

The cover features a large, stylized graphic on the right side. It consists of several concentric, curved bands. The outermost band is a solid light green. Inside it is a band with a vibrant nebula or galaxy image, showing orange, red, and blue hues. Further in, there's another solid light green band, followed by a thin white band, and then another light green band. The overall effect is a modern, scientific aesthetic.

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Regional tendencies of research collaboration of social sciences in China: Analysis based on papers of economic journals*

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Abstract

Purpose: This study intends to evaluate the regional tendencies of research collaboration of social sciences in China, and shows the pattern of China's inter-regional research collaboration (IRRC).

Design/methodology/approach: By using 10 years' data of 150 economic journals in CNKI database, this paper used the Salton index as the indicator to measure the collaborative intensity of 31 regions in China.

Findings: First, regional tendencies of research collaboration in social sciences do exist in China. Second, there is a positive correlation between collaborative tendency and regional scientific productivity. Every region would like to cooperate with high productive regions, and high productive regions tend to have collaborations within the region itself. Third, geographical proximity is an important factor affecting China's IRRC.

Research limitations: There are many other important external conditions which may affect research collaboration, but not all of them have been taken into account in this research.

Practical implications: The proposed method can be also applied to detect cooperation preference of different authors, scientific research institutions and countries. And the study will help us understand the importance of distance in scholarly cooperation.

Originality/value: Previous researches proved that regional research collaborations exist in natural sciences in China, while this research showed that the same phenomenon also appears in social sciences in China.

Keywords Research collaboration; Regional tendency; Scientific productivity; Physical distance



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1 Introduction

As a general rule, researchers that are in close vicinity interact more intensively than those at a distance. However, some have declared that the phenomenon of “the tyranny of distance” would be ended with the rapid development in information and telecommunication technologies. *The World is Flat*^[1]. Human activities are known to cluster in space, and scientific research is no exception.

Many studies showed that physical distance and territorial borders (such as regional and national borders and language barriers) have influenced the intensity of the research collaboration. Using the data of all co-publications between 313 regions in 33 European countries for the period 2000–2007, Hoekman et al.^[2] found that collaborations with physically proximate partners did not decrease, while the bias towards collaboration within territorial borders did decrease over time.

To examine the geographical effect specifically on intra-national scientific collaboration, Katz^[3] presented an investigation of intra-national university-university collaboration in Canada, Australia and the United Kingdom, and demonstrated that research cooperation decreased exponentially with the distance separating the collaborative partners. Amd Kyungjoon et al.^[4] found that the relationship existed between the distance of coauthors and citations for four kinds of author relationships (first-last, first-middle, last-middle, and middle-middle author relationship) at different spatial scales.

At all sizes of collaboration, including collaboration from two authors to dozens of authors, geographical proximity between the first and the last author is highly informative of impact at the microscale (i.e. within building) and beyond. The mean citation for the first-last author relationship decreased as the distance between them increased in less than 1 km range as well as in the three categorized ranges (in the same building, same city, or different city).

Haustein et al.^[5] described the different forms of reasons for international scientific collaboration in general. In their study, co-publication networks among 11 countries are generated to observe the development of cooperation bonds in the region. By applying Salton's measure of international collaboration strength, they observed an above-average strengthening of scientific collaboration in the Asia-Pacific region. Based on the 253,362 papers of 12 Latin American countries, Huamani et al.^[6] found that Brazil was the most productive country in terms of centrality in South America Continent. Archambault et al.^[7] discussed the calculation approaches of scientific collaboration in different regions and scales.

Liang et al.^[8] found that distance was an important factor which affected research collaboration of European Union (EU). On the basis of the frequency distribution of China's inter-regional co-authored papers retrieved from the Chinese Science



Citation Database, she showed the patterns of China's inter-regional research collaboration (IRRC)^[9]. Her results proved that regional scientific productivity affected both the collaborative preference and ranking of authors' name, and geographical proximity was an important factor determining the pattern of IRRC. In addition, Liang et al.^[10] also found that there are Matthew effect and geographical preference of research collaboration among 34 universities in China^[10,11]. Sun^[12] demonstrated that collaboration among libraries had obvious regional features.

