International Collaboration Networks of Chinese Scientometrics

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Abstract

In the present study, we try to identify the structure of scientific collaboration networks in scientometrics by using bibliographic data of all papers published by Chinese scientometricians in the international journal *Scientometrics* retrieved from the Science Citation Index (SCI) of the years 1978-2007. The study is based on bibliographic data retrieved from the Web of Science. The data contains all types of documents published by Chinese scientometricians in *Scientometrics* during 1978 to 2007.Combined analysis of social network analysis (SNA), co-occurrence analysis, is explored to reveal: (1) The structure of the international collaboration network of Chinese scientometrics; (2) The major collaborative fields of the whole network and of different collaborative sub-networks; (3) The collaborative center of the collaboration network in Chinese scientometrics.

1 Introduction

In the field of scientometrics and informetrics many studies on international cooperation have been devoted into collaboration patterns and relationships between organizations, institutions and scientists aspects (Beaver & Rosen, 1978, 1979a, 1979b; Dutt, Garg, & Bali, 2003; Glanzel, 2002; Kretschmer, 2004; Kretschmer & Aguillo, 2004; Newman, 2004; Price, 1986; Schubert, 2002). Using social network analysis, we constructed actual collaboration networks between scientometricians at micro level to reveal the structure of collaboration network in the field of scientometrics (Hou, Kretschmer, & Liu, 2008). In the present study, we try to identify the structure of scientific collaboration networks in scientometrics by using bibliographic data of all papers published by Chinese scientometricians in the international journal *Scientometrics.*

Scientometric research is an international scientific cause; for this reason, Chinese scholars have established cooperative relationships with international scholarly circles since the early time and are still in well communication with celebrated foreign scholars such as E Garfield, T Braun, H Egghe and R Rousseau. Chinese scholars have attended the International Colloquium on Bibliometrics, Scientometrics and Informetrics since the first time, which is held every two years; Beijing itself hosted the 9th International Conference on Scientometrics and Informetrics in 2003; National Colloquium on Scientometrics has also been successfully held every two years for three times, which attracted numerous foreign delegates to exchange ideas.

Chinese scholars has cooperated with scientometricians from countries such as US, Germany, Belgium, India and Australia, resulting in a international collaboration network with Liang Liming being its core figure. International cooperation and exchanges have

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greatly promoted the development and maturity of scientometrics research in China.

Chinese scholars have published 95 English papers in international journal Scientometrics since Zhao Hongzhou published his first scientometrics paper in the journal in 1984.

All together 106 Chinese scholars (including scholars from Hong Kong and Taiwan) published 95 papers, 4 papers per year in average in Scientometrics in period 1984-2007, which takes up 4.11% of the total 2309 papers(see Table 1). These figures show that Chinese scholars play an important role, which cannot be neglected. Among these authors, 79 were from mainland China who produced 71 papers within 24 years--3 papers per year on average, including 20 internationally collaborated papers involving 12 foreign collaborators; 27 were from Taiwan province that produced 23 papers, including one paper whose coauthors included an American; one from Hong Kong who independently published a paper.

Table 1: Statistics of papers by Chinese scholars，1984-2007

Period	*1984-1995*	*1996-2007*	*1984-2007*
Number of papers	12	83	95
Papers/year	1	7	4
Internationally collaborated papers	3	18	21
Papers from mainland China	11	60	71
Internationally collaborated Papers from mainland China	3	17	20

2 Method

In the present study we adopte an integrated procedure of author co-citation analysis, pathfinder network scaling(White, 2003), social network analysis (SNA), co-occurrence analysis and frequency analysis of topic terms (Braam, Moed, & van Raan, 1991). Citespace Ⅱ is designed as a tool for visualizing bibliographic data, which is a free online-software published by Chaomei Chen (Chen, 2006). In the present study, Citespace Ⅱ is used to show the structure of research group networks in the field of enterprise risk management.

