The internationalization of Chinese scholarly journals based on publications deriving from the G8 countries

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ABSTRACT

China's rapid rise in international collaboration and scientific research has been widely documented, but the progress of Chinese scholarly journals towards internationalization has been less investigated. This study examines the internationality of Chinese scholarly journals using bibliometric analysis of publications deriving from the eight highly industrialized countries (the Group of 8, or G8) namely, Canada, France, Germany, Italy, Japan, Russia, the UK and the USA, from 1979 to 2016 based on the databases of the Chinese National Knowledge Infrastructure (CNKI). Annual production and research trends, research affiliations, research emphases and foci, and common journal sources were analyzed. The analysis reveals that the internationality of Chinese scholarly journals has been continuously growing since 1979 and increased rapidly from 2004 to 2010. Both foreign researchers' submissions and internationally co-authored Chinese publications substantially contributed to the internationalization of Chinese scholarly journals. This internationalization was also influenced by the academic scopes, journal titles and disciplinary categories of Chinese journals. The potential implications and limitations of this study are discussed.

Keywords: Internationalization; Bibliometrics; Scientific Journals; Journal studies; Collaboration.

INTRODUCTION

With the deepening of globalization and the popularization of the Internet, academic exchange and collaboration between the West and East have reached unprecedented levels, with China becoming a powerhouse in research and development spending. As a result, along with China's growing global influence and international engagement, the internationalization of China in scientific research has substantially improved (Liu et al. 2015; Tollefson 2018; Zhou and Leydesdorff 2007). Chinese research accounted for 324,613 international publications indexed in the world's first citation database, the Web of Science, a share of approximately 20 percent, in 2016[1], second only to the USA. One aspect of internationalization in scientific research and academic collaboration is the internationalization of scientific journals. As a key medium for publishing scientific information, scholarly journals play an important role in scientific knowledge dissemination and academic exchange. Accompanying the rapid internationalization of China in science and technology (S & T), the internationality of Chinese scholarly journals is becoming an increasingly important issue that deserves investigation. The Chinese journals mentioned here refer to Chinese scholarly journals published in China rather than to scholarly journals published in Chinese, and this study focuses particularly on the Chinese journals included in the Chinese National Knowledge Infrastructure (CNKI) databases. However, few studies have examined the internationalization of Chinese academic journals. Ren and Rousseau (2002) assessed the potential characteristics of Chinese physics and chemistry journals in terms of the country of origin of the published articles, the composition of the editorial board, and their citation patterns. The results revealed that Chinese journals, irrespective of whether they are included in international databases, are not internationally recognized and suffer from low international visibility. Following Okubo (1999)'s approach of comparing Chinese journals with well-known foreign journals in the same category, He and Liu (2009) sampled chemistry journals and assessed the internationalization of Chinese scientific journals by individually comparing three journals from China, England, and Japan. Their findings demonstrated that the Chinese scholarly journals fell behind the other two selected journals, especially the English journal, in terms of the geographical distributions of the editorial board members, authors, citation countries and citation patterns. By focusing on the journal impact factor, total citations, Journal Citation Report (JCR) list rank, proportion of international papers and global citation distribution, Wang, Wang and Weldon (2007) employed bibliometric analysis to assess the internationalization of 10 Chinese English-language scholarly journals. They found that these Chinese journals' subject ranks have slightly decreased, although their overall impact factor and total citation trends continue to increase. Specifically, these journals' low proportions of international papers and international citations is incongruous with their JCR list rank and impact factor and inconsistent with the finding that journals with a high impact factor always have a high level of internationalization.

[1] http://gb.oversea.cnki.net/Seminar/2017Seminar/en/images/hypdf/fh5/08.pdf ohttp://www.nsfc.gov.cn/publish/portal0/tab440/info69785.html

The mixed findings from different studies on the internationalization of Chinese scholarly journals have several implications. First, the indicators and references that are selected to assess the internationalization efforts of Chinese academic journals may influence the eventual results. For example, Okubo (1999) used a sole indicator, namely, the proportion of international publications, to assess the journals' internationalization, whereas Wang, Wang and Weldon (2007) selected multiple indicators to assess the internationalization efforts of Chinese journals. Additionally, the well-known international journals in Okubo (1999) had no obvious reference; Wang and colleagues used different references but compared them only with one another. Second, even when adopting the same references and observable indices, these studies, particularly Okubo (1999) and Wang, Wang and Weldon (2007), may result in conflicting findings regarding the ongoing internationalization efforts of Chinese scholarly journals. In fact, Wang, Wang and Weldon (2007) also noted this point and argued that the results of Okubo (1999) may be outdated or premature. Third, non-representative samples and small samples are obvious problems that may have contributed to the inconsistent findings. For example, only 18 Chinese physics and chemistry journals were used in Ren and Rousseau (2002); three journals, only one of which was a Chinese journal, were used in He and Liu (2009); and ten Chinese journals were used in Wang, Wang and Weldon (2007). Finally, the internationalization of Chinese scholarly journals may vary according to the journals' disciplinary nature, which is typically illustrated by the significant difference in the number of international journal publications by Chinese scientists in the "hard sciences" compared with the "soft sciences".

