

China's S&T and Innovation studies since 1978: A meta-analysis based on bibliometrics

Yutao Sun

Faculty of Management and Economics, Dalian University of Technology, Dalian China, 116024

Tel: [13500700842](tel:13500700842)

Email: sunyutao82@foxmail.com

Abstract: China's STI studies were emerging as a field attracting extensive attention. Using the bibliometric method, this paper attempts to provide a comprehensive picture, identifying major countries and institutions, key journals, the seminal contributions and the contributors, and showing the relative positioning of topics within the China's STI studies literature both through quality and quantity based on data derived from the Web of Knowledge. HistCite, a software tool for analyzing and visualizing citation linkages between scientific papers, is applied to investigate a large body of literature. The preliminary findings show that, first, China's STI studies emerged along with its STI development, and the year 1995 was an important starting point; second, P.R. China, the US and the UK are main countries contributing to China's STI studies, contributed 50%, 27.2% and 12% respectively, Tsinghua University, Zhejiang University and Chinese Academy of Science are main institutions; third, seminal works focused on the STI issues at the macro-, meso- and micro-level, and most of them were published in the journal of *Research Policy*, although *Scientometrics* published the most of the papers in this field. In addition, duplication of Chinese names is a problem in bibliometrics, which is similar with duplication of Japanese names, thus it is much hard to identify the primary contributors.

Key words: STI studies, bibliometric, China, HistCite

1 Introduction

With globalization, a combination of revolutionary technologies in transportation and communications, the increasing power of transnational corporations (TNCs) and special regions such as Silicon Valley have become the drivers of the world economy, but without taking economic power away from the nation-state (Dicken 2007). The state is the significant unit for comparing levels of innovative activity internationally, with the national interest being of prime importance within global governance (Sun and Grimes, 2016). That is, national science & technology (S&T) and innovation studies are still central to understand the corporation development and international competition.

China is a typical case of raising as a leading country in S&T and innovation during the age of globalization (Zhou and Leydesdorff, 2006). Indeed, since the 1950s, when the Chinese Communist Party (CCP) proclaimed "the love of science" to be a national virtue, China's persistent struggle to achieve rapid and sustained economic growth has been made conspicuous by the critical role attached to the modernization of science and technology (Simon, 1989). In 1978, China has embraced "the spring of science" after the reform and opening-door

policy. In addition to the above indicators, China's S&T and innovation system has produced some major accomplishments since 1949 in areas such as nuclear weapons, space, and certain fields of basic research (Xue, 1997). These achievements demonstrated that China has the institutional capacity to mobilize the talents and the material resources required to achieve high-priority, national-security objectives (Suttmeier, 1981). However, the general inefficiency of transferring R&D achievements to production processes, particularly after the economic reform started in 1978, also made it clear that structural reform of China's S&T and innovation system was imperative if the system was to meet the demand for successful technological innovations in a market-oriented economy. Then, the question is raised by scholars, why China can't innovate or China's R&D is diligently pursued but breakthroughs are rare (Abrami et. al., 2014). There is no doubt that China has become a powerhouse in S&T and innovation, which has attracted much attention and been the spot in international academic community.

In sum, China's S&T and innovation (STI) studies should be a primary case for understanding the national innovation in knowledge-based economy and integrated into studies of technological catching-up. Over the

years, scholars have published several excellent experiential surveys of the China's S&T and innovation (e.g. Zhou and Leydesdorff, 2006; Mu and Qu, 2008; Hu and Mathews, 2008; Fan, 2014;); international organizations also have published several comprehensive reviews, such as UNESCO Science Report: China (Cao, 2015), OECD Reviews of Innovation Policy: China (OECD, 2008), World Bank Promoting Enterprise-Led Innovation in China (Zhang, et al, 2009). But, there appears to be a lack of a comprehensive literature review on China's STI studies that are necessary to understand the studies situation as a whole.

This paper attempts to provide a comprehensive picture, showing the topics within the China's STI studies literature both through quality and quantity based on data derived from the Web of Knowledge. HistCite, a software tool for analyzing and visualizing citation linkages between scientific papers, is applied to investigate a large body of literatures. We try to map the whole dynamic picture of China's STI studies, identifying major countries and institutions, key journals, the seminal contributions and the contributors, the evolution of citations network.