Similar to the law of universal gravitation, an indicator model was adopted by Isard^[13] while analyzing the spatial structure of research collaboration. Using the same method, Ponds et al.^[14] studied the geographical and institutional proximity of research collaboration in Netherlands in 2007, and Hoekman^[15] analyzed the research collaboration productivity of EU in 2009. Liang Liming et al.^[9] discussed the regional tendencies of China's research collaboration by using Salton's method^[16]. However, most studies mentioned above were based on oversea databases and focused on natural sciences. This paper will analyze the research collaboration of social sciences based on papers of economic journals in China.

2 Data

According to Gauffriau et al.^[17], co-authored paper is one of the main forms of research collaboration. Data used in this study are collected from China National Knowledge Infrastructure (CNKI) of 2003–2012, including 150 journals of economics. "Regions" analyzed in this paper only refer 31 provinces, autonomous regions and municipalities on the Mainland. Table 1 presents the result of the total collected papers and the frequencies of research collaboration.

In Table 1, if an author from region X and an author from region Y are co-authors of a paper, it is considered that there exists a relationship of the IRRC between region X and region Y .

It is worth to mention that there are differences between an "inter-regional collaborative paper" and an "inter-regional collaborative relationship", since one inter-regional collaborative paper might include two or more inter-regional collaborative relationships.

Table 2 shows a matrix of the observed value of IRRC. Regions in the column at the left side are the first-authored regions, ranking in a descending order of their productivities (i.e., total papers), while those at the top of the matrix are the non-first-authored regions, arranged from the left to right in a descending order in term of their productivities.

As shown in Table 2, the number of the row is presented with i and that of the column with j , x_{ij} is the frequency of IRRC of i -th region and j -th region with i -th region as the first-authored one.