As indicated by Wang, Wang and Weldon (2007), the few prior results cannot depict the situation of Chinese journals in more recent years because their findings were early and are not currently representative. The internationalization of Chinese journals reported so far does not accurately represent the current status of China's internationalization because of its rapid development over the past ten years. Chinese government bodies, both national and local, have adopted many cogent measures to support the rapid internationalization of Chinese scholarly journals. For instance, the National Natural Science Foundation of China and the China Association for S & T have granted six million RMB per year to approximately 100 Chinese scientific journals since 2000. Since 2011, the National Social Science Foundation of China has provided 400,000 RMB (plus a flexible fund of 100,000 to 200,000 RMB) per year to each journal for four to five years. With the above measures, the current internationalization of Chinese journals may have improved and may be substantially different from that ten years ago.

This study attempts to fill some of the aforementioned gaps. To do so, the performance and characteristics of the Group of 8 (G8) countries' publications in Chinese scholarly journals from 1979 to 2016 were examined. The G8, an intergovernmental political forum, originated from the G6 in 1975 and was recast as the G7 in 2014 because of Russia's suspension, but it commonly refers to the eight highly industrialized nations of Canada (CAN), France (FRA), Germany (DE-Deutschland), Italy (ITA), Japan (JPN), Russia (RUS), the United Kingdom (UK), and the United States of America (USA). Overall, the current study is a continuation of earlier efforts to characterize the internationalization of Chinese scholarly journals, which will

deepen the understanding of this topic. Unlike previous bibliometric studies in this field that have strongly emphasized revealing the extent of internationalization that selected Chinese journals have attained, the focus here is on using big data regarding the international scientific literature to probe the complex driving forces behind the rapid internationalization of Chinese scholarly journals in recent years.

MATERIALS AND METHOD

Following common practice, the datasets that are used in this study are retrieved from the China Academic Journals (CAJ) Full-text Database, a part of the CNKI. The CNKI is an electronic platform that was launched in June 1999 and has been updated daily since then; it contains several key databases, such as the CAJ, China Core Newspapers Database and China Yearbooks Full-text Database. As the largest Chinese scholarly journal database, the CAJ includes at least 10,903 academic journals in the social sciences, arts and humanities, and science from mainland China and has more than 5,500 customers, including universities, public and corporate libraries, institutions, hospitals, and many foreign organizations, such as the British Library and Cambridge University. Due to its comprehensive coverage of important academic output, the CNKI has been used in a growing number of large-scale bibliometric and/or scientometric analyses in many fields (e.g., Ren and Gong 2012; Scherngell and Hu 2011).

The current study mainly profiles the internationalization of China in academic research, particularly in Chinese scholarly journals, by examining the number of publications in Chinese scholarly journals deriving from the G8 from 1979 to 2016. Based on the CNKI, in June 2017, the corresponding Chinese terms of “France” (法国), “Germany” (德国), “Italy” (意大利), “the United Kingdom” (英国), “Japan” (日本), “the United States” (美国), “Canada” (加拿大), “Russia” (俄罗斯), “the Soviet Union” (苏联), and “the Byelorussian Soviet Socialist Republic” (白俄罗斯)[2] were searched in the country field. All papers from 1979 to 2016 were collected. The number of clean records retrieved was as follows: 56,450 for the USA; 37,034 for Japan; 12,872 for the UK; 11,900 for Germany; 8,224 for Canada; 6,164 for France; 1,728 for Italy; 7,569 for Russia (1992-2016); 3,133 for the Soviet Union (1979-1991); and 186 for the Byelorussian Soviet Socialist Republic (1992-2016). In using the process mentioned above, the number of hits for Russia was found to be 10,516 (1979-2016). Additionally, all the numbers were based on author-reported affiliated countries.

RESULTS

[2] Russia or the Russian Federation (“俄罗斯” or “俄罗斯联邦” in Chinese), as the main legal successor of the Soviet Union after its collapse, partially overlaps with the Byelorussian Soviet Socialist Republic (“白俄罗斯”) in Chinese expressions. Alternative measures were used to estimate the number of Russian articles in Chinese journals. To be specific, the number of papers published in Chinese journals by authors from the Soviet Union from 1979 to 1991 is directly considered as that by Russia, and the precise number of Russian papers since 1992 is obtained by searching “Russia” ***not*** the “Byelorussian Soviet Socialist Republic”’ in the affiliated country field (to exclude papers from the Byelorussian Soviet Socialist Republic published in Chinese journals and to obtain the accurate number of Russian articles published after 1991).