3 Data

The study is based on bibliographic data retrieved from the Web of Science. The data contains all types of documents published by Chinese scientometricians in Scientometrics between 1978 and 2007. The data of each document includes author names, title, abstract, date, document type, addresses, and cited references. Author names were standardized because some authors may report their names differently in different papers. We identified each author by his or her surname and first initial only. The retrieval was finally updated on Jan 25, 2008.

4 Results

4.1 International collaboration on scientometric research in China (1984-1995)

In the network of period 1984-1995, there are 56 links between the 19 authors (including 13 mainland authors, 5 foreign collaborators and one author from Taiwan province)（Table 2）and 19 topical words extracted from titles and keywords of articles, all of which are presented as 38 nodes（see Figure. 1）. A circle signifies an author; a triangle a topical word. The size of a node is in proportion to the production of papers or the frequency the occurrence of topical words. The color of a link indicates the year of first collaboration between two authors or the year

when the author used that topical word for the first time.

During 1984-1995,Chinese authors published 12 papers, including 11 from the mainland and one from Taiwan province, one paper per year on average. 3 papers were coauthored by Chinese and foreign scholars. Zhao HZ produced 3 articles; Jiang GH published 2 articles; others produced 1 article each.

Table 2 19 Chinese authors and their foreign collaborators (1984-1995)

Author	*Institution*	*Production*	*Centrality*	*Year of first publication*
ZHAO HZ	INST PHYS, Chinese Academy of Sciences	3	0.01	1984
JIANG GH	National Institute of Educational Research of China	2	0	1985
JIN XY	Chinese Acad Sci, Documentat & Informat Ctr	1	0	1988
PORTER AL	GEORGIA INST TECHNOL	1	0	1988
CHUBIN DE	GEORGIA INST TECHNOL	1	0	1988
HAN HC	Engineering Mechanics Dep. ,Xi'an Jiaotong Univ	1	0	1989
MIAO QH	INST SCI & TECH INFORMAT SHANGHAI	1	0	1990
ZHANG ZZ	INST SCI & TECH INFORMAT SHANGHAI	1	0	1990
ZHU J	CHINESE ACAD SCI,SHANGHAI INST NUCL RES	1	0	1991
MEADOWS AJ	LOUGHBOROUGH LE11 3TU,LEICS,ENGLAND	1	0	1991
MASON G	LOUGHBOROUGH LE11 3TU,LEICS,ENGLAND	1	0	1991
ZHANG QQ	CHINA NATL RICE RES INST	1	0	1992
ROUSSEAU R	KHBO, BELGIUM	1	0	1992
LIMING L	Henan Normal Univ, Inst Sci Technol & Soc	1	0	1993
LIHUA L	BEIJING INST MAT	1	0	1993
ZHANG HQ	NATL INST CONTROL PHARMACEUT & BIOL PROD	1	0	1994
SHU SH	INST SCI & TECH INFORMAT SHANGHAI	1	0	1995
LIU JM	CHINESE ACAD SCI,SHANGHAI ASTRON OBSERV	1	0	1995
TSAY MY	Tamkang Univ, Dept Informat & Lib Sci Taiwan	1	0	1995