2 Method and data

The paper, by combined use with research means of quantity and quality, analyses the literature in China's STI studies. A bibliometric method is used to quantify and compare scientific activities at various levels of aggregation including institutions, countries, authors, journals and so on. Citation analysis is one of the fastest growing areas of research in the bibliometric analysis, and many papers have examined both individual articles and conducted citation analyses over time (Walters 2011). Its limitations are also clear. It is possible that the literature data based on keyword search has a certain amount of noise, including unrelated literature or missing some important literatures. In that case, the qualitative analytical method could make up these limitations. Based on authors' more than 20 years of research experience and interviewing to leading scholars, we could know seminal contributions and contributors to China's STI studies excluded in bibliometric analysis.

HistCite software has been common used to visualize development path of study field (Lucio-Arias and Leydesdorff 2008; Garfield 2009). A process and software called HistCite provides a good tool for historical analysis, which could be applied to explore the

evolutionary characteristics of national innovation studies (Garfield et al. 2002). Its inputs are bibliographic records (with cited references) from the "Web of Knowledge" (WoK) or other similar sources. Its outputs are various tables and graphs with informetric indicators about the knowledge domain under study (Garfield et al. 2006). We use the Social Science Citation Index (SSCI) and Science Citation Index (SCI) of WoK as our data source. Thomson Reuters' WoK was used as a data tool through several steps. At first, we opened the web page of "basic search" in the database of "Web of Science TM Core Collection", and the words "China + innovation" or "China +science and technology" or "China +S&T" were inserted in the search box as "topic". Second, we selected the "timespan" from 1978 to 2015 and the settings "Science Citation Index Expanded (SCI-EXPANDED) -1945-present" and "Social Sciences Citation Index (SSCI) --1956-present" in "Web of Science Core Collection: Citation Indexes".

Standard bibliometric analysis was carried out in HistCite using data downloaded from the WoK. These imported records are defined as a knowledge domain (collection). Between 1978 and 2015, there were 2041 published records, 3473 authors, 506 journals and 71255 cited references. In order to learn the development trend of China's STI studies and the dynamic relations among published records, we added all publications that cited the 2041 publications as well as all the references quoted in those citing papers. The resulting aggregated database is referred to as the China's STI research collection (STIRC). In addition, the time window is one year in this work. Several indicators will be used in our analysis. TLCS-total local citations scores means all local citations within the basic collection- STIRC. TLCS/x means total citation score excluding self-citations. ALCS-the average local citation scores means the local citation scores per paper. LCS/t means the score per year, which shows the average citation score since the publication date. LCS_e shows the LCS for the period from the arbitrary cut-off year until the last three years of the collection time span. LCS_b shows the LCS only from the beginning three years of the collection to an arbitrary cut-off year. LCS (e/b) equals LCS_e divided by LCS_b. When LCS (e/b) is greater than 1, this means that citations tend to increase; in contrast, when LCS (e/b) is less than 1, citations tend to decrease.

3 The emerging process of China's STI studies

This section consists of three main parts. The first part reviews the growth trends of China's STI studies. The last two parts analyze the contributing economies and institutions to China's STI studies.

3.1 The growth trends

Before 1995, China's STI studies were still in the incubation period, with few scholars interested in this topic and the number of publications in each year is the rate in single digits (see Figure 1). In fact, there are only three papers of China's STI in our research collection between 1978 and 1985. The first paper is *Education, Science, and Technology in China (EST)* published by Abelson in *Science* (1979). After reform and opening-up policy in 1978, the AAAS Board of Directors organized a 3-week visit to China aiming to arrange cooperation between AAAS and the Chinese Scientific and

Technical Association. The issue of *China in Transition* including EST was published in *Science* after the visit. Although it is a personal impressions of the editor of *Science* rather than an academic paper, we could learn the scene of China's S&T in 1979. At that time, most researches are carried out at institutes affiliated with the Chinese Academy of Sciences, and a lesser amount is conducted at universities in China (Abelson, 1979). Scientific leadership in China will rest with foreign-trained Chinese, and these educated in the US are particularly prominent, China's rulers have little experience in the effective integration of advanced research and development into major industrial complexes (Abelson, 1979). EST put forward one of the major questions about China was "Why hasn't China developed faster and more extensively?"