Trend Analyses

The G8 countries produced a total of 144,888 articles published in Chinese journals from 1979 to 2016, and the number of papers published annually increased over the period (see Appendix 1). By identifying each publication's institutional affiliation, each G8 country's academic productivity in terms of the number of Chinese publications can be calculated. The yearly Russian production of Chinese journal articles increased from 47 in 1979 to 505 in 2016 and peaked at 587 in 2014. The Canadian annual output of papers published in Chinese journals rose rapidly from 14 in 1979 to 291 in 2016, with a peak of 456 in 2006. The yearly number of articles from Italy steadily increased from 8 in 1979 to 78 in 2016 and peaked at 112 in 2010. The yearly Japanese production publications grew dramatically from 118 in 1979 to 942 in 2016 and peaked at 1,771 in 2005. The annual number of articles published in Chinese journals increased from 3 to 507 for Germany, from 39 to 639 for the UK, from 23 to 234 for France, and from 169 to 2,221 for the USA from 1979 to 2016. The individual peaks for these countries were 735 in 2005 for Germany, 681 in 2007 for the UK, 379 in 2006 for France, and 2,797 in 2009 for the USA. In the studied period, the USA published the most articles in Chinese journals, far more than any other G8 country. Thus, the USA unsurprisingly leads in the total number of publications in Chinese journals, followed by Japan and the UK, while Canada, France and Italy are the three least productive countries in terms of articles published in Chinese journals (see supplementary data - Appendix 1 and Appendix 2).

Affiliation Analyses

This section mainly explores which institutions are the most productive in each G8 country in terms of publishing articles in Chinese journals. By identifying the number of articles published in Chinese journals by the top 40 institutions in each G8 country, each G8 member's top 10 productive institutions were obtained (Figure 1); these were primarily drawn from the authors' self-reported affiliations in each publication. Moreover, the results show that the most productive institutions for RUS, DE, and JPN, including University of Chinese Academy of Social Sciences (CASS) and Tongji University, are all in China, whereas the top productive institutions in the other five countries are all in their own countries. Figure 1 illustrates that the top ten productive institutions in the UK and Canada (University of Toronto, British Columbia, McGill, Western Ontario, Alberta, Waterloo, York, Calgary, Québec and Ottawa) that publish articles in Chinese journals are in their own countries, followed by Italy, with nine of the top 10 productive institutions being located in Italy. The other G8 countries all include one or more Chinese institutions among their top 10 productive institutions. Among these countries, Russia leads in the number of Chinese institutions in the top 10 productive institutions, with only three native institutions, followed by Japan, which is closely followed by the USA, France and Germany. One obvious feature of the G8 countries' top productive institutions is that they are globally well known; nearly all are world-class universities as identified by the QS World University Rankings and/or Times Higher Education, which suggests that academic internationalization or international collaboration is a key aspect of establishing world-class universities.

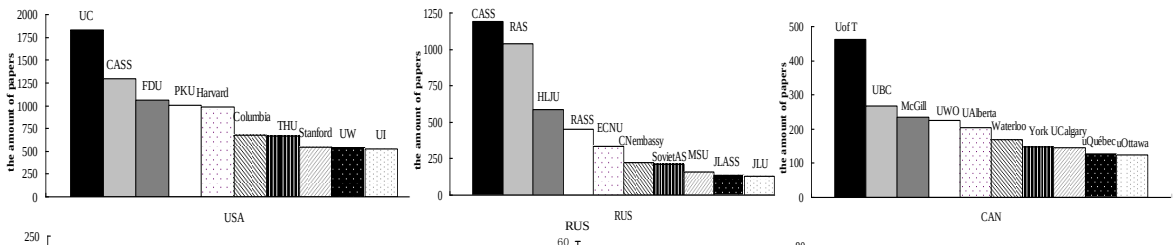

Figure 1: The number of publications published in Chinese journals from each G8 country's 10 leading productive affiliations. The terms "10 leads" and "40 leads" denote the percentage of papers published in Chinese journals by each G8 country's top 10 or 40 affiliations, respectively, out of this country's total in the studied period, while the terms "foreign 10 leads" and "foreign 40 leads" denote the percentage of papers published in Chinese journals by foreign institutions within the top 10 or 40 affiliations, respectively, out of the country's total.

