The Evolution of Core-Periphery Structure in Mainland China's Inter-Provincial Social Science Collaboration Networks: Evidence from 1998-2017 Chinese SSCI Paper Data (Postprint)

Authors: Qiu Changbo, Zhang Xiwen, Meng Jing

Date: 2023-04-01T16:16:04+00:00

Abstract

[Purpose/Significance] Investigating the evolution of strength and status of 31 provincial regions in mainland China in social science collaboration is conducive for relevant departments to grasp the dynamics of inter-provincial social science collaboration and provides a reference basis for science and technology managers to formulate regional research planning and make scientific decisions. [Method/Process] Utilizing SSCI paper data from China spanning 1998-2017, we construct a social science collaboration network among 31 provincial regions in mainland China, employing social network analysis and multidimensional scaling methods to analyze the evolution of the core-periphery structure of the inter-provincial social science collaboration network. [Results/Conclusions] From 1998-2017, the intensity of social science collaboration among 31 provincial regions in mainland China gradually increased; the inter-provincial social science collaboration network exhibits a distinct core-periphery structure, with an increasing number of provinces joining the core and semi-core regions of the collaboration network and the number of provinces in the peripheral region substantially decreasing; the main fields of regional social science collaborative research are economics and business, psychology, health sciences, and environmental sciences; cross-provincial social science collaboration in mainland China is primarily concentrated between provinces within the core region and between provinces in the core and semi-core regions.

Full Text

Research on the Evolution of Core-Periphery Structure in Inter-provincial Social Science Cooperation Networks in Mainland China: Evidence from Chinese SSCI Publications, 1998–2017

Qiu Changbo, Zhang Xiwen, Meng Jing
School of Management, Jilin University, Changchun 130022

Abstract:
[Purpose/Significance] Examining the changing dynamics of strength and status among China's 31 provincial-level regions in social science cooperation helps relevant departments understand inter-provincial collaboration patterns and provides a reference for science and technology managers to formulate regional research plans and make scientific decisions. [Method/Process] Using Chinese SSCI publication data from 1998–2017, this study constructs an inter-provincial social science cooperation network among 31 provincial regions in mainland China and employs social network analysis and multidimensional scaling methods to analyze the evolution of the core-periphery structure in this network. [Result/Conclusion] From 1998 to 2017, the intensity of social science cooperation among China's 31 provincial regions gradually increased. The inter-provincial social science cooperation network exhibited a clear core-periphery structure, with more provinces joining the core and semi-core regions while the number of peripheral provinces decreased significantly. The main research fields for regional social science cooperation were economics and business, psychology, health sciences, and environmental sciences. Cross-provincial social science cooperation in mainland China was primarily concentrated between provinces in the core region and between core and semi-core regions.

Keywords: inter-province; SSCI; cooperation network; core-periphery structure; evolution
Classification Number: G250
DOI: 10.13266/j.issn.0252-3116.2020.23.008

Introduction

Scientific collaboration has become a primary mode of contemporary scientific research. Since the 1960s, with Derek Price's pioneering work on scientific collaboration, the study of collaboration patterns has emerged as a central focus in scientometrics research [1]. As the scope and scale of scientific cooperation have expanded rapidly, inter-provincial collaborative research has become increasingly common [2]. Policymakers and science managers need to understand the dynamics of scientific cooperation across Chinese provinces, prompting numerous scholars to investigate this phenomenon.

Previous studies have primarily examined inter-provincial scientific coopera-

tion in China using data from domestic databases. Liang et al. [2] utilized the Chinese Science Citation Database (CSCD) to analyze cross-provincial co-authorship patterns in 1999. Zhang et al. [3] examined cooperation among 39 major Chinese cities using Web of Science data from 1975–2007. Guo et al. [4] employed multiple regression analysis on CNKI data from 2005–2014 to identify factors influencing cooperation intensity among 31 provinces. Li et al. [5] analyzed the dynamic evolution of scientific knowledge networks in the Yangtze River Delta urban agglomeration using cooperation data from 2000–2015. H. Ma et al. [6] studied inter-provincial scientific collaboration networks using data from the China Academic Journal Network Publishing Database (CAJNPD) for 2014–2016. These studies predominantly focused on natural sciences using CNKI and SCI databases.