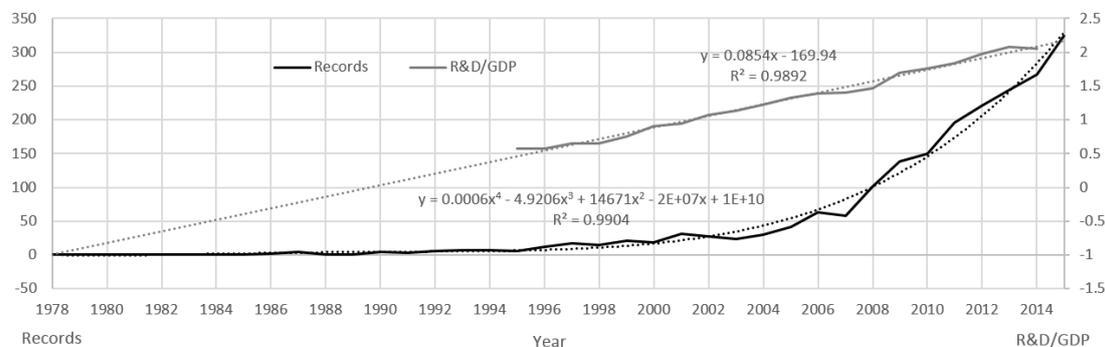


Figure.1 Published papers on China's STI studies (1978-2015) and R&D/GDP(1995-2014)

Clearly, China's S&T reform was one of the main forces behind GERD/GDP growth and STI studies. China initiated the S&T reform to ensure the close alignment of the S&T system with the economy in 1985. Then, the CCP's Central Committee (CCPCC) issued the "Decision on the Reform of the S&T System", the strategy of "revitalizing the nation through the science and education" in 1995 and "constructing national innovation system with Chinese characteristics" in 1999 are boosters of STI development and studies (Liu et al., 2011). However, along with opening to the outside world, international technology transfer that is useful for improving China's technological sophistication might have hindered the development of its indigenous capability of creating new, cutting-edge innovation. To respond to the challenge of economic development depending on international technology transfer overly, in early 2006, CCPCC and the State Council unveiled the "Decision on Implementing S&T Plan and Strengthening Indigenous Innovation Capability." The indigenous innovation strategy has become

a new milestone in China's innovation drive (Cao et al., 2006; Serger and Bredine, 2007).

China's STI studies became a rapidly emerging field from the 1995's in particularly 2006's onwards partly in response to the increased demand within academia and policymaking related to China's STI and economic development trends during this period. Within the policymaking realm, on the one hand, Chinese policymakers want to know how to develop S&T endeavors and promote economic growth through S&T; on the other hand, international policymakers want to know the policy mechanisms of China's STI and economics growth rapidly, and what are the impacts of China's growth to other countries. In the academic realm, scholars attempted to state China's way to develop STI and economics and propose a China's model for S&T and innovation.

3.2 The contributing economies

Then, we pay attention to the economies and institutions contributing to China's STI studies. Table 1 shows the records of papers from various economies published from 1978 to

2015. China is the undoubted leader, followed by the US and the UK. As we know, most of the STI literatures were published in China's journals in Chinese, however China's local journals were not included in the SSCI/SCI realm that favors international journals in English (Van Leeuwen et al. 2001). Thus, this indicates that scholars in China pay most attention to China's STI issues. More importantly, these scholars have international visions and academic competence in social science, and their STI studies could be accepted by international academic community and published in international journal. Thus, it is worth noting that China's social science also develop rapidly along with STI developing.

Around 89.2% of the total number of papers is from these three economies, with a large gap between top three and the remaining economies. The US and the UK pay more attention to China's STI than other countries. As we know, North America and Europe are the

global science, technology and innovation leaders. Because of rapid economic growth since the 1990s, China has become the second largest economies since 2010. China will be a main competitors for the US and the UK following China's rise sharply. In particular, the US worries about its leading position of S&T and innovation in the world. Scholars are increasing their focus on rapid economic and innovation growth in China, despite increasing attention is being focused on the rise of innovation in Asia by North America and Europe, and these innovation studies in Asia have been lagging compared with the US and the UK (Teixeira 2014). This indicates that scholars from North America and Europe have stronger consciousness of national innovation. Certainly, a large number of overseas Chinese scholars are working in American and British academic institutions, and most of these scholars have facilitated worldwide research focusing on China (Liu et al, 2015).