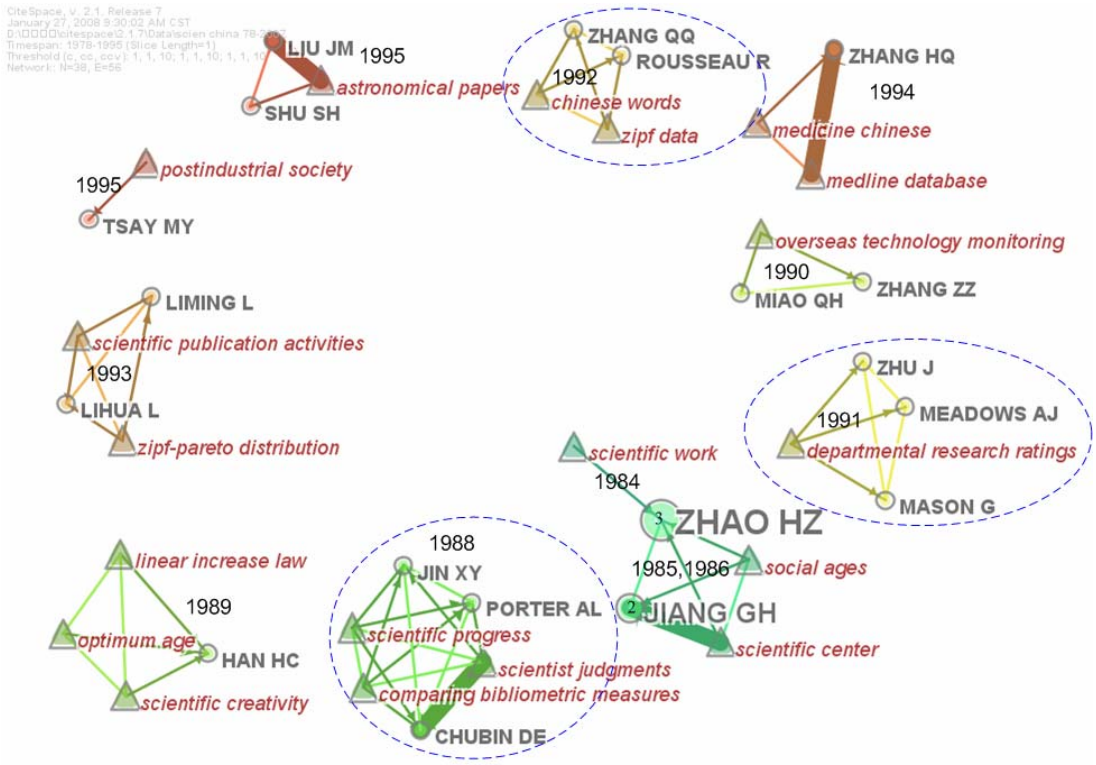

Figure 1: Collaboration Networks of 14 Chinese authors (1984-1995)

There are 2 single-authored paper as well as 8 isolated sub-networks. There are 3 sub-networks of collaboration between Chinese and foreign authors, which are circled in Figure 1. These sub-networks in the 1984-1995 period are separated without any links, which shows that there was no collaboration between the sub-networks. The Chinese authors in the 3 sub-networks of international collaboration are JIN XY, ZHU J, and ZHANG QQ, who have not, however, published any paper in *Scientometrics* since 1996.

The earliest paper by Chinese published in Scientometrics is ZHAO HZ's 1984 paper "AN INTELLIGENCE CONSTANT OF SCIENTIFIC WORK", which was single-authored without national or international collaboration. In 1985 and 1986 ZHAO HZ and JIANG GH successively coauthored two articles on shifting of world's scientific center, the age of scientists, and life-span and precocity of scientists. From 1984 to 1986, Chinese scholars began publishing papers in Scientometrics, though there were only two authors without international cooperation.

In 1988， JIN XY, PORTER AL, and CHUBIN DE coauthored "CITATIONS AND SCIENTIFIC PROGRESS--COMPARING BIBLIOMETRIC MEASURES WITH SCIENTIST JUDGMENTS", resulting in the first scientometric article of international collaboration between Chinese and foreign scholars.

In 1991， Zhu J collaborated with MEADOWS AJ and MASON G on the paper "CITATIONS AND DEPARTMENTAL RESEARCH RATINGS"，in which they ranked by using citation data the chemistry departments of two British universities in order of research ability, and compared the results with those of peer reviews.

In 1992， Zhang QQ, department of S&T information) and ROUSSEAU R collaborated on the article "ZIPF DATA ON THE

FREQUENCY OF CHINESE WORDS REVISITED". They employed Zipf data in studying the frequency of Chinese words in order to measure the core of frequently used Chinese words.

Between 1993 and 1995，Chinese scholars published 4 papers in *Scientometrics* one of which was the first paper authored by a Taiwanese scholar. None of the 4 papers were from international collaboration and the paper by Taiwanese CAI YM was single-authored.