Research Paper

Table 1 Papers and frequencies of IRRC of 31 Chinese regions

| No. | Region | N_{TP} | N_{SAP} | N_{CAP} | R_{CAP} (%) | N_{IRP} | N_{FAP} | R_{FAP} (%) | F_{FAF} (Times) | F_{NFAF} (Times) | F_{TCF} (Times) |
|----------------------------------|--------------|----------------|----------------|---------------|------------------|---------------|---------------|------------------|----------------------|-----------------------|----------------------|
| 1 | Beijing | 53,908 | 35,539 | 18,369 | 34.07 | 9,988 | 8,381 | 45.63 | 7,664 | 7,346 | 15,010 |
| 2 | Jiangsu | 23,890 | 14,543 | 9,347 | 39.13 | 5,030 | 4,317 | 46.19 | 3,670 | 3,830 | 7,500 |
| 3 | Shanghai | 21,693 | 14,374 | 7,319 | 33.74 | 3,906 | 3,413 | 46.63 | 3,107 | 3,039 | 6,146 |
| 4 | Hubei | 18,126 | 11,504 | 6,622 | 36.53 | 3,225 | 3,397 | 51.30 | 3,084 | 2,732 | 5,816 |
| 5 | Guangdong | 17,095 | 12,225 | 4,870 | 28.49 | 2,576 | 2,294 | 47.10 | 2,117 | 2,222 | 4,339 |
| 6 | Sichuan | 13,361 | 8,741 | 4,620 | 34.58 | 2,248 | 2,372 | 51.34 | 2,140 | 2,216 | 4,356 |
| 7 | Liaoning | 10,605 | 6,661 | 3,944 | 37.19 | 1,851 | 2,093 | 53.07 | 1,890 | 1,982 | 3,872 |
| 8 | Shaanxi | 8,108 | 4,357 | 3,751 | 46.26 | 1,858 | 1,893 | 50.47 | 1,634 | 1,624 | 3,258 |
| 9 | Zhejiang | 12,854 | 9,259 | 3,595 | 27.97 | 1,911 | 1,684 | 46.84 | 1,542 | 1,739 | 3,281 |
| 10 | Tianjin | 9,345 | 5,978 | 3,367 | 36.03 | 1,573 | 1,794 | 53.28 | 1,619 | 1,671 | 3,290 |
| Total/ mean No. 1–10 | | 188,985 | 123,181 | 65,804 | 34.82 | 34,166 | 31,638 | 48.08 | 28,467 | 28,401 | 56,868 |
| 11 | Hunan | 8,842 | 5,530 | 3,312 | 37.46 | 1,591 | 1,721 | 51.96 | 1,538 | 1,184 | 2,722 |
| 12 | Shandong | 8,937 | 5,977 | 2,960 | 33.12 | 1,219 | 1,741 | 58.82 | 1,615 | 1,726 | 3,341 |
| 13 | Jiangxi | 8,050 | 5,616 | 2,434 | 30.24 | 1,170 | 1,264 | 51.93 | 1,165 | 1,140 | 2,305 |
| 14 | Fujian | 8,301 | 6,017 | 2,284 | 27.51 | 1,188 | 1,096 | 47.99 | 1,023 | 1,112 | 2,135 |
| 15 | Chongqing | 5,496 | 3,332 | 2,164 | 39.37 | 994 | 1,170 | 54.07 | 1,036 | 1,033 | 2,069 |
| 16 | Hebei | 4,644 | 2,717 | 1,927 | 41.49 | 762 | 1,165 | 60.46 | 1,062 | 942 | 2,004 |
| 17 | Jilin | 4,624 | 2,716 | 1,908 | 41.26 | 881 | 1,027 | 53.83 | 928 | 811 | 1,739 |
| 18 | Henan | 8,440 | 6,953 | 1,487 | 17.62 | 531 | 956 | 64.29 | 863 | 1,295 | 2,158 |
| 19 | Anhui | 4,430 | 2,962 | 1,468 | 33.14 | 554 | 914 | 62.26 | 1,103 | 769 | 1,872 |
| 20 | Heilongjiang | 3,065 | 1,710 | 1,355 | 44.21 | 637 | 718 | 52.99 | 633 | 559 | 1,192 |
| Total/ mean No. 11–20 | | 64,829 | 43,530 | 21,299 | 32.85 | 9,527 | 11,772 | 55.27 | 10,966 | 10,571 | 21,537 |
| 21 | Yunnan | 4,254 | 2,969 | 1,285 | 30.21 | 699 | 586 | 45.60 | 516 | 884 | 1,400 |
| 22 | Gansu | 2,616 | 1,709 | 907 | 34.67 | 325 | 582 | 64.17 | 521 | 367 | 888 |
| 23 | Shanxi | 2,473 | 1,848 | 625 | 25.27 | 240 | 385 | 61.60 | 364 | 375 | 739 |
| 24 | Guangxi | 2,095 | 1,520 | 575 | 27.45 | 224 | 351 | 61.04 | 331 | 362 | 693 |
| 25 | Xinjiang | 1,251 | 794 | 457 | 36.53 | 191 | 266 | 58.21 | 238 | 349 | 587 |
| 26 | Guizhou | 1,079 | 766 | 313 | 29.01 | 77 | 236 | 75.40 | 229 | 234 | 463 |
| 27 | Neimenggu | 756 | 549 | 207 | 27.38 | 59 | 148 | 71.50 | 139 | 214 | 353 |
| 28 | Hainan | 619 | 414 | 205 | 33.12 | 78 | 127 | 61.95 | 117 | 117 | 234 |
| 29 | Ningxia | 450 | 340 | 110 | 24.44 | 31 | 79 | 71.82 | 74 | 73 | 147 |
| 30 | Qinghai | 318 | 231 | 87 | 27.36 | 24 | 63 | 72.41 | 55 | 55 | 110 |
| 31 | Tibet | 181 | 133 | 48 | 26.52 | 20 | 28 | 58.33 | 24 | 39 | 63 |
| Total/ mean No. 21–31 | | 16,092 | 11,273 | 4,819 | 29.95 | 1,968 | 2,851 | 59.16 | 2,608 | 3,069 | 5,677 |
| Total/ mean | | 269,906 | 177,984 | 91,922 | 34.06 | 45,661 | 46,261 | 50.33 | 42,041 | 42,041 | 84,082 |

Note: TP, Total paper; TC, total collaboration; SAP, single-authored paper; CAP, co-authored (CA) paper; IRP, intra-regional paper; FAP, first-author (FA) paper; FAF, first-authored frequency; NFAF, non-first-authored (NFA) frequency. $R_{CAP} = \text{CA paper}/\text{total paper}$; $R_{FAP} = \text{FA paper}/\text{CA paper}$; $F_{TCF} = F_{FAF} + F_{NFAF}$; $TP = SAP + CAP$.