Table 1 The distribution of publication on China's STI studies by economies

No.	Country	Recs	Percent (%)	No.	Country	Recs	Percent(%)
1	China	1020	50	11	Japan	38	1.9
2	the U.S.	556	27.2	12	India	34	1.7
3	the U.K.	244	12	13	Spain	32	1.6
4	Taiwan	121	5.9	14	Denmark	30	1.5
5	Australia	87	4.3	15	France	30	1.5
6	Canada	84	4.1	16	Sweden	29	1.4
7	Germany	70	3.4	17	Italy	23	1.1
8	South Korea	62	3	18	Belgium	21	1
9	Singapore	50	2.4	19	Malaysia	17	0.8
10	Netherlands	49	2.4	20	Switzerland	16	0.8

Note: Taiwan is a part of P.R. China. In this paper, Taiwan is considered as an economy.

Although China as a rising science and innovation power has attracted North America and Europe's attention besides Greater China, however, China's STI has not become mainstream field in global scale, particularly in East Asia. Indeed, most STI studies of these economies were published in local journals with the local language (Sun and Grimes, 2016). Our view is that, first, China as second largest economies and STI powerhouses in the world has not shown enough influence, and it is also difficult to attract global attentions; second, it is

possible that China's rise could change the geographical distribution of global R&D and innovation gradually, so North America and Europe considers China as their competitor and collaborator; third, Japan and South Korea as two major R&D and innovation centers in Asian even in the world pay more attention to America and Europe besides their own countries, rather than their neighbor China.

3.3 The contributing institutions

Table 2 The distribution of publication on China's STI studies by institutions

#	Institution	Recs	#	Institution	TLCS
1	Tsinghua Univ	91	1	City Univ Hong Kong	232
2	Zhejiang Univ	90	2	Tsinghua Univ	188
3	Chinese Acad Sci	64	3	Univ Hong Kong	182
4	City Univ Hong Kong	62	4	Chinese Univ Hong Kong	169
5	Peking Univ	56	5	Texas A&M Univ	116
6	Univ Hong Kong	55	6	Calif State Univ Northridge	103

7	Fudan Univ	39	7	Rice Univ	94
8	Renmin Univ China	38	8	State Sci Technol Commiss China	92
9	Natl Univ Singapore	34	9	Fudan Univ	83
10	Xi An Jiao Tong Univ	34	10	Beijing Univ Aeronaut & Astronaut	82
11	Shanghai Jiao Tong Univ	33	11	Zhejiang Univ	82
12	Chinese Univ Hong Kong	32	12	Inst Sci & Tech Informat China	79
13	Univ Nottingham	31	13	Natl Univ Singapore	79
14	Sichuan Univ	29	14	Univ Amsterdam	78
15	Hong Kong Univ Sci & Technol	28	15	Lingnan Univ	75
16	Wuhan Univ	26	16	Peking Univ	69
17	Georgia Inst Technol	24	17	Brandeis Univ	62
18	Natl Taiwan Univ	23	18	Univ Nottingham	61
19	E China Normal Univ	22	19	Georgia Inst Technol	54
20	Univ Manchester	22	20	Univ Miami	54

Note: “Tsinghua Univ” and “Tsing hua Univ” are merged them into Tsinghua Univ.

Of the 1289 institutions that contributed to the field of China’s STI studies, Table 2 identifies the top 20 institutions in terms of records and TLCS. Published records are still regarded as the primary contribution by academics to their institutions. Among the top 20 institutions, Tsinghua University is foremost, with most contributions from School of Economics and Management (SEM) in particular Research Centre of Technology Innovation led

by Prof. Jin Chen now and also from School of Public Policy and Management (SPPM) led by Prof. Lan Xue. Two subdivisions provided different views for China’s STI, SEM focuses on technological innovation and development at the level of enterprises and industries, and SPPM pays more attention to institution, policy and governance at the level of technology field and national system. Certainly, a part of them is interdisciplinary research.