Of these 14 Chinese authors who continued publishing articles in *Scientometrics* after 1996 are LIANG LM, ZHANG HQ, ZHAO HZ, JIANG GH, and CAI MY. LIANG LM and CAI MY became more active compared with the other authors. An international scientific collaboration network of which LIANG LM was the core figure was formed. CAI MY published 5 papers which were all collaborated on with scholars from Taiwan province.

4.2 International collaboration on scientometric research in China (1996-2007)

In period 1996-2007, the network formed by 127 authors contains 763 links and 280 nodes (including 153 topical words extracted from titles and keywords) (see Figure. 2). There are 27 sub-networks, of which 8 are connected by topical words, indicating the emergence of common research subjects and/or the same studied object and method for different scientometric sub-networks in China, e.g. Chinese scientific journals, Chinese publications, developing English-language academic journals, molecular biology, basic research, impact factor, bibliometric analysis.

Among the 27 sub-networks, there are 4 isolated international collaboration networks, which are circled by dotted line in the graph. Of the 4 international collaboration networks, 3 are mainland author-involved and 1 Taiwanese author-involved.

In this period, Chinese authors published 83 papers, of which 60 were from the mainland, 22 from Taiwan, and 1 from Hong Kong; 7 papers were published per year on average. There were 18 internationally coauthored papers, of which 17 are mainland author-involved and one Taiwanese author-involved. Since 1996, a great increase had been seen in the total number of publications, number of annual publications on average, and number of internationally coauthored papers. Mainland authors were the main contributors in terms of number of publications and number of internationally coauthored papers; 27 Taiwanese authors had published 23 papers within 13 years (1.77 papers annually on average) since their first publication in *Scientometrics* in 1995, but they coauthorships had mainly been confined in one single institute in one district thus lacking cooperation with mainland authors and foreign scholars. There was only one scientometric paper from Hong Kong, which was published in 1998 without collaboration with mainland or foreign authors (Table 3).

During 1996 and 2007, Chinese scientometricians greatly strengthened their cooperation with foreign fellow researchers, resulting in the international collaboration network of which LIANG LM is at the hub (Figure3). The largest international collaboration group was comprised of 33 collaborators who were from China, Germany, Belgium, Holland, Australia, America, and India etc.

The topical words appeared in the largest international collaboration network show that the focus of research group represented by LIANG LM was Chinese scientific research system whose word frequency is 10, and which included research subjects such as Chinese publications, journals, Chinese Science Citation Index(CSCI), computer science, scientometric indicators, research situation of Chinese universities and the visibility of Chinese research system in the world; that the second largest research field is scientific collaboration whose word frequency is 8, and which included detailed research subjects such as coauthorship network, collaboration model, foundation of a global interdisciplinary research network (COLLNET)(whose virtual centre is Berlin), age structure of collaboration. Webometric research is the Kretchmers's main research field, including web hyperlinks and web visibility etc.; h-index research can be found in the article "h-index sequence and h-index matrix: Constructions and applications", in which LIANG LM put forword and explained the h-index sequence and h-index matrix; citation analysis research can be found in "Lattices in

citation networks: An investigation into the structure of citation graphs" which studied citation Gestalt by means of citation graphs.