As China's international political and economic status has grown, the state has increasingly emphasized enhancing national cultural soft power to strengthen international discourse and cultural influence [7]. Social sciences play a crucial role in this effort, drawing growing scholarly attention to academic collaboration in this domain. Hao et al. [7] analyzed cooperation characteristics in Chinese humanities and social sciences using data from over 790 journals between 2000–2014. Su [8] examined geographical preferences in social science cooperation using 10 years of data from 150 core economics journals in CNKI. However, these studies relied on domestic publications, leaving a research gap regarding inter-provincial cooperation in internationally published social science research.

Created in 1973, the Social Sciences Citation Index (SSCI) is widely recognized as the most comprehensive and authoritative source for measuring international social science research [9]. This study utilizes Chinese SSCI publication data from 1998–2017, applying social network analysis and multidimensional scaling to examine the evolution of core-periphery relationships among 31 provincial regions in mainland China. By clarifying each province's changing position in social science cooperation networks and identifying differences across research fields, this research provides valuable insights for science managers to understand collaboration dynamics and make informed decisions about regional research planning.

1. Data Sources and Processing

Data were retrieved from the SSCI database on the Web of Science platform using the search query "Publication Year = 1998–2017" and "Address = Peoples R China," yielding 114,633 SSCI publications from mainland China. Since SSCI includes non-social science papers, we excluded publications whose subject area field (WC) did not contain SSCI social science disciplines, following established classification rules [10].

The author address field (C1) in SSCI typically follows the format: "Primary Institution Name, Secondary Institution Name, Region and Postal Code, Country" [11]. We extracted provincial regions by parsing this field using comma

delimiters. Following previous research [12], we focused exclusively on mainland China's 31 provincial-level regions, excluding publications with Hong Kong, Macau, or Taiwan addresses.

After processing, we obtained 54,749 SSCI papers from mainland China between 1998–2017, including 11,130 inter-provincial co-authored papers. Table 1 shows annual publication counts and inter-provincial cooperation rates:

Table 1. SSCI Publications and Inter-provincial Cooperation in Chinese Social Sciences, 1998–2017

Year	Mainland Papers	Inter-provincial Co-authored Papers	Cooperation Rate (%)
1998–2004	[data]	[data]	11.11–14.78
2005–2013	[data]	[data]	14.47–21.91
2014–2017	[data]	[data]	23.65–25.12

Note: Inter-provincial cooperation rate = (Inter-provincial co-authored papers / Mainland papers) × 100%

Table 1 reveals that SSCI publications, inter-provincial co-authored papers, and cooperation rates all increased steadily from 1998–2017. Growth was slow from 1998–2004, with cooperation rates fluctuating at low levels. From 2005–2013, inter-provincial co-authored papers grew continuously, with cooperation rates approaching 20%. Beginning in 2014, the annual increase exceeded 300 papers, reaching 2,800 co-authored papers in 2017 and a cooperation rate of 25.12%.

The number of co-authored papers serves as a key indicator of scientific collaboration activity [13]. The gradual increase in inter-provincial social science co-authorship demonstrates accelerating cooperation development.

2. Construction of Inter-provincial Social Science Cooperation Networks

If a paper's author addresses include two provinces A1 and A2, this constitutes one scientific collaboration A1-A2. For three provinces A1, A2, and A3, there are three collaborations: A1-A2, A1-A3, and A2-A3. For n provinces, there are C(n,2) collaborations.

Analyzing author addresses from 1998–2017 SSCI papers, we constructed twenty 31$×$31 provincial cooperation matrices. These valued networks have densities equal to the mean of the cooperation matrices. Table 2 shows network density and growth rates for each year:

Table 2. Evolution of Network Density in Inter-provincial Social Science Cooperation, 1998–2017

Period	Density	Growth Rate
1998	0.015	-
1998–2004	0.015–0.032	0.652–1.254
2005–2010	0.045–0.116	3.101–4.994
2011–2013	0.084–0.213	-1.587–6.422
2014–2017	0.209–0.437	6.174–10.310

In 1998, network density was 0.015, meaning provinces averaged only 0.015 cooperation instances—far less than one. Density remained below 0.1 with modest growth from 1998–2004. From 2005–2010, density approached and exceeded 1. During 2011–2013, density fluctuated between 3–4. From 2014–2017, density surpassed 6, reaching 10.31 in 2017.

To simplify analysis and avoid random annual fluctuations, we divided 1998–2017 into four periods: 1998–2004, 2005–2010, 2011–2013, and 2014–2017. Figure 1 [Figure 1: see original paper] illustrates the cooperation networks for these periods.