Table 3 Top 15 seminal articles in the field of China’s STI studies by LCS/t

#	Code	Publication	LCS	LCS/t	LCSx	LCSb	LCSe	LCS(e/b)
1	148	Liu XL, White S. Comparing innovation systems: a framework and application to China's transitional context. RESEARCH POLICY. 2001 AUG; 30 (7): 1091-1114	92	6.13	89	2	35	17.50
2	298	Zhou P, Leydesdorff L. The emergence of China as a leading nation in science. RESEARCH POLICY. 2006 FEB; 35 (1): 83-104	59	5.9	53	5	23	4.6
3	700	Zhang Y, Li HY. Innovation search of new ventures in a technology cluster. STRATEGIC MANAGEMENT JOURNAL. 2010 JAN; 31 (1): 88-109	34	5.67	31	4	30	7.5
4	154	Li HY, Atuahene-Gima K. Product innovation strategy and the performance of new technology ventures in China. ACADEMY OF MANAGEMENT JOURNAL. 2001 DEC; 44 (6): 1123-1134	81	5.4	74	0	34	34/0
5	609	Hu AG, Jefferson GH. A great wall of patents: What is behind China's recent patent explosion?. JOURNAL OF DEVELOPMENT ECONOMICS. 2009 SEP; 90 (1): 57-68	30	4.29	30	5	18	3.6
6	857	Sheng SB, Zhou KZ, Li JJ. The Effects of Business and Political Ties on Firm Performance: Evidence from China. JOURNAL OF MARKETING. 2011 JAN; 75 (1): 1-15	21	4.2	19	4	19	4.75
7	558	Li XB. China's regional innovation capacity in transition: An empirical approach. RESEARCH POLICY. 2009 MAR; 38 (2): 338-357	29	4.14	27	6	17	2.83
8	433	Altenburg T, Schmitz H, Stamm A. Breakthrough? China's and India's transition from production to innovation. WORLD DEVELOPMENT. 2008 FEB; 36 (2): 325-344	31	3.88	30	3	22	7.33
9	723	Zhou KZ, Wu F. Technological capability, strategic flexibility, and product innovation. STRATEGIC MANAGEMENT JOURNAL. 2010 MAY; 31 (5): 547-561	22	3.67	18	6	16	2.67
10	486	Hu MC, Mathews JA. China's national innovative capacity. RESEARCH POLICY. 2008 OCT; 37 (9): 1465-1479	29	3.63	25	3	12	4.00
11	586	Guan JC, Yam RCM, Tang EPY, Lau AKW. Innovation strategy and performance during economic transition: Evidences in Beijing, China. RESEARCH POLICY. 2009	24	3.43	20	3	17	5.67

		JUN; 38 (5): 802-812						
12	375	Li HY, Zhang Y. The role of managers' political networking and functional experience in new venture performance: Evidence from China's transition economy. STRATEGIC MANAGEMENT JOURNAL. 2007 AUG; 28 (8): 791-804	30	3.33	24	2	21	10.50
13	142	Park SH, Luo YD. Guanxi and organizational dynamics: Organizational networking in Chinese firms. STRATEGIC MANAGEMENT JOURNAL. 2001 MAY; 22 (5): 455-477	48	3.27	49	0	23	23/0
14	384	Motohashi K, Yun X. China's innovation system reform and growing industry and science linkages. RESEARCH POLICY. 2007 OCT; 36 (8): 1251-1260	27	3	23	0	16	16/0
15	948	Liu FC, Simon DF, Sun YT, Cao C. China's innovation policies: Evolution, institutional structure, and trajectory RESEARCH POLICY. 2011 SEP; 40 (7): 917-931	15	3	13	2	13	6.5

Our data on local citations, however, shows a very different picture from that of the records, with only one in the top five institutions being located in Mainland. Comparing with the list of records, we could find several interesting things in the list of citations. Only four of eleven Mainland institutions in the list of records are retained in the list of citations, however three of four Hong Kong institutions are in the top five according to citation, and three of four non-Greater China institutions are also retained in the citation list. Being the undisputed leader in relation to TLCS, the City University of Hong Kong (CUHK) don't have a subdivisions like the Science Policy Research Unity (SPRU) in the University of Sussex who focuses on research, science and innovation studies (Fagerberg 2004). However, Collage of Business, College of Science and Engineering, Department of Public and Social Administration are all related to STI in China. These indicate that, in generally, mainland academic institutions' impact on international community is still smaller than overseas'.