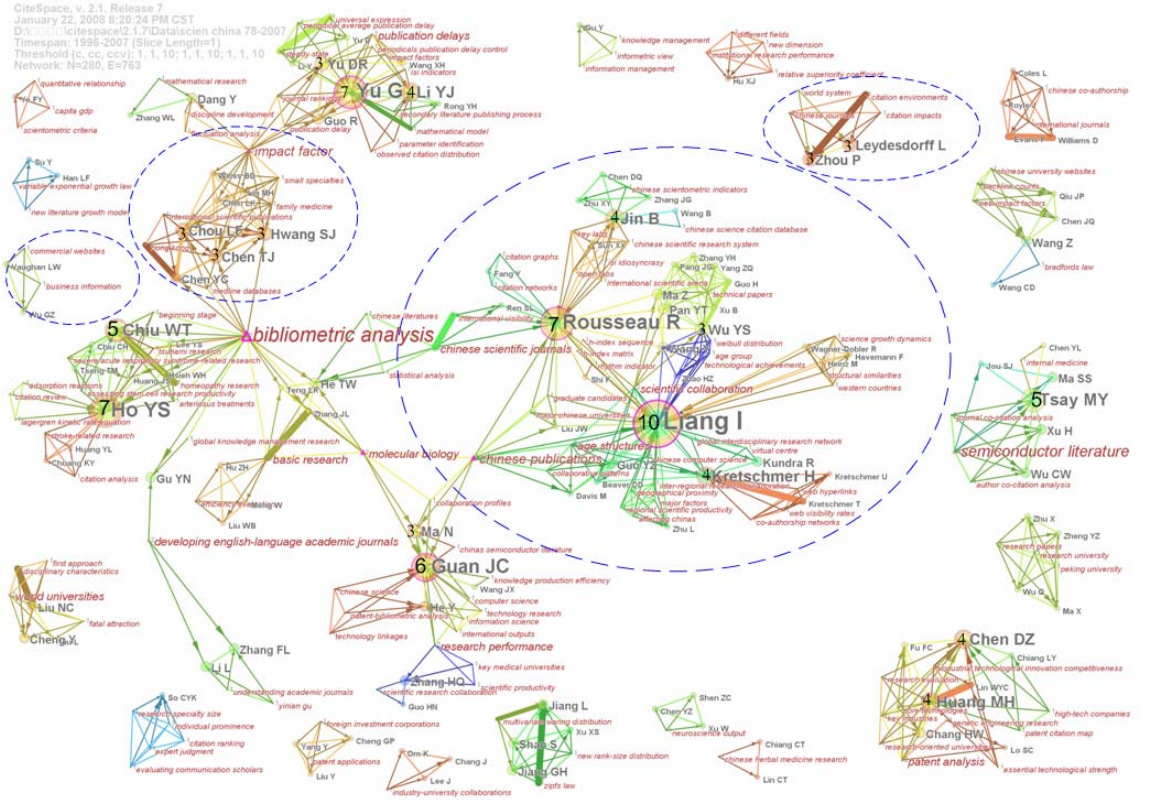

Figure 2: International collaboration network of Chinese authors (1996-2007)

Table 3 Chinese authors who had 3 or more publications and their foreign collaborators (1996-2007)

Author	*No. of papers*	*centrality*	*publication year of the author's first paper in Scientometrics since 1996*
Liang l	10	0.2	1996
Rousseau R	7	0.2	2001
Yu G	7	0.1	2003
Ho YS	7	0.07	2003
Guan JC	6	0.11	2004
Chiu WT	5	0.01	2003
Tsay MY	5	0	2000
Jin B	4	0.05	1999
Kretschmer H	4	0.04	2001
Li YJ	4	0	2003
Huang MH	4	0	2003

Chen DZ	4	0	2003
Hwang SJ	3	0.08	2006
Chou LF	3	0.08	2006
Chen TJ	3	0.08	2006
Wu YS	3	0.03	1996
Ma N	3	0.03	2004
Yu DR	3	0.02	2005
Zhou P	3	0	2005
Leydesdorff L	3	0	2005