Figure 1. Inter-provincial Social Science Cooperation Networks in Mainland China by Period, 1998–2017

In the first period, inter-provincial cooperation was sparse, yielding a relatively simple network where Beijing and Shanghai occupied central positions with the most connections, while Ningxia and Tibet remained isolated. In subsequent periods, cooperation intensified, connections multiplied, and networks became increasingly complex, making it difficult to discern provincial positions through visual inspection alone. Social network analysis is therefore required to examine each province's positional characteristics.

3. Visual Analysis of Core-Periphery Structure Evolution

To clearly analyze provincial positions, we employed Multidimensional Scaling (MDS) to examine relative distances in the cooperation network. Figure 2 [Figure 2: see original paper] presents the MDS results from UCINET's Metric MDS module.

Figure 2. MDS Maps of Inter-provincial Social Science Cooperation Networks by Period, 1998–2017

The MDS maps reveal a distinct core-periphery structure across all four periods. However, while some provinces clearly occupy core or peripheral positions, others fall into ambiguous zones. Beijing and Shanghai consistently occupy the network center, while Guangxi, Ningxia, and Tibet remain at the periphery. The classification of provinces like Jiangsu and Guangdong as central, and the

status of Sichuan, Shandong, and Shaanxi as either core or peripheral, cannot be determined through visual inspection alone. Quantitative analysis is needed to delineate the core-periphery structure.

4. Quantitative Analysis of Core-Periphery Structure Evolution

4.1 Coreness and Concentration Analysis

Using UCINET's core-periphery module, we calculated each province's coreness and concentration. The correlation between the core-periphery structure matrix and the original matrix, along with the Gini coefficient, appears in Table 3 :

Table 3. Correlation and Gini Coefficients by Period, 1998–2017

Period	Correlation	Gini Coefficient
1998–2004	0.727	0.989
2005–2010	0.644	0.975
2011–2013	0.538	0.988
2014–2017	0.571	0.988

Correlations exceed 0.95 in all periods, indicating that the core-periphery structure matrices fit the original data well. The declining Gini coefficients (all above 0.5) reveal high but decreasing inequality in the cooperation network, suggesting the core's dominant role is diminishing.

Table 4 presents provinces ranked by coreness and their corresponding concentration values:

Table 4. Coreness and Concentration by Province and Period, 1998–2017

Rank	1998–2004 (Coreness, Concentration)	2005–2010 (Coreness, Concentration)	2011–2013 (Coreness, Concentration)	2014–2017 (Coreness, Concentration)
1	Beijing (0.953, 0.206)	Beijing (0.968, 0.807)	Beijing (0.910, 0.250)	Beijing (0.944, 0.817)
2	Shanghai (0.114, 0.089)	Shanghai (0.702, 0.633)	Shanghai (0.175, 0.114)	Shanghai (0.817, 0.743)
…	…	…	…	…

From 1998–2004, provincial rankings were unstable except for Beijing and Shanghai, primarily due to the small number of co-authored papers. In later periods, Beijing, Shanghai, Guangdong, Jiangsu, Zhejiang, Sichuan, Hubei, Shaanxi, and Shandong consistently ranked in the top 10, while Xinjiang, Inner Mongolia, Hainan, Guizhou, Ningxia, Qinghai, and Tibet remained in the bottom 7.

Among the remaining 14 provinces, Tianjin and Chongqing rose significantly, while Henan, Yunnan, and Guangxi declined markedly.

4.2 Core-Periphery Structure Partitioning

Current approaches to partitioning valued networks include: (1) using coreness thresholds subjectively, or (2) combining coreness ranking with concentration values [16]. We adopt the latter approach, classifying provinces into four zones based on concentration: core ($ $0.8), semi-core (0.6–0.8), semi-periphery (0.4–0.6), and periphery (<0.4) [17].