Given the considerable number of domestic Chinese academic institutions, especially Chinese universities, that contributed significantly to the G8's Chinese journal publications in the studied period, an analysis was conducted to characterize the common features of the most productive Chinese institutions for multiple G8 countries. In fact, the most productive Chinese academic organizations are found to collaborate with the different G8 countries. Domestic Chinese affiliations are also reported in these publications, which involve at least one author-reported foreign organization from a G8 country. This implies that these publications are actually the result of collaboration between China and one or multiple G8 countries. Table 1 lists the most productive affiliations between China and at least two G8 countries. By analyzing their common characteristics, some insights into building world-class universities could be obtained, given that most of the collaborating organizations are Chinese universities. Geographically, these Chinese universities are unevenly distributed in different provinces or cities. Five are in Beijing (PKU, THU, BNU, RUC and CAU), four are in Shanghai (FDU, TONGJI, ECNU and SJTU), two are in Tianjin, and the remaining seven universities are in the following seven different cities/provinces: Hangzhou, Zhejiang; Guangzhou, Guangdong; Nanjing, Jiangsu; Wuhan, Hubei; Xi'an, Shanxi; Harbin, Heilongjiang; and Changchun, Jilin. Unsurprisingly, Beijing and Shanghai rank first and second, respectively, among the top Chinese universities. However, Nanjing, Wuhan and Xi'an, all with more high-level universities than Tianjin, all follow Tianjin in the number of collaborations. This finding

is likely because Tianjin has geographical superiority: since it is near Beijing, it can benefit from Beijing's frequent international collaborations or communications.

Table 1: The Most Productive Chinese Affiliations involved in Collaborations with Multiple G8 Countries.

No	Affiliation	USA	FRA	UK	DE	JPN	ITA	CAN	RUS	Total
8	Peking University (PKU)	1006	42	171	140	357	10	102	67	1895
7	Zhejiang University (ZJU)	388	38	102	122	372	11	59	-	1092
7	Tsinghua University (THU)	662	78	178	96	442	30	47	-	1533
7	Beijing Normal University (BNU)	378	34	90	51	-	9	87	75	724
6	Nanjing University (NJU)	389	90	91	84	169	-	73	-	896
6	Renmin University of China (RUC)	458	34	112	90	-	10	-	38	742
5	Xi'an Jiaotong University (XJTU)	-	30	84	-	193	7	60	-	374
5	Fudan University (FDU)	1064	-	94	-	322	-	56	83	1619
4	Sun Yat-sen University (SYSU)	269	31	80	-	-	-	55	-	435
4	Wuhan University (WHU)	301	62	-	-	-	8	58	-	429
4	Nankai University (NKU)	288	-	-	-	612	-	54	28	982
4	Tongji University (TONGJI)	-	90	-	414	310	18	-	-	832
3	East China Normal University (ECNU)	259	36	-	-	-	-	-	335	630
3	Shanghai Jiao Tong University (SJTU)	357	32	-	-	300	-	-	-	689
3	University of Chinese Academy of Social Sciences (CASS)	1294	-	-	-	1260	-	-	1335	3889
3	Harbin Institute of Technology (HIT)	-	-	69	55	-	-	-	57	181
3	China Agricultural University (CAU)	-	-	-	61	257	8	-	-	326
3	Jilin University (JLU)	-	-	-	-	550	8	-	131	689
2	Tianjin University (TJU)	-	-	-	-	-	7	50	-	57
5	CNembassy (Chinese Embassy)	-	87	179	241	-	10	-	222	739

Interestingly, these results reveal that the Chinese embassies (CNembassy) in the UK, France, and Germany, as non-academic institutions, have also published many academic articles in Chinese scholarly journals, which suggests that their roles in international academic collaboration should not be ignored. Additionally, CASS, the giant in Chinese philosophy and social science research, is a high-level research institute that was organized directly by the Chinese State Council and has close associations with local academies of the social sciences in each province, autonomous region, and city in China. Importantly, CASS has more than 90 research centers and one graduate school and has established specialized academic research organizations that focus on G8 countries, such as the "Institute of American Studies", the "Institute of Russian, Eastern European & Central Asian Studies" and the "Institute of Japanese Studies". For these reasons, CASS is an important institute that simultaneously collaborates with multiple G8 countries and has published many internationally co-authored Chinese papers. In fact, Figure 1 reports that the high position of CASS among the most productive institutions in the USA, Russia and Japan may be due to the three institutes that specialize in American, Russian and Eastern European, and Japanese studies.

Research Foci

To identify the G8 countries' research interests or foci in Chinese publications, a co-word analysis was employed as a content analysis technique that can effectively map the strength of the associations among textual information items. The top 40 most frequent keywords that were distributed in the G8 countries' Chinese-journal publications were extracted. Table 2 shows these co-occurring keywords for at least two countries. The results show that the most common interests in multiple G8 countries' Chinese-journal publications are "China", "landscape architecture", "application", "development", "numerical simulation", "globalization", "rats", "gene expression", "climate change", "sustainable development", "higher education", "gene", "influence factor", "research", "model", "European Union", and "Europe". Among these terms, "influence factor" and "research" seem to be insifnificant because they are often used in Chinese papers to reflect the surface characteristics of a study. The other terms that reflect the common topics for four or more countries can be classified into three categories. The first category includes words regarding international issues, such as "globalization", "climate change", "development", "higher education" and "sustainable development". The second category contains high-frequency terms that are inevitable in the G8 countries' publications, namely, "China", "European Union", and "Europe", because all the listed papers were published in Chinese journals, and five G8 members are located in Europe. The third category involves popular or common terms that usually appear in modern academic research (research objects or methods), including "rats", "gene", "numerical simulation", "model", and "landscape architecture".