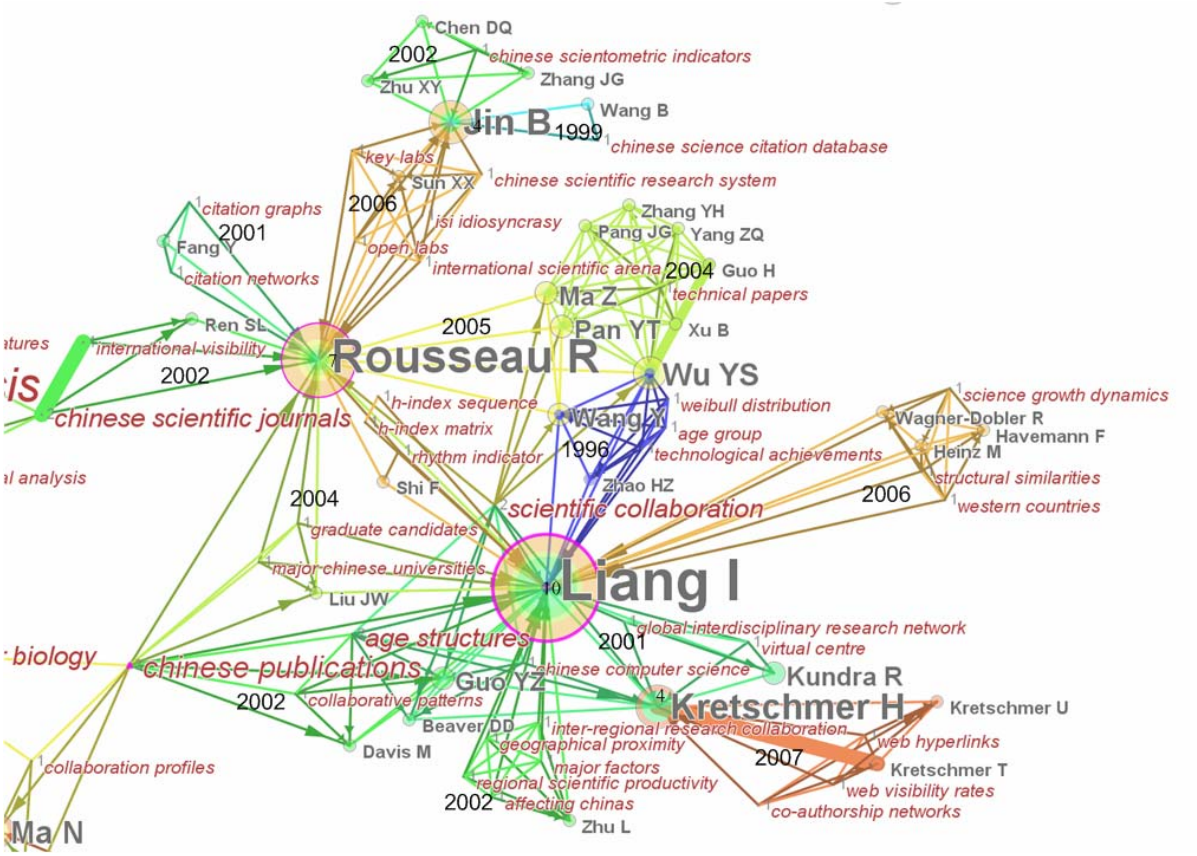

Figure 3: The largest international collaboration network of which LIANG LM is at the hub

Table 4 The largest international collaboration network, with LIANG LM its core

Research field (frequency of words)	*topical words*	*frequency of words*	*centrality*
Chinese scientific research system (10)	Chinese publications	2	0.28
	Chinese scientific journals	1	0.07
	Chinese computer science	1	0
	Chinese science citation database	1	0
	Chinese scientific research system	1	0
	Chinese scientometric indicators	1	0
	major Chinese universities	1	0
	affecting chinas	1	0
	international visibility	1	0
	international scientific arena	1	0
scientific collaboration (8)	scientific collaboration	2	0.01
	co-authorship networks	1	0
	collaborative patterns	1	0
	global interdisciplinary research network	1	0
	age structures	2	0.01
	age group	1	0
h-index (2)	matrix	1	0
	h-index sequence	1	0
webometrics (2)	web hyperlinks	1	0
	web visibility rates	1	0
citation networks (2)	citation graphs	1	0
	citation networks	1	0

It is worth mentioning that LIANG LM published 10 papers in the period of 1996-2007 (Figure 4). Among these 10 papers, there are only 5 papers studing Chinese issues and the other 5 papers studing the issues having no relationship with China, which is the difference between Liang and the mass of Chinese authors. Among all the Chinese scientometrics researchers, she excel in the total number of papers and the value of centrality, thus making her the core figure in international collaboration network of scientometrics in China.