Table 5 presents the partitioned structure:

Table 5. Core-Periphery Structure by Period, 1998–2017

Period	Core	Semi-core	Semi-periphery	Periphery
1998–2004	Beijing, Shanghai (2)	Jiangsu, Hubei (2)	Guangdong, Zhejiang, Hunan, Shandong, Tianjin, Fujian, Shaanxi, Sichuan, Henan, Liaoning (10)	17 provinces
2005–2010	Beijing, Shanghai (2)	Guangdong, Jiangsu, Zhejiang (3)	Hubei, Hunan, Shandong, Tianjin, Fujian, Shaanxi, Sichuan, Henan, Liaoning (9)	17 provinces
2011–2013	Beijing, Shanghai, Guangdong (3)	Jiangsu, Zhejiang, Hubei, Hunan, Shandong, Tianjin, Fujian, Shaanxi, Sichuan, Henan, Liaoning (11)	Chongqing, Yunnan, Anhui, Hebei, Heilongjiang, Jiangxi, Jilin, Shanxi, Gansu, Guangxi, Qinghai (11)	6 provinces

Period	Core	Semi-core	Semi-periphery	Periphery
2014–2017	Beijing, Shanghai, Guangdong, Jiangsu (4)	Zhejiang, Hubei, Hunan, Shandong, Tianjin, Fujian, Shaanxi, Sichuan, Chongqing (9)	Henan, Liaoning, Yunnan, Anhui, Hebei, Heilongjiang, Jiangxi, Jilin, Shanxi, Gansu, Guangxi (11)	7 provinces

The core-periphery structure evolved significantly. From 1998–2004, only Beijing and Shanghai were in the core, with most provinces in peripheral zones. During 2005–2010, Guangdong and Zhejiang moved into the semi-core, while nine provinces shifted from periphery to semi-periphery. From 2011–2013, Guangdong entered the core, the semi-core expanded to 11 provinces, and the periphery shrank to six. In 2014–2017, Jiangsu joined the core, Chongqing moved from semi-periphery to semi-core, while Liaoning, Gansu, and Guangxi dropped to peripheral status.

4.3 Research Field Analysis in Core-Periphery Zones

Social science encompasses numerous research fields. SSCI's subject classification (WC) includes 58 categories, which we aggregated into 18 broader fields following established methods [18]. Table 6 shows inter-provincial co-authorship counts by zone and field (averaged per province per year to control for period length and zone size):

Table 6. Inter-provincial Co-authorship by Zone and Research Field (papers/year/province), 1998–2017

Field	Core Zone	Semi-core Zone	Semi-periphery Zone	Periphery Zone
Economics & Business	2.8–192.4	1.1–56.8	0.2–17.3	0.1–3.2
Psychology	2.8–137.1	0.4–46.4	0.3–18.8	0.1–6.0
Health Sciences	0.9–97.3	0.1–27.8	0.1–12.2	0.0–4.9
Environmental Sciences	1.9–76.9	0.4–24.8	0.4–9.7	0.1–4.6

Core zone provinces produced few co-authored papers in 1998–2004, but saw substantial growth in economics & business, psychology, health sciences, and environmental sciences. By 2014–2017, these four fields reached 192.4, 137.1, 97.3, and 76.9 papers respectively, with public management, geography, and library & information science also increasing.

Semi-core provinces showed similar patterns, with economics & business, psychology, and health sciences reaching 56.8, 46.4, and 24.8 papers by 2014–2017. Semi-periphery provinces had minimal cooperation until 2014–2017, when psychology (18.8 papers), economics & business (17.3), environmental sciences (12.2), and health sciences (9.9) showed modest growth. Peripheral provinces had negligible cooperation, averaging fewer than one paper across most fields and periods.

5. Evolution of Cooperation Density Between Core-Periphery Zones

5.1 Overall Density Evolution

Table 7 presents cooperation densities within and between zones:

Table 7. Cooperation Density Within and Between Zones by Period, 1998–2017

Zone Pair	1998–2004	2005–2010	2011–2013	2014–2017
Core-Core	21.0	148.0	168.0	415.17
Core-Semi-core	6.5	51.67	54.27	133.5
Semi-core-Semi-core	0	39.28	53.47	18.98
Core-Semi-periphery	3.25	25.35	18.98	53.47
Semi-core-Semi-periphery	0	16.98	10.97	16.75
Semi-periphery-Semi-periphery	0.5	3.5	5.5	7.0
Periphery-Any zone	<0.1	<0.5	<0.3	<0.4

Four cooperation patterns emerge: (1) Core-core cooperation increased from 21 to 415.17, showing the strongest and most significant intensification. (2) Core-semi-core cooperation grew from 6.5 to 133.5, also strengthening markedly. (3) Semi-core internal and core-semi-periphery cooperation increased from 0–3.25 to 39.28–53.47, showing growing intensity. (4) Cooperation involving peripheral provinces remained consistently low.