This study also finds that the term that appears the most frequently is "China", which has the highest frequency in all the G8 countries except Russia. Two other words with the highest frequency are "landscape architecture" and "application". Surprisingly, the term "America" is the most frequent word except for "China" in publications from the USA, Canada and Russia. Generally, co-word frequency is utilized to assess the strength of the relationships among all co-occurring items, and their clustering is viewed as a brief illustration of the research themes. The high frequency of "America" is likely because the USA exerts broad influence than Russia and Canada in terms of geographical relationships and international image. The remaining co-occurring words include "apoptosis" (92, 2)[3], "culture" (91, 3), "children" (87, 2), "financial crisis" (76, 2), "cancer" (68, 2), "inspiration" (66, 3), "education" (64, 3), "innovation" (62, 3), "Marx" (62, 2), "review" (60, 2), "stability" (53, 3), "structure" (53, 3), "effect" (53, 2), "neural network" (46, 2), "output" (44, 2), "mechanical property" (38, 2), "design" (32, 3), "rock mechanics" (31, 2), "technology" (28, 2), "mathematical model" (28, 2), and "soil" (20, 2). Among these words, "culture", "children", "financial crisis", "education", "innovation", "Marx" and "technology" mainly represent international hotspots or social issues, and "apoptosis", "cancer", "neural network", "mechanical property", "rock mechanics", "mathematical model", and "soil" are often used in the sciences to reflect scientific advances and innovations. The remaining words, such as "inspiration" and "effect", are general expressions describing scientific results and findings.

[3] The 1st and 2nd numbers in parentheses denote the total frequencies and the number of involved countries, respectively.

Table 2: High-frequency (>100) Words Occurring in Multiple G8 Countries' Publications in Chinese Journals.

No	Terms	USA	FRA	UK	DE	JPN	ITA	CAN	RUS	Total
7	landscape architecture	96	14	56	21	89	5	9	-	290
7	application	107	6	12	38	37	3	12	-	215
7	China	327	16	63	44	161	-	39	203	853
6	development	62	7	17	23	-	3	-	18	130
5	gene expression	80	18	11	15	40	-	-	-	164
5	numerical simulation	86	13	15	-	72	-	21	-	207
5	climate change	70	7	14	-	-	-	11	1	103
5	rats	129	-	12	13	132	-	20	-	306
5	globalization	166	-	24	19	-	5	13	-	227
4	influence factor	81	7	12	-	-	-	13	-	113
4	sustainable development	58	8	26	-	-	-	9	-	101
4	gene	133	8		-	59	-	14	-	214
4	higher education	65	-	17	-	27	-	9	-	118
4	research	40	-	22	-	39	-	16	-	117
4	model	57	-	-	14	37	-	10	-	118
4	European union	-	8	11	41	-	-	-	44	104
4	Europe	-	8	11	20	-	4	-	-	43
3	USA	701	-	-	-	-	-	13	52	766
3	economic growth	59	-	24	-	-	-	-	19	102
3	diabetes	52	-	-	-	39	-	-	-	104
2	mice	96	-	-	-	72	-	-	-	168
2	rice	-	11	-	-	124	-	-	-	135
2	apoptosis (cell)	71	-	-	-	41	-	-	-	112
2	immunohistochemistry	-	-	-	21	81	-	-	-	102

To investigate each country's distinctive research interests in the articles that appear in Chinese journals, the top five most frequent terms were listed[4]. As Table 3 shows, the most frequently appearing terms (highlighted in bold) for each G8 country, except the USA, are all countries' own names, which indicates that their domestic affairs are the most typical descriptions that manifest the countries' distinctive characteristics. Briefly, aside from the words that describe each G8 country's name (e.g., "Germany"), political leader or relationship (e.g., "Putin", "American diplomacy", and "Puppet Manchuria"), historic features (e.g., "Puppet Manchuria"), geographic features (e.g., "Roman law" and "Central Asia"), or relationship with China (e.g., "Sino-Russia relations"), most words reflect each country's influential or priority research fields or fronts, for example, biology or life science research in the USA, city design and municipal engineering in the UK, and automation and mechanical engineering in Canada.

[4] Only the top five terms for each G8 country are listed, and terms that appear fewer than 11 times are not provided.