LIANG had extensive cooperation with 8 foreign peers who came from 5 countries including Rousseau, DD Beaver, R Kundra, F Havemann, M Heinz and R Wagner-Dobler，M Davis, and German scientometrician H Kretschmer.

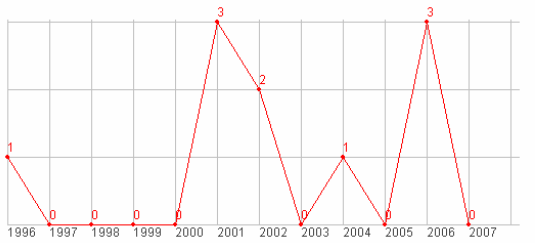

Figure4: Liang's publication in *Scientometrics*, 1996-2007

Belgian scientometrician Rousseau played an important role in the internationalization of scientometrics in China; he and 12 Chinese scholars coauthored 8 papers（Figure 5）of which 2 were collaborated on with LIANG and 2 with JIN BH. The centralities of Rousseau and LIANG together rank the first thus making him another core author in the network.

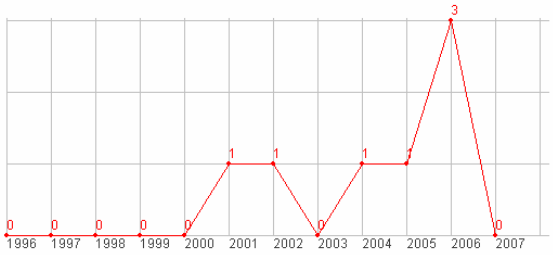

Figure 5: Rousseau and his Chinese collaborators' coauthored papers in *Scientometrics*, 1996-2007

JIN BH had published 4 papers in Scientometrics since 1999（Figure 6）, 2 of which are coauthored with Rousseau--"Key Labs and Open Labs in the Chinese scientific research system: Their role in the national and international scientific arena" and "Another ISI idiosyncrasy".

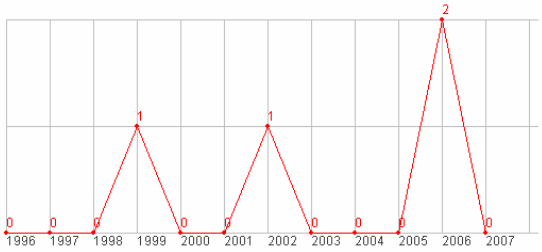

Figure 6: Jin's publication in *Scientometrics*, 1996-2007

German scientometrician H Kretschmer and Chinese scholars coauthored 3 papers on scientific collaboration in 2001, and she, as a Specially Appointed Professor of Dalian University of Technology, published a paper on scientific collaboration on the web（Figure 7）.

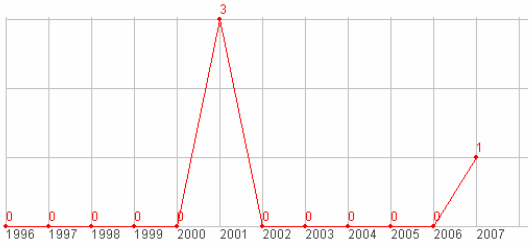

Figure 7: Kretschmer and her Chinese collaborators' coauthored papers in *Scientometrics*, 1996-2007

Wu, YS had published 3 scientometric papers since 1996, one of which was coauthored with Rousseau and his Chinese colleagues in 2005 on scientific collaboration in China.

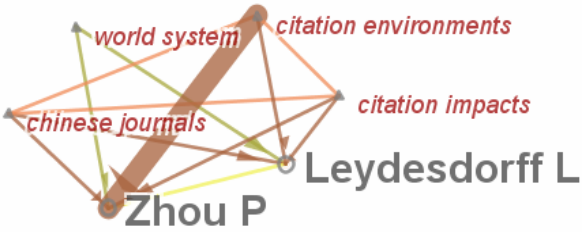

Figure 8: Network of Collaboration between Zhou P and L Leydesdorff

Since 2005, Zhou P who was a visiting scholar in Amsterdam University had published in collaboration with L Leydesdorff 3 scientometric papers（Figure 8, 9）.