5.2 Field-Specific Density Evolution

To examine variation across research fields, we constructed 72 field-specific cooperation networks (18 fields × 4 periods). Based on density patterns, we classified fields into three groups:

Nearly No-Cooperation Fields: Communication, linguistics, social sciences-mathematical methods, international relations, law, political science, anthropology, sociology, social sciences-interdisciplinary, education, and history (11 fields). Table 8 illustrates communication studies, where all inter-zonal densities are negligible.

Table 8. Cooperation Density in Communication Studies by Zone Pair, 1998–2017

Zone Pair	1998–2004	2005–2010	2011–2013	2014–2017
Core-Core	0.33	1.5	2.0	6.0
Core-Semi-core	0.15	0.44	1.03	2.03
Core-Semi-periphery	0	0.11	0.28	0.64
Semi-core-Semi-core	0	0.06	0.25	0.23
Semi-core-Semi-periphery	0	0.01	0.19	0.12
Semi-periphery-Semi-periphery	0	0	0.07	0.02

Core-Zone Cooperation Fields: Public management, library & information science, and geography (3 fields). Table 9 shows public management, where core-core cooperation intensified from 3 to 22.5 papers while other zone pairs remained low.

Table 9. Cooperation Density in Public Management by Zone Pair, 1998–2017

Zone Pair	1998–2004	2005–2010	2011–2013	2014–2017
Core-Core	3.0	9.0	21.0	22.5
Core-Semi-core	0.75	2.4	5.19	5.1
Core-Semi-periphery	0.06	0.27	0.93	1.17
Semi-core-Semi-core	0	0.25	1.43	1.4
Semi-core-Semi-periphery	0	0.19	0.07	0.13
Semi-periphery-Semi-periphery	0	0	0.07	0.04

Multi-Zone Cooperation Fields: Economics & business, psychology, health sciences, and environmental sciences (4 fields). Table 10 shows that in economics & business, core-core density grew from 7 to 140.33, core-semi-core from 2.75 to 41.92, and semi-core internal and core-semi-periphery cooperation also intensified significantly. Psychology and health/environmental sciences show similar patterns of strong core cooperation expanding to adjacent zones.

Table 10. Cooperation Density in Multi-Zone Cooperation Fields by Zone Pair, 1998–2017

Economics & Business: | Zone Pair | 1998–2004 | 2005–2010 | 2011–2013 | 2014–2017 | |———|———|———|———|———| | Core-Core | 7 | 70 | 123.33 | 140.33 | | Core-Semi-core | 2.75 | 16.83 | 42.81 | 41.92 | | Core-Semi-periphery | 0.38 | 7.5 | 20.47 | 11.5 | | Semi-core-Semi-core | 0 | 10.17 | 17.11 | 10.52 | | Semi-core-Semi-periphery | 0 | 1.6 | 4.87 | 4.8 |

Psychology: | Zone Pair | 1998–2004 | 2005–2010 | 2011–2013 | 2014–2017 | |———|———|———|———|———| | Core-Core | 9 | 42 | 67.33 | 69 | | Core-Semi-core | 3.83 | 18.17 | 42.8 | 20.31 | | Core-Semi-periphery | 2 | 8.5 | 20.47 | 9.06 | | Semi-core-Semi-core | 0 | 6.28 | 9.7 | 4.97 | | Semi-core-Semi-periphery | 0.25 | 1.4 | 2.96 | 2.03 |

Conclusions

This study analyzed inter-provincial social science cooperation in mainland China using SSCI data from 1998–2017, revealing several key findings:

1. **Intensifying Cooperation:** Inter-provincial social science cooperation strengthened significantly. SSCI publications, inter-provincial co-authored papers, and cooperation rates all increased markedly, with network density growing continuously.
2. **Evolving Core-Periphery Structure:** The network exhibited a clear core-periphery structure that evolved substantially. More provinces joined the core and semi-core zones while peripheral provinces decreased sharply. Beijing and Shanghai consistently occupied the core. Guangdong and Jiangsu moved from semi-core to core, while Zhejiang, Hubei, Hunan, Shandong, Tianjin, Fujian, Shaanxi, Sichuan, and Chongqing advanced from peripheral/semi-peripheral to semi-core positions.
3. **Dominant Research Fields:** Economics & business, psychology, health sciences, and environmental sciences dominated cooperation across all zones. Over time, core provinces also increased cooperation in public management, geography, and library & information science.
4. **Collaboration Patterns:** Cross-provincial cooperation concentrated primarily between core provinces and between core and semi-core provinces, with densities growing significantly. Cooperation within semi-core zones and between core and semi-periphery also intensified, though cooperation involving peripheral provinces remained limited.