4 Seminal contributions, contributors and journals in China's STI studies

This section consists of three main parts. The first part reviews the seminal contributions of China's STI studies. The last two parts analyze main journals publishing China's STI studies and seminal contributors to do that.

4.1 The seminal contributions

During the period of bibliometric analysis (1978-2015), articles were published at different stages. Generally speaking, the longer the published time is, the more citations would be expected, and assuming the quality of articles is similar. The time interval between the publication date and 2015 would influence the total number of citations. Considering the time interval, the LCS/t - the average LCS per year since the publication date is a more effective indicator than either the TLCS or the TLCS/x -

total citation score, excluding self-citations in identifying seminal contributions. Only a small number of the 2041 articles published could be regarded as "seminal" which is defined by LCS/t.

Table 3 lists 15 seminal articles published during this period. China's STI was rising since 1995, meanwhile China's STI studies are emerging as a relatively new field of research, and the scale of its academic impact was also expanded gradually. Of the 15 seminal articles, all were published after 2000, with three published in 2001 and others published after 2006. This indicates that China's STI studies show the academic influence after 2006 in which indigenous innovation strategy lunched, and more scholars pay more attention to China's STI issues. Obviously, all of these papers on STI focused on China or based on China, and were empirical rather than theoretical in approach, although we can't see "China" in the title of two papers (Code 700 and 723).

Seven of the 15 articles appeared in *Research Policy (RP)*, four appeared in *Strategic Management Journal (SMJ)*, and the remainder in four different journals. It indicates that RP became the preferred journal for authors in this STI field, helping to develop an identity for this group of researchers (Sun and Grimes, 2016), and innovation studies could be considered as a part of strategic management or are linked closely with strategic studies. RP prefers to do published STI system and policies at the national and regional level, and the studies of technology and product innovation at the level of firm would like to be published in SMJ and *Academy of Management Journal (AMJ)*. I have not yet found that one author contributed two or more articles in the seminal list. In addition to an article (Code 433), Chinese contributed all of other seminal articles, and majority of Chinese authors are major contributors or first author. These Chinese contributors are from Mainland China or overseas institutions. It is also a typical localization effect, which means that Chinese

will pay more attention to China's STI issue firstly.

4.2 The main journals

The 2041 papers were published in 506 journals, with the top 10 journals publishing 25.6% of all papers. This is the Matthew effect, and a few journals published the most papers. As we know, SCIM is concerned with the quantitative features and characteristics of S&T and scientific and technological research. Emphasis is placed on investigations in which the development and mechanism of S&T are studied by statistical mathematical methods. This indicates that plenty of China's STI studies are still rest on the data analysis.

In addition to the number of records, and considering the effect of the period since publication on the number of citations, we also analyze the average LCS per year since the publication date of papers (LCS/t) rather than the TLCS, which provides an indication of the impact of journals in the field of China's STI studies (Sun and Grimes, 2016). The most important journal in terms of LCS/t is RP whose LCS/t is more than that of SCIM, which is in second place. In general, more than half the journals could be classified in the field of technology and innovation management (TIM),

while the remainder refer to economics, management, business and environment so on, indicating that China's STI studies related to several different disciplinary fields. RP was launched in SPRU by Freeman, its founding editor and is a multi-disciplinary journal devoted to the policy and management problems posed by innovation, R&D, technology and science. The journal's high impact factor (3.117) reflects its status as a leading academic journal in this field although the impact factor as a measurement of journal influence not entirely accurate (Linton 2006; Van Leeuwen 2012). It is interesting that the CMS and CER, the two journals focusing on economics and management. CMS was founded at 2007 and it provides an approach to documenting and disseminating research into Chinese processes of managing enterprises, firms and corporations. As a new journal, its academic impact is very limited (IF=0.294). CER publishes original research works on the economy of China, and its relation to the world economy. CER was founded at 1989 and has a longer history than CMS. Obviously, international academic community concerning with Chinese economics was sooner than its management.

