible.

C-STMJs are rarely bilingual and mainly Chinese. From the perspective of scholarly communication, having English abstracts better disseminates research results. In 2002, 80.01% of CSCD journals already had English abstracts, which rose to 84.44% in 2018. As a result, CSCD was included in the WoS when more than 80% of its papers had English abstracts, meaning that more Chinese journals could be understood globally.

In 1989 to 2018, 5.043 million papers were published on CSCD journals by 1996.29 million authors. In 1989, the degree of author collaboration was 2.9, and in 2018, the degree was 4.7. So during the 30 years, the degree of author collaboration was on the rise. In terms of the number of authors and the distribution of published papers, the proportion of papers published by a single author in 1989 was 23.14%, but by 2018 this figure was only 3.33%. In 1989, the number of papers published by two coauthors was the largest group, accounting for 27.88% of all the

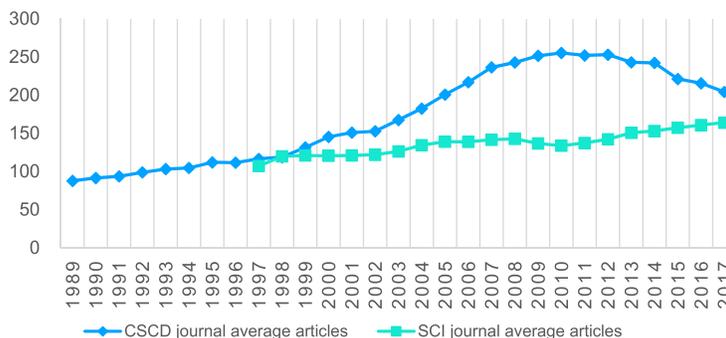


Figure 1. CSCD and SCI: the number of published articles per journal.

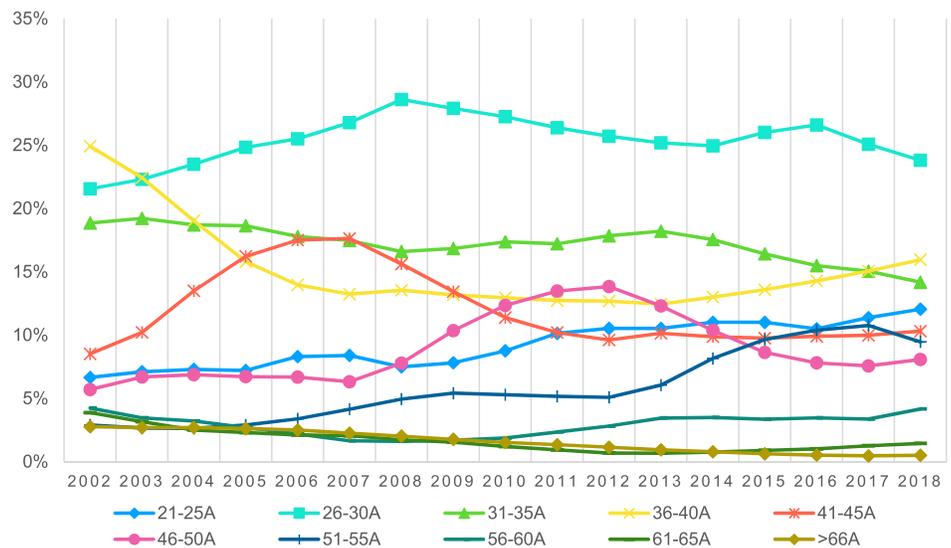


Figure 2. Age distribution of first authors.

papers published that year, but by 2018 this figure had dropped to 10.92%. The proportion of the papers by one to three authors showed a downward trend and the proportion of papers by four or more authors has been increasing. In 2018, the proportion of papers by four authors increased by 1.57 times compared to 1989. The number of papers by five authors increased by 1.69 times, and the number of papers by six to nine authors increased by 2.62, 2.65, 2.39, and 2.40 times respectively. The number of papers with more than 10 authors increased by 1.75 times. Although the number of papers with 8–10 authors accounted for a small percentage in all papers (only 3.01% in 1989), it had risen to 12.59% by 2018. In 1989, the number of papers with one to three authors accounted for 71.65% of the total, falling to 68.49% in 2018. These data show that China’s scientific research model in the past 30 years has shifted from independent research to joint research, with cooperation becoming the new normal.

To research the author characteristics of the CSCD journal, I analyzed the ages of authors who published papers between 2002 and 2018. Age information on around 20% of authors was available. It is typical in China to place special emphasis on the first author, so here I make a distinction between the age distributions of the first authors and of all authors. After collecting the author’s age information, the age is divided into a time periods of 5 years, and the proportion of each age group to the number of authors with age information for the year is calculated. For first authors (FIR-Auth), those between 21 and 40 years old accounted for about 77% of all first authors, which meant they are productive. First authors under the age of 30 were on the rise, accounting for 45.18% in 2018, making them an important author group. The proportion of authors over the age of 31 was declining gradually, especially between the ages of 36 and 40, which decreased by 11.01% in 2018 compared with 2002. The proportion of authors aged 41–45 was relatively high in 2004–2009, but was only 8.72% in 2018, the same as in 2002 (Figure 2).