IRP means co-authored paper with authors from the same region;

IRRC (intra-regional research cooperation) paper is co-authored paper with authors from at least two different regions; and

CAPs are the total sum of both IRP and IRRC papers.



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Table 2 Matrix A: Observed values of IRRC

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | |
|-----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-----|-----|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|----|-------|--------|
| Bei jing su hai | 775 | 652 | 609 | 417 | 462 | 532 | 405 | 323 | 386 | 256 | 457 | 209 | 231 | 224 | 241 | 188 | 293 | 173 | 124 | 166 | 103 | 95 | 61 | 101 | 38 | 83 | 22 | 16 | 16 | 6 | 7,664 | |
| Jiang su hai | 819 | 353 | 251 | 201 | 167 | 151 | 95 | 184 | 93 | 96 | 172 | 213 | 107 | 84 | 62 | 56 | 72 | 156 | 64 | 95 | 33 | 27 | 35 | 30 | 22 | 13 | 11 | 4 | 2 | 2 | 3,670 | |
| Shanghai | 594 | 371 | 185 | 157 | 155 | 120 | 130 | 217 | 140 | 106 | 144 | 106 | 77 | 44 | 53 | 80 | 99 | 63 | 39 | 95 | 29 | 24 | 22 | 28 | 13 | 10 | 1 | 3 | 0 | 2 | 3,107 | |
| Hubei | 718 | 290 | 199 | 206 | 181 | 110 | 115 | 147 | 76 | 135 | 90 | 116 | 89 | 89 | 57 | 59 | 136 | 39 | 26 | 58 | 26 | 19 | 37 | 16 | 26 | 4 | 12 | 3 | 1 | 4 | 3,084 | |
| Guang dong | 388 | 187 | 179 | 205 | 151 | 99 | 80 | 98 | 57 | 88 | 71 | 57 | 86 | 67 | 34 | 22 | 47 | 32 | 16 | 37 | 22 | 17 | 32 | 13 | 10 | 5 | 7 | 5 | 5 | 0 | 2,117 | |
| Sichuan | 408 | 190 | 136 | 154 | 149 | 78 | 87 | 80 | 57 | 71 | 65 | 48 | 51 | 124 | 57 | 22 | 85 | 29 | 26 | 68 | 12 | 16 | 38 | 15 | 30 | 8 | 14 | 3 | 8 | 11 | 2,140 | |
| Liaoning | 467 | 194 | 137 | 89 | 103 | 105 | 88 | 63 | 89 | 24 | 78 | 31 | 34 | 25 | 37 | 95 | 44 | 25 | 43 | 30 | 9 | 13 | 16 | 11 | 9 | 18 | 8 | 3 | 0 | 2 | 1,890 | |
| Shaanxi | 381 | 146 | 124 | 75 | 97 | 112 | 82 | 64 | 44 | 38 | 71 | 31 | 33 | 36 | 39 | 17 | 80 | 29 | 7 | 22 | 11 | 38 | 10 | 20 | 8 | 7 | 0 | 8 | 3 | 1 | 1,634 | |
| Zhejiang | 288 | 173 | 166 | 108 | 83 | 77 | 66 | 60 | 44 | 56 | 45 | 41 | 60 | 38 | 31 | 29 | 36 | 28 | 12 | 41 | 12 | 13 | 7 | 6 | 7 | 7 | 3 | 1 | 3 | 1 | 1,542 | |
| Tianjin | 373 | 123 | 115 | 90 | 58 | 64 | 74 | 45 | 40 | 35 | 128 | 29 | 38 | 20 | 109 | 34 | 55 | 56 | 28 | 31 | 13 | 22 | 10 | 8 | 3 | 13 | 2 | 2 | 1 | 0 | 1,619 | |
| Hunan | 286 | 143 | 133 | 177 | 151 | 81 | 47 | 54 | 68 | 50 | 31 | 54 | 39 | 44 | 18 | 16 | 35 | 20 | 7 | 17 | 12 | 5 | 14 | 9 | 8 | 5 | 7 | 2 | 4 | 1 | 1,538 | |
| Shandong | 364 | 162 | 139 | 84 | 62 | 70 | 96 | 86 | 51 | 139 | 26 | 22 | 34 | 30 | 41 | 22 | 42 | 21 | 25 | 37 | 15 | 10 | 3 | 13 | 7 | 7 | 3 | 2 | 2 | 0 | 1,615 | |
| Jiangxi | 191 | 212 | 106 | 90 | 72 | 53 | 49 | 26 | 50 | 34 | 38 | 36 | 34 | 34 | 21 | 11 | 27 | 8 | 9 | 23 | 4 | 4 | 9 | 5 | 6 | 4 | 6 | 2 | 1 | 0 | 1,165 | |