These findings reveal significant and persistent imbalances in knowledge diffusion and flow across provinces. While inequality is decreasing, complete balance is neither achievable nor necessary. To enhance cooperation, core provinces should: (1) maintain strong collaborations in dominant fields to boost international influence; (2) expand cooperation into broader fields; and (3) leverage their influence to develop peripheral provinces' research capacity. Peripheral provinces should strengthen knowledge exchange with core provinces based on their resource advantages.

Future research should examine whether similar patterns emerge from CSSCI data, investigate cooperation mechanisms at the institutional level, and explore the underlying causes of these collaboration patterns.

References

[1] Derek J, Solla P. Little science, big science[J]. Von Der Studierstube, 1963, 7(3/6): 443-458.
[2] Liang Liming, Zhu Ling, Hou Changhong. Matthew effect and geographical preference in China's inter-provincial scientific collaboration[J]. Journal of Dialectics of Nature, 2002, 24(2): 42-50.

[3] Zhang Dongling, Wang Xianwen, Hou Jianhua. Analysis of high-level scientific paper cooperation networks among Chinese cities[J]. China Science and Technology Forum, 2008(9): 102-106.
[4] Guo Shufen, Zhang Jun. Analysis of scientific cooperation intensity and influencing factors among 31 provinces in mainland China[J]. Journal of Nanjing Tech University (Social Science Edition), 2016, 15(2): 103-110.
[5] Li Jiancheng, Wang Qingxi, Tang Gennian. Dynamic evolution of scientific knowledge networks in the Yangtze River Delta urban agglomeration[J]. Studies in Science of Science, 2017, 35(2): 189-197.
[6] Ma H, Fang C, Lin S, et al. Hierarchy, clusters, and spatial differences in Chinese inter-city networks constructed by scientific collaborators[J]. Journal of Geographical Sciences, 2018, 28(12): 1793-1809.
[7] Hao Ruoyang, Lu Wanhui. Evolution of academic cooperation characteristics in Chinese humanities and social sciences[J]. Journal of Intelligence, 2018, 37(6): 124-132.
[8] Su Jinyan. Geographical preferences in Chinese humanities and social sciences cooperation: A bibliometric analysis based on economics journals[J]. New Technology of Library and Information Service, 2013, 29(10): 43-52.
[9] Zhang Chunbo, Ding Kun, Wang Xianwen, et al. Issues in using SSCI to measure China's international social science output[J]. Information and Documentation Services, 2017, 38(3): 26-32.
[10] Browse, search, and explore journals in the Science Citation Index[EB/OL]. [2020-05-01]. https://mjl.clarivate.com/scope-notes.
[11] He Chunjian. Semi-automatic data cleaning method for extracting secondary institution data from WOS address fields[J]. New Century Library, 2017(8): 56-58, 70.
[12] Miao Hong, Lü Jing, Huang Lucheng. Current status and evolution of cross-strait scientific cooperation from a co-authorship perspective[J]. Journal of Intelligence, 2013, 32(11): 64-70.
[13] Wang Gong, Zhao Xinli. Cross-strait scientific cooperation through SCI co-authored papers[J]. China Soft Science, 2007(8): 56-64.
[14] Song Ge. Core-periphery structure analysis of economics journal citation networks[J]. Journal of the China Society for Scientific and Technical Information, 2011, 30(1): 93-101.
[15] Zhang Yu, Wang Yanan, He Xuan. Analysis of China's service trade international competitiveness based on whole-network analysis[J]. International Economics and Trade Research, 2020, 36(1): 19-32.
[16] Wei Xiaojun, Tan Zongying. Analysis of international scientific cooperation networks based on core-periphery structure: The case of nanotechnology (1996–2004)[J]. Library and Information Service, 2006, 50(12): 35-38.
[17] Wu Minglong, Tu Jintang. SPSS and Statistical Analysis Application[M]. Dalian: Dongbei University of Finance and Economics Press, 2012: 187.
[18] Jiang Chunlin, Sun Yu. Rationally viewing SSCI's position and role in social science evaluation[J]. Information and Documentation Services, 2007(2): 26-28.

Author Contributions

Qiu Changbo: Conceptualization, methodology, manuscript revision;
Zhang Xiwen: Data analysis, writing;
Meng Jing: Data processing, manuscript editing.

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