The overall age distribution in the group of all authors (All-Auth) is consistent with that of first authors (First-Auth). About 66% of All-Auth were aged between 21 and 40, lower than 77% in the Fir-Auth age group of 21–40. The number of authors under the age of 30 is on the rise, becoming an important group for publishing papers. Unlike Fir-Auth, the proportion of authors aged between 31 and 40 varied slightly from year to year, but was relatively stable. The proportion of authors aged 51–55 in All-Auth is significantly higher than that in Fir-Auth, especially

after 2014, with a 4–5 percentage points margin, which partly resulted from the cooperation between young authors and experienced researchers.

The age distribution in All-Auth and Fir-Auth reveals that young professionals under the age of 30 make up the majority of authors for CSCD journals and the declining trend in the age of authors is conspicuous.

References show the author's understanding of extant researches and are the basis of scientific research. Therefore, authors' habits when using literature can also be understood through reference statistics. Between 2002 and 2018, CSCD journals had 6.591 million records of references, and the average number of references per paper increased from 9.18 in 2002 to 24.28 in 2018 (Figure 3). Despite a rapid increase, the number was still lower than the international average of 35 references per paper (Scimago Lab, 2018). CSCD-J's references include journal papers, monographs, conference proceedings, theses and dissertations, and patents. Journal papers take up a significant proportion: 75.23% of the total references in 2002 rising to 87.62% in 2018. Monographs are another important type of literature, accounting for 15.79% of all references in 2002 but falling to a mere 4.15% in 2018. This shows that in scientific research, Chinese scholars are more accustomed to using journal literature, and that journal papers are becoming more and more important in scientific research.

From the perspective of the annual distribution of journal references, comparing 2018 to 2002, 80% of the total journal citations were published in the preceding 15 years. In 2018, 8.72% of the citations were published in the preceding two years, whereas this number for 2002 is 7.72%.

About 67% of the references are to foreign journals. Since 2002, the journals cited most often are *Nature*, *Science*, *Journal of the American Chemistry Society*, *Cell*, *New England Journal of Medicine*, *Proceedings of the National Academy of Sciences of the United States of America*, *Physical Review Letters*, *Lancet*, *Journal of Biological Chemistry*, and *Physical Review B*. Since 2014, *PLOS ONE* has become a highly cited journal, behind *Nature* and *Science*. According to the SCI-JCR data, these journals are also highly cited journals in SCI. The journals cited by Chinese and foreign scholars are consistently similar.

Further, only 33% of referenced journal papers were Chinese journal articles. In 2002, the percentage was 33.73%. Between 2007 and 2014, the figure reached about 37%, but by 2018 it had dropped to 33.86%. These data indicate that Chinese scholars are inclined to use Western literature. Interestingly, I counted the number of documents whose authors' names possessed Chinese characteristics. The proportion of journal papers in Chinese and English journals by Chinese authors in all CSCD references increased from 46.32% in 2002 to 58.80% in 2018. From this point of view, although the citation proportion of English journals is about 66%, one

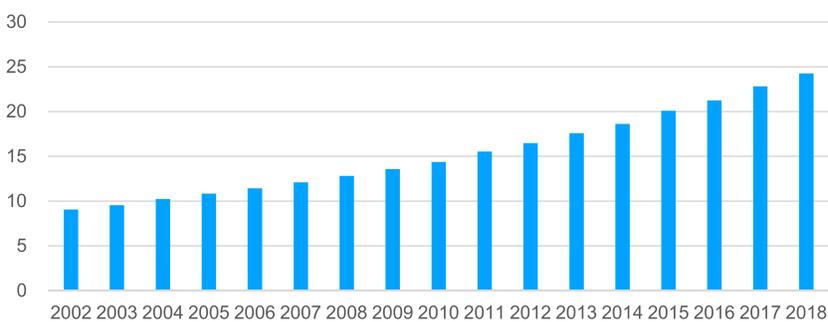


Figure 3. CSCD: average references per article.