| Fujian | 212 | 102 | 89 | 64 | 82 | 58 | 31 | 26 | 57 | 34 | 25 | 34 | 27 | 27 | 10 | 18 | 38 | 11 | 14 | 20 | 4 | 5 | 17 | 8 | 5 | 2 | 2 | 1 | 0 | 0 | 1,023 | |
| Chongqing | 229 | 82 | 64 | 70 | 52 | 117 | 37 | 27 | 28 | 35 | 26 | 24 | 18 | 28 | 23 | 14 | 25 | 9 | 9 | 31 | 18 | 11 | 11 | 16 | 21 | 2 | 3 | 3 | 1 | 2 | 1,036 | |
| Hebei | 259 | 80 | 39 | 57 | 32 | 46 | 53 | 55 | 46 | 171 | 15 | 37 | 18 | 17 | 23 | 16 | 22 | 13 | 20 | 16 | 6 | 8 | 5 | 1 | 2 | 3 | 1 | 1 | 0 | 0 | 1,062 | |
| Jilin | 241 | 46 | 59 | 60 | 29 | 25 | 112 | 30 | 31 | 48 | 24 | 41 | 21 | 30 | 22 | 15 | 21 | 7 | 36 | 8 | 1 | 3 | 4 | 7 | 1 | 2 | 0 | 3 | 1 | 0 | 928 | |
| Henan | 183 | 81 | 51 | 74 | 50 | 47 | 38 | 46 | 27 | 31 | 17 | 36 | 21 | 26 | 21 | 13 | 17 | 14 | 14 | 21 | 5 | 8 | 4 | 9 | 2 | 3 | 1 | 3 | 0 | 0 | 863 | |
| Anhui | 188 | 210 | 89 | 70 | 44 | 54 | 64 | 24 | 42 | 33 | 27 | 28 | 18 | 32 | 16 | 24 | 23 | 34 | 16 | 15 | 13 | 13 | 5 | 6 | 3 | 3 | 1 | 2 | 0 | 6 | 1,103 | |
| Heilongjiang | 137 | 59 | 35 | 36 | 20 | 24 | 43 | 20 | 29 | 28 | 18 | 36 | 12 | 6 | 8 | 11 | 36 | 9 | 11 | 4 | 2 | 4 | 3 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 633 | |
| Yunnan | 114 | 59 | 36 | 43 | 35 | 38 | 16 | 17 | 15 | 18 | 8 | 19 | 7 | 7 | 16 | 13 | 1 | 20 | 6 | 8 | 1 | 3 | 3 | 1 | 5 | 0 | 7 | 0 | 0 | 0 | 516 | |
| Gansu | 114 | 35 | 32 | 22 | 28 | 28 | 25 | 31 | 27 | 7 | 10 | 28 | 8 | 15 | 9 | 12 | 6 | 16 | 5 | 6 | 17 | 1 | 13 | 8 | 5 | 2 | 6 | 1 | 1 | 4 | 0 | 521 |
| Shanxi | 97 | 28 | 29 | 22 | 14 | 17 | 23 | 23 | 6 | 21 | 2 | 21 | 5 | 3 | 7 | 5 | 7 | 8 | 5 | 2 | 4 | 3 | 0 | 5 | 1 | 4 | 0 | 1 | 1 | 0 | 364 | |
| Guangxi | 60 | 25 | 24 | 34 | 38 | 23 | 7 | 14 | 8 | 10 | 19 | 10 | 10 | 6 | 7 | 4 | 4 | 8 | 0 | 3 | 7 | 2 | 0 | 3 | 1 | 0 | 4 | 0 | 0 | 0 | 331 | |
| Xinjiang | 64 | 13 | 17 | 14 | 15 | 8 | 7 | 10 | 10 | 5 | 7 | 7 | 14 | 4 | 4 | 4 | 7 | 5 | 3 | 1 | 7 | 1 | 0 | 2 | 1 | 0 | 0 | 2 | 2 | 1 | 238 | |
| Guizhou | 45 | 20 | 21 | 15 | 11 | 26 | 8 | 10 | 13 | 6 | 8 | 6 | 4 | 4 | 5 | 3 | 4 | 4 | 2 | 1 | 3 | 3 | 2 | 1 | 3 | 1 | 0 | 0 | 0 | 0 | 229 | |
| Neimenggu | 50 | 6 | 9 | 9 | 5 | 3 | 8 | 4 | 3 | 9 | 2 | 6 | 1 | 3 | 3 | 1 | 5 | 1 | 2 | 1 | 1 | 0 | 1 | 0 | 4 | 0 | 1 | 1 | 0 | 0 | 139 | |
| Hainan | 19 | 5 | 4 | 16 | 6 | 15 | 3 | 1 | 8 | 3 | 5 | 1 | 4 | 7 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 117 | |
| Ningxia | 29 | 6 | 1 | 5 | 2 | 4 | 1 | 8 | 1 | 1 | 1 | 2 | 2 | 0 | 1 | 3 | 0 | 2 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 74 | |
| Qinghai | 22 | 6 | 0 | 2 | 3 | 3 | 1 | 3 | 3 | 2 | 0 | 2 | 0 | 0 | 3 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 55 | |
| Tibet | 6 | 1 | 1 | 2 | 0 | 2 | 1 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | |
| Total | 7,346 | 3,830 | 3,039 | 2,732 | 2,222 | 2,216 | 1,982 | 1,624 | 1,739 | 1,671 | 1,184 | 1,726 | 1,140 | 1,112 | 1,033 | 942 | 811 | 1,295 | 769 | 559 | 884 | 367 | 375 | 362 | 349 | 234 | 214 | 117 | 73 | 55 | 39 | 42,041 |