Table 4 Top 10 journals publishing China's STI studies by records and TLCS/t

#	Journal ranking by Recs	Recs	%	IF
1	SCIENTOMETRICS	101	4.9	2.183
2	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	70	3.4	0.625
3	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	64	3.1	2.058
4	CHINESE MANAGEMENT STUDIES	61	3	0.294
5	RESEARCH POLICY	50	2.4	3.117
6	TECHNOVATION	43	2.1	2.526
7	ASIA PACIFIC JOURNAL OF MANAGEMENT	36	1.8	1.218
8	TECHNOLOGY ANALYSIS & STRATEGIC MANAGEMENT	36	1.8	0.942
9	CHINA ECONOMIC REVIEW	33	1.6	1.264
10	JOURNAL OF BUSINESS RESEARCH	29	1.4	1.480
#	Journal ranking by TLCS/t	TLCS/t	TLCS	IF
1	RESEARCH POLICY	54.36	450	3.117
2	SCIENTOMETRICS	31.67	157	2.183
3	STRATEGIC MANAGEMENT JOURNAL	23.25	204	3.341
4	TECHNOVATION	21.13	166	2.526
5	TECHNOLOGICAL FORECASTING AND SOCIAL CHANGE	17.7	96	2.058
6	WORLD DEVELOPMENT	15.62	121	1.965
7	ASIA PACIFIC JOURNAL OF MANAGEMENT	15.38	85	1.218
8	TELECOMMUNICATIONS POLICY	12.22	57	1.411
9	ENVIRONMENT AND PLANNING A	12.21	96	1.604
10	INTERNATIONAL JOURNAL OF TECHNOLOGY MANAGEMENT	10.93	74	0.625

Notes: LCS/t shows the average LCS per year since the publication date. The impact factor considers all journals currently listed in the 2013 Journal Citation Reports (Thomson Reuters 2014, <http://admin-apps.webofknowledge.com/JCR/JCR?PointOfEntry=Home&SID=1BoxsbQ4ouoHivAhGNQ>)

4.3 The main contributors

Identifying the seminal contributors is significant for understating the process of China's STI studies. There are total 3473 authors who contributed to China's STI studies, and three lists according to records, TLCS and LCS/t can be identified, which was much less than 6948 authors who contributed to national innovation studies (Sun and Grimes, 2016). Duplication of Chinese names is a problem in bibliometrics, which is similar with duplication of Japanese names (Cornell, 1982). Bibliometrics has not been able to offer a valid large-scale alternative because of almost overwhelming difficulties in identifying the true author of each publication (D'Angelo et al., 2011).

A single example will illustrate the severity of the problem of duplication. A contributor "Liu Y" ranks the third place according to records and it contributed 23 total records. The single entry Liu Y refers to a total of 9 different individuals. Liu Yi from Xi'an Jiaotong University contributed 10 records, Liu Yun from Beijing Institution Technology contributed 2 records, Liu Yang from South China Univ of Technology contributed 4 records, Liu Yang from University Science and Technology of China contributed 2 records, and Liu Ying from Tsinghua University, Liu Yu Peking University, Liu Ye from China University of Geoscience, Liu Yu from University of Texas, El Paso and Liu Yu from Capital Medical University contributed 1 record. Relatively, the most common surname/initials combination is shared by 1.2% of the authors of that surname in the Western case (Cornell, 1982). Thus, the discussion of authors' lists don't have much meaning.

5 Discussion and Conclusions

China's STI studies were emerging as a new field attracting extensive attention along with it raising as a leading country in STI since 1978. Using the bibliometric method, this paper attempts to provide a comprehensive picture of China's STI studies literature both through quality and quantity based on data derived from the Wok. The study includes 2041 papers from 1289 institutions in 506 journals with 71255 references and citations.