Table 3: High-frequency Terms Reflecting Each G8 Country's Distinctive Research Foci

terms	times	origin	terms	times	origin	terms	times	origin
Sino-US relations	**202**	**USA**	**Russia**	**1055**	**RUS**	**Canada**	**118**	**CAN**
Tumor	78	USA	Sino-Russia relations	80	RUS	Automation	20	CAN
American diplomacy	77	USA	Central Asia	78	RUS	Black soil	14	CAN
AIDS	57	USA	Putin	71	RUS	Fluidized bed	14	CAN
Receptors	43	USA	Soviet Union	67	RUS	Reliability	13	CAN
Nitric oxide	43	USA	**Japan**	**963**	**JPN**	**Germany**	**266**	**DE**
UK	**92**	**UK**	Sino-Japan relations	149	JPN	Performance	55	DE
Power systems	29	UK	Chemical composition	44	JPN	Dyeing	38	DE
City design	19	UK	Puppet Manchuria	43	JPN	Craft	34	DE
Electricity market	18	UK	Japanese economy	41	JPN	Nonwoven	22	DE
Countermeasure	17	UK	**France**	**95**	**FRA**	**Italy**	**23**	**ITA**
Corporate governance	17	UK	Trichinella spiralis	26	FRA	Roman law	11	ITA

In addition, to identify the scholarly journals common to or shared by at least two G8 countries, the top 40 Chinese journals in which most of each G8 country's papers are published were retrieved. The results show that most journals include words such as "world", "global", "international" or "foreign" in the journal titles. Additionally, "Mineral Engineering", "World Education Information" and "Global Law Review" were the most common academic journals in seven G8 countries, which implies that no Chinese scientific journal is commonly used by all G8 countries to publish scientific articles. By convention, each journal has its own characteristics and relatively fixed research scope or field, which suggests that academic papers that are published in the same journal by different countries may involve similar research interests or topics and are at least similar in scope or field. From this perspective, the co-journal analyses of the G8's Chinese-journal publications likely reflect, at least to some extent, the eight countries' common research interests or topics. Additionally, this study conducted an analysis of the top 10 Chinese journals for each G8 country. Appendix 2 shows that the majority of most G8 countries' top 10 Chinese journals are used in at least two G8 countries.

DISCUSSION

China has achieved tremendous progress in many research fields. For example, the country has a rapidly increasing economy, and its total production of international publications has grown to the second largest in the world in recent years. Previous studies that have adopted the recently questioned "inside-out" approach by introducing bibliometric analyses of Chinese academic performance in international journal publications may establish a critical misunderstanding of the international impact of China in academic research and international collaboration due to biased research results. By contrast, the current study follows the "outside-in" approach and identifies the global impact of China in scientific

research, especially with respect to the internationalization of Chinese academic journals, by investigating the G8's publication performance in Chinese journals.

The current study observed that the growth rates of G8 countries' publications in Chinese journals sharply increased in the S&T innovation promotion and indigenous innovation enhancement phases and then slowed in the collaborative and mass innovation phase. This study speculates that the slight decline in the growth rate in the last stage can be accounted for, at least partially, by recent transformations in Chinese scientific research and an increased emphasis on the application of existing innovative achievements and technologies. This decline is also partly explained by the growing number of international publications (co-authored with foreign scholars), which is considered to have a reverse association with the output of domestic papers. This reverse association is because many Chinese articles that are identified as G8 works are actually contributed by Chinese researchers studying abroad (which involves one foreign and one domestic affiliation simultaneously) or are due to collaborations with foreign scholars (i.e., internationally co-authored). Most G8 countries reached a peak in the number of Chinese publications between 2005 and 2016, especially between 2005 and 2010, which indicates that the internationalization of Chinese journals rapidly grew in this period, particularly in the indigenous innovation enhancement phase.

The USA, Japan and the UK are the three most productive countries in terms of publishing articles in Chinese journals. By contrast, Canada, France and Italy all fell behind Germany and Russia and represent the three countries that published the fewest papers in Chinese journals. In other words, Chinese scholarly journals may have higher international visibility in the USA, Japan, the UK, Germany and Russia than in Canada, France and Italy. Intuitively, we believe that the language that is used in published papers is an important factor that influences each G8 country's Chinese-journal publications. The USA is the largest country from which Chinese scientists' collaborators originate, followed by Japan and the UK (Zou and Laubichler 2017; Wang 2016). Accordingly, the USA, with the strongest global capability in scientific research, could contribute the most internationally co-authored (with Chinese collaborators) papers to Chinese academic journals and likely has more opportunities to be invited to publish articles in Chinese journals. The UK has language superiority over Germany, Russia and Italy because English is a universal language that many Chinese researchers speak, whereas knowledge of German, Russian or Italian is less common; this commonality results in more international collaborations or academic exchanges, both private and public, between the UK and China. As geographical neighbors of China, it seems reasonable that Japan and Russia would have equivalent production rates in terms of Chinese publications. However, Japan exceeds Russia in the number of published articles, which is likely because Japan has advantages in language (the Japanese language has many similarities to Chinese) and research investment (King 2004; Bordons et al. 2015).