**Table 1.** Distribution of the number and frequency of cited papers from 1989 to 2018

Year	Number of cited CSCD papers (AC)	Frequency of citation (C)	Average citation per paper (C/AC)	Proportion of cited papers in all CSCD papers (AC/A) (%)
1989	12,516	49,117	3.92	45.69
1990	13,512	54,977	4.07	47.17
1991	13,908	58,824	4.23	47.44
1992	15,152	62,480	4.12	48.64
1993	15,696	69,767	4.44	48.74
1994	18,729	92,692	4.95	56.60
1995	20,013	101,071	5.05	56.51
1996	36,136	176,974	4.90	54.32
1997	39,228	200,645	5.11	56.46
1998	4,2855	229,862	5.36	60.30
1999	64,726	341,141	5.27	46.54
2000	84,727	475,225	5.61	58.55
2001	90,526	507,972	5.61	60.50
2002	103,413	590,767	5.71	67.95
2003	119,094	676,123	5.68	68.16
2004	130,987	724,247	5.53	68.93
2005	145,135	776,537	5.35	69.43
2006	157,079	816,508	5.20	69.59
2007	171,033	819,332	4.79	66.70
2008	173,553	798,483	4.60	65.74
2009	183,136	790,452	4.32	64.81
2010	186,882	788,558	4.22	65.14
2011	186,565	753,876	4.04	65.76
2012	182,402	697,441	3.82	64.20
2013	175,607	640,940	3.65	63.29
2014	166,259	560,598	3.37	60.12
2015	156,263	481,820	3.08	58.83
2016	137,627	364,930	2.65	53.17
2017	113,295	247,943	2.19	45.10
2018	62,065	101,410	1.63	25.21
Total	3,018,119	13,050,712	4.32	59.85

third of them come from Chinese authors, indicating that Chinese scholars cited scientific research groups that they were more familiar with.

How influential have published papers been since 1989? I looked into all cited CSCD papers from 1989 to 2018. Among the 5.043 million CSCD papers, 3.013 million were cited (art\_cited, AC), and the yearly average proportion of cited papers in all published papers (AC/A) was 59.85%, where 2005 and 2006 saw the highest AC/A at 69.43% and 69.59% respectively. AC/A was lowest in 1989–1999 and had been on the rise since 2000. Statistics show that at least half of the papers published every year were cited after publication and attracted scholarly interest.

A total of 3.013 million papers were cited 13.53 million times (Table 1). The average frequency of citations per paper (C/A) was 4.32. The peak C/A appeared in 2002 and reached 5.71 times. Since 2007, the values of AC/A and C/A had been decreasing. Among the Art\_cited group, those cited once accounted for about 33%, those cited twice about 20%, and those cited three times about 12%. 80% of citation frequencies came from papers cited four or more times, which account for about 35% of all cited papers. In 1997–2006, where  $C/A > 5$ , papers cited once accounted for less than 30%. Based on data from 2002 and 2006, the peak C/A was in 2002, and the peak of AC/A was in 2006. Compared with 2002, both the number of cited articles and the frequency of citation per journal showed an increase, but C/A did not increase with them. By calculating the median of average citation per paper (C), number of cited articles (AC), and the sum frequency of citation (sum\_cit), I found that the medians AC were 7 in both 2002 and 2006, the medians for C were 86.5 and 81 respectively, and the medians for sum\_cit were 651 and 630. It could be seen that the C and sum\_cit values in 2002 were higher than in 2006, which indicated that more highly cited papers were published in 2002. The data showed that although around half of all journal papers were cited, a large number of papers were cited 1–4 times, and there were only a few high-impact papers.

### 3. CONCLUSION

The paper analyzed CSCD data on number of published papers, frequency of being cited, author collaboration and use of references to delineate the development of CSTMJs in the most recent three decades. The selection criteria of CSCD make it highly representative of STM journals in China and the rich data from it makes it a good study subject. First, the types of STM journals in China experienced a rapid expansion, from above 2,000 in the 1990s to 5,052 so far. Among them English journals grew fastest, by almost eight times from above 40 in the 1990s to more than 330 so far. In 1999, 35 Chinese journals were collected in SCI and this number grew sevenfold to 250 in 2020. The trend is consistent with the increase of English journals in China. Second, the average annual number of published journal papers exploded exponentially. In 2018 the number was 2.3 times of that in 1989. Third, collaboration is more extensive. The average number of authors per paper was 2.9 in 1989 and 4.7 in 2018, corresponding to the rising trend of international collaboration (Adams, 2012; Gui, Liu, & Du, 2019). Fourth, the authors of C-STMJs are becoming noticeably younger. Whether among first authors or all authors, 50% of them were under 35 years old. Fifth, the number of references increased, meaning that Chinese scientists are drawing more on existing research, but the number was still lower than the international average. The fact that about 33% references are from C-STMJs, whereas about 33% are from English journals showed that Chinese scholars are referring more to research results from their international counterparts. The influence of C-STMJs is shown by the fact that 70% of them were cited after publication.

This article described the general trend of STM journals in China in the past three decades based on CSCD data only. Statistics suggest that C-STMJs played an important role in domestic

scholarly communication. But there are also limitations to the findings. Different disciplines may have their specific publication and citation standards, which is not discussed in this article. Furthermore, the relation between data was not exploited to a deeper extent, such as whether authors cited their own works or whether collaborators referenced each others' publication. It is worth noting that STM papers by young scholars have been widely cited.

#### COMPETING INTERESTS

The author has no competing interests.

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No funding has been received for this research.

#### DATA AVAILABILITY

The data for this article can be found at <http://www.cscd.ac.cn>.

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