First, China's STI studies emerged along with its development of STI since 1978, and the year 1995 was an important starting point. This rapid growth in the number of records from the early 1995 is accompanied with China's GERD/GDP, which was due to the strategy of

"revitalizing the nation through the science and education" in 1995. China's STI studies became a rapidly emerging field from the 1995's in particularly 2006's onwards partly in response to the increased demand of learning China within academia and policymaking. China, the US and the UK are main countries contributing to China's STI studies, contributed 50%, 27.2% and 12% respectively, which depends on Chinese disperse, English language and their concern. However, South Korea and Japan from the East Asian pay less attention to China's STI issues. To be honest, China has raising as a leader in STI, but China's STI studies have not become mainstream field which also reflect China's impact.

Second, according to TLCS, Tsinghua University, Zhejiang University and Chinese Academy Science are top three institutions, a group of well-known universities in the Greater China (Mainland, Kong and Taiwan) have placed a leading position in China's STI studies, which could be explained by home academic effect. Comparing with the list of records, the list of top institutions according to citation is a very different picture, and the contributions of Mainland institutions reduced and Hong Kong institutions increased.

Third, top 15 seminal works focused on the STI issues at the macro-, meso- and micro-level, and most of them were published in the journal of *Research Policy*, although *Scientometrics* published the most of the papers in this field. More than half main journals publishing China's STI studies could be classified in the field of TIM, while the remainder refer to economics, management, business and environment so on. In addition, duplication of Chinese names is a problem in bibliometrics, which is similar with duplication of Japanese names, thus it is much hard to identify the primary contributors. However, the finding shows that, Jianchen Guan, Professor of UCAS now is the most prolific author in China's STI studies, and also in national innovation studies.

It is also important to consider in what direction China's STI studies going. Will it continue to prosper or fail and if it does prosper, in what form? Obviously, China continues to be the most significant country in STI development and China's STI studies will rise continually. Meanwhile, China's practices should contribute more new theories to international community. In addition, two limitations should be considered in the future study. A limitation of this study remains that we only collected the data of publications from WoK, favors English-language journals. It is possible that our contribution,

therefore, is not comprehensive, in particular excluding publishes in Chinese. Second is the drawback of bibliometrics. It is possible that this paper still included other risks of mistake, although we have indicated the problems of duplication and citation.

References (a part):

- Abelson P. Education, science, and technology in China. *Science*, 1979, 203(4380): 505-509.
- Abrami R.M., Kirby W.C., McFarlan F.W. Why China can't innovate and what's it's doing about it. *Harvard Business Review*, 2014, (3): 107-111.
- Altenburg T., Schmitz H., Stamm A. Breakthrough? China's and India's transition from production to innovation. *World Development*, 2008, 36(2): 325-344.
- Cao C. China, in UNESCO, UNESCO Science Report 2015. Paris: UNESCO, publishing, 2015.
- Cao C. Zhongguancun and China's high-tech parks in transition: "growing pains" or "premature senility"? *Asian Survey*, 2004, 44(5): 647-668.
- Cao C., Li N., Li X., Liu L. Reforming China's S&T system. *Science*, 2013, 341(6145): 460-462.
- Cao C., Suttmeier R.P., Simon D.F. China's 15-year science and technology plan. *Physics Today*, 2006, 59(12): 38-43.
- Chang P.L., Shih H.Y. Comparing patterns of intersectoral innovation diffusion in Taiwan and China: A network analysis. *Technovation*, 2005, 25(2): 155-169.
- Chang P.L., Shih H.Y. The innovation systems of Taiwan and China: a comparative analysis. *Technovation*, 2004, 24(7): 529-539.
- Chen G.Q., Liu C.H., Tjosvold D. Conflict management for effective top management teams and innovation in China. *Journal of Management Studies*, 2005, 42(2): 277-300.
- Chen K., Kenney M. Universities/Research institutes and regional innovation systems: The cases of Beijing and Shenzhen. *World Development*, 2007, 35(6): 1056-1074.
- Cornell L.L. Duplication of Japanese names: A problem in citations and bibliographies. *Journal of the American Society for Information Science*, 1982, 33(2): 102-104.
- Crescenzi R., Rodríguez-Pose A., Storper M. The territorial dynamics of innovation in China and India. *Journal of Economic Geography*, 2012, 12(5): 1055-1085.