The affiliation analyses indicate that most of the top productive institutions are well known globally, and nearly all the universities from G8 countries are world-class universities, as identified by multiple university rankings, which implies that internationalized universities play a critical role in the internationalization of Chinese academic journals. This idea is

further supported by the fact that some important Chinese universities are listed among the G8's top productive affiliations. Crucially, these Chinese universities (except CASS and CNembassy) are universities in China's 985 project and recently became A-class world-class universities (from Chinese Double First-Class Universities). In fact, these findings also clarify the development of world-class universities, which suggests that extensive international collaboration should be inherent in the concept of world-class universities. Only one university is highly internationalized, a fundamental qualification to become a world-class university. Therefore, internationalization is one essential precondition to become a world-class university. Naturally, many methods can lead to internationalization, but the study results do not indicate whether a world-class university could be internationalized because the results reveal only that collaboration with foreign/international researchers from many countries is possible. Following this point, it is speculated that a large volume of international journal papers may not be essential to becoming a world-class university, and a more important factor behind building world-class universities is the widest possible academic collaboration in publications regardless of the nature of the journals published in (either domestic/Chinese or foreign/English). Consistent with the present findings, Willis (2006) believes that Chinese universities that are allied with foreign universities could benefit by introducing or co-developing new or additional courses and programs, increasing and elevating their (international) image, status and competitive position and internationalizing themselves to be a part of the global academic community. Similarly, by examining the internalization challenges and experiences of Japan's top universities, Yonezawa and Shimmi (2015) emphasize the key role of internationalization in constructing top-tier universities and argue that universities that pursue a world-class status should strive to strengthen their internationalization efforts. Nevertheless, whether in-depth collaboration with foreign universities in publishing co-authored papers or all-around internationalization is necessary to build world-class universities deserves exploration.

In addition, the research foci analyses reveal that the G8 countries' common and unique research foci can be categorized into three classes. The core features of these common research foci mainly involve international relationships or global issues, life/biological science research, and numerical simulations and computer modeling. Similarly, further analysis of each G8 country's distinct research foci shows that they mainly involve cultural and historical studies germane to the country itself, research on each G8 country's international relationship with China, and some natural science issues (e.g., life sciences/medicine, management science, and municipal engineering). These findings suggest that the internationalization of Chinese academic journals should focus on international or global issues, foreign cultures, history and politics (or international relationships), and some leading or priority natural science fields, including the life sciences (medicine), computer science, management science and certain emerging engineering fields. In support of the findings reported here, Wang, Wang and Weldon (2007) also qualitatively discussed the influence of journal titles on manuscript submission and argued that localized journal titles may limit a journal's international impact by causing foreign scholars to view these journals as non-international and open only to certain specialized topics, cultures and even nations.

CONCLUSIONS

In conclusion, by analyzing G8 countries' publication performance in Chinese scholarly journals from 1979 to 2016, this research reveals that Chinese journals' internationalization has been continuously growing since 1979 and experienced a period of rapid increase from 2004 to 2010. Both foreign scholars' submissions and internationally co-authored Chinese publications play crucial roles in facilitating the internationalization of Chinese scientific journals, which is also greatly influenced by the scope, titles and disciplinary categories of Chinese journals. Moreover, the results suggest that international collaboration or internationally co-authored publications, regardless of whether they are in English, are a key aspect of world-class universities. However, this study has some limitations. First, this study examined only the G8 countries' publication performance in Chinese scholarly journals, which accounts for only a part of all papers published in Chinese journals by international researchers. In addition to the G8 countries, many other countries have institutions that publish papers in Chinese journals, either alone or in collaboration with Chinese institutions. Second, an elaborate differentiation of the papers published in Chinese journals by each G8 country or of the collaborations with China of each G8 country was not conducted. Third, these publications in Chinese scholarly journals are primarily limited to the articles that were published in mainland China, and few Chinese scientific publications include papers from Taiwan or Hong Kong. Nevertheless, due to the earlier and greater internationalization of Chinese journals in Taiwan and Hong Kong, it is believed that their levels of journal internationalization do not diminish the observed internationalization level.

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APPENDIX

Supplementary data

The top 10 of the 40 academic institutions that published papers in Chinese journals for RUS, CAN, ITA, JPN, DE, the UK, FRA, and the USA account for 42.39% (55.91%), 25.63% (50.96%), 20.20% (39.29%), 20.54% (44.37%), 16.08% (35.44%), 24.06% (48.35%), 17.12% (34.93%), and 16.18% (34.95%), respectively, of their own total production of Chinese publications from 1979 to 2016. The values in parentheses are the number of papers that were published in Chinese journals by each G8 country's top 40 institutions. Within the top 10 productive institutions, some are domestic, and others are located in a G8 country. The corresponding numbers of foreign institutions in the above G8 countries' top 10 (40) affiliations are 3 (14) for RUS, 10 (27) for CAN, 9 (22) for ITA, 5 (20) for JPN, 6 (24) for DE, 10 (27) for the UK, 6 (24) for FRA and 6 (27) for the USA. The values and percentages in parentheses denote the (accounting) values of foreign institutions within the top 40 institutions. The values that actually account for the total of all foreign affiliations within the top 10 (40) institutions are 13.37% (17.70%) for RUS, 25.63% (41.14%) for CAN, 18.46% (27.95%) for ITA, 11.01% (22.95%) for JPN, 8.37% (20.76%) for DE, 24.06% (37.27%) for the UK, 11.52% (22.05%) for FRA and 9.05% (22.35%) for the USA.