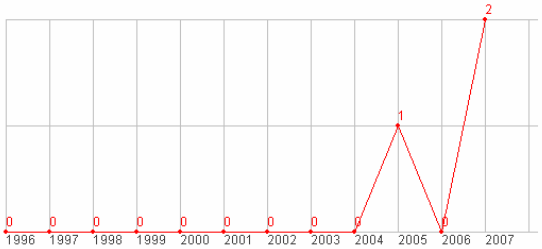

Figure 9: Papers by Zhou P and L Leydesdorff in *Scientometrics*, 1996-2007

The three coauthored papers are "The citation impacts and citation environments of Chinese

journals in mathematics", "Nanotechnology as a field of science: Its delineation in terms of journals and patents", and "Are the contributions of China and Korea upsetting the world system of science".

In 2004, Wu GZ collaborated with Vaughen Liwen, who was a professor in The University of Western Ontario, Canada, on a paper, namely "Links to commercial websites as a source of business information". In 2005, Vaughan LW's another paper that illustrated the competing position of firms by web chain analysis was chosen as the best in the 10th ISSI conference （Figure 10）.

Figure 10: Network of Collaboration between Wu GZ and Vaughan LW

In 2006, several Taiwanese scholars of medical field collaborated with BD Weisson the article "The impact of impact factor on small specialties: A case study of family medicine in Taiwan"（Figure 11）.

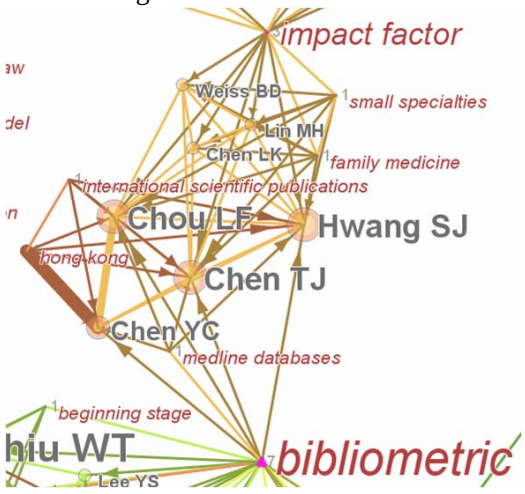

Figure 11: Network of Collaboration between Taiwanese scholars of medical field and BD Weiss

In this network, there are three prominent nodes indicating three Taiwanese scholars, two of whom were from medical field, namely Tzeng-Ji Chen, who was a doctor of medicine in University of Heidelberg and a professor in Medical School of Taiwan Yangming University focusing on family medicine, medical information, database management system, clinic computer system and global information network, and SJ Hwang, who was a professor of family medicine in the Medical Dept of Yangming University focusing on internal medicine, stomach & intestines medicine, family medicine, district medicine and elder medicine, another one of whom was LF Chou, who focused on finance, social insurance, government funding, human resource development, social welfare and medicine economy.

5 Conclusion

China has made initial progress in the internationalization of scientific research and international collaboration, especially in scientometric field; however, the internationalization of scientific research and international collaboration of scientometrics in China still need to be further developed, for the number of Chinese institutes and scholars who are active on the international scholarly stage, and of foreign institutes and scholars who cooperated with them is still limited. From 1980s to mid-1990s, only three minor international collaboration networks were formed in regards to the cooperation in scientometric studies between China and abroad; scientometric research in China lacked cooperation and many Chinese scholars published paper in Scientometrics did not belong to the scientometric field in actuality who ceased production of scientometric papers after 1996.Late 1990s had seen a great increase in the total number of published papers, the number of published papers on average and internationally collaborated papers; there were still three international collaboration sub-networks, but the whole network became larger and steadier, with LIANG LM its core author. Besides, authors from mainland China were the main force of publication of papers while authors from Taiwan province also became a noticeable force in the scientometric field.

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