Appendix 1: The Number of Papers the G8 Published in Chinese Scholarly Journals from 1979 to 2016.

Year	RUS	CAN	ITA	JPN	DE	UK	FRA	USA
2016	505	291	78	942	507	639	234	2221
2015	532	334	82	993	525	616	289	2382
2014	587	302	66	1071	499	674	254	2410
2013	488	302	67	1016	445	652	236	2392
2012	494	296	61	1116	407	567	258	2399
2011	444	300	77	1157	455	546	229	2411
2010	363	320	112	1276	526	592	256	2701
2009	360	349	75	1300	539	626	294	2797
2008	324	323	73	1515	560	665	299	2662
2007	318	426	99	1654	669	681	294	2685
2006	356	456	80	1640	704	663	379	2749
2005	327	432	66	1771	735	665	299	2726
2004	341	347	69	1708	649	606	278	2459
2003	331	354	72	1677	543	436	301	2127
2002	282	294	64	1552	527	354	252	1888
2001	193	268	48	1574	448	304	218	1699
2000	168	254	38	1389	390	240	154	1479
1999	131	216	34	1273	401	228	144	1300
1998	127	186	43	1301	382	237	140	1257
1997	113	136	37	1115	321	236	126	1068
1996	122	140	29	1011	223	210	108	882
1995	120	131	19	969	197	159	72	844
1994	151	155	23	865	145	146	70	807
1993	168	171	37	809	204	232	103	868
1992	38	169	28	726	180	194	74	819
1991	298	167	30	685	117	169	75	775
1990	299	138	31	590	107	150	81	811
1989	334	136	33	629	106	168	84	840
1988	277	130	23	509	88	159	62	929
1987	402	135	28	480	83	181	78	845
1986	388	106	20	557	72	179	69	824
1985	330	97	16	498	64	139	70	700
1984	225	108	23	389	36	140	54	689
1983	179	77	11	347	20	137	75	652
1982	181	78	14	372	10	109	60	499
1981	102	47	8	253	5	64	42	370
1980	71	39	6	187	8	70	30	315
1979	47	14	8	118	3	39	23	169
Total	10516	8224	1728	37034	11900	12872	6164	56450

Appendix 2: The Top 10 Journals in Which Each G8 Country Published the Most Chinese Papers.

Journal source	times	Journal source	times	Journal source	times
USA		Germany		Canada	
mineral engineering	712	international textile herald	598	mineral engineering	433
foreign livestock (pigs & birds)	651	Germany studies	215	work & study abroad	93
smart building & intelligent city	412	world education information	155	foreign livestock (pigs & birds)	68
international economic review	385	mineral engineering	92	mining technology	65
American studies	371	industrial engineering & management	82	urban planning	42
diabetes world (clinical)	265	modern manufacturing	76	China pulp & paper	42
infrared	244	forum on Chinese-German law	49	international urban planning	36
world knowledge	207	comparative law research	45	South Reviews	35
world pesticides	205	journal of HUST (medicine)	45	human environment magazine	34
advanced display	201	foreign livestock (pigs & birds)	44	international social sciences	32
France		Japan		Russia	
international social sciences	83	Japanese Studies	647	mineral engineering	1255
mineral engineering	49	Japanology	643	Eurasian economy	406
world building guide	46	world pesticides	361	Siberian Studies	353
world sci-tech research & development	44	contemporary economy of Japan	278	mining technology	337
world education information	39	studies of foreign problems	206	coal technology	233
West China stomatology journal	39	research on Japan issues	194	Russia, East Europe & East Asia	232
contemporary foreign literature	38	mineral engineering	178	Russian journal	231
Diogenēs	37	Japanese learning and study	164	world education information	217
foreign livestock (pigs & birds)	32	foreign language in northeast Asia	158	Russian Studies	169
Sino-overseas grapevine & wine	31	infrared	140	global law review	100
UK		Italy			
mineral engineering	361	architectural creation	19		
foreign livestock (pigs & birds)	179	Stone	18		
world education information	154	international textile herald	18		
world pesticides	95	creativity and design	17		
international urban planning	81	China leather	13		
power system & automation	69	world movie	11		
global law review	57	modern manufacturing	11		
world architecture	51	comparative law research	10		
foreign theoretical trends	50	world art/door & window	10		
mining technology	48	Chinese journal of general surgery	10		

Note: The underlined journal sources are unique to the G8 country.