Research Paper

Based on matrix **A** (Table 2), we could create a new matrix of observed values. Let the elements of the new matrix be x_{ij}^* ($i \neq j$), $x_{ij}^* = x_{ij} + x_{ji}$. Thus, x_{ij}^* presents the frequency of collaboration between the i -th and j -th regions, no matter which is the first-authored region. Since $x_{ij}^* = x_{ji}^*$, the new matrix is symmetric with the diagonal as the axis of symmetry. We mark the new matrix as **A***. In Table 3, both at the left column and in the top of matrix **A***, there is no difference between first-authored regions and non-first-authored regions.

Table 3 Partial results of matrix **A***

| | 1 Beijing | 2 Jiang su | 3 Shang hai | 4 Hubei | 5 Guang dong | 6 Si chuan | 7 Liao ning | 8 Shaan xi | 9 Zhe jiang | 10 Tian jin | ... |
|-----------------|--------------|------------------|-------------------|------------|--------------------|------------------|-------------------|------------------|-------------------|-------------------|-----|
| 1 Beijing | | 1,594 | 1,246 | 1,327 | 805 | 870 | 999 | 786 | 611 | 759 | |
| 2 Jiangsu | | | 724 | 541 | 388 | 357 | 345 | 241 | 357 | 216 | |
| 3 Shanghai | | | | 384 | 336 | 291 | 257 | 254 | 383 | 255 | |
| 4 Hubei | | | | | 411 | 335 | 199 | 190 | 255 | 166 | |
| 5 Guang dong | | | | | | 300 | 202 | 177 | 181 | 115 | |
| 6 Sichuan | | | | | | | 183 | 199 | 157 | 121 | |
| 7 Liaoning | | | | | | | | 170 | 129 | 163 | |
| 8 Shaanxi | | | | | | | | | 124 | 89 | |
| 9 Zhejiang | | | | | | | | | | 84 | |
| 10 Tianjin | | | | | | | | | | | |
| ... | | | | | | | | | | | |

3 Methods

3.1 Calculation of expected value

In the probability theory, the expected value refers to that of a random variable one “expects” to find. If a random variable process could repeat an infinite number of times, we could obtain the mean values^[18]. Let X be a discrete random variable and take values x_1, x_2, \dots with probabilities p_1, p_2, \dots , respectively, the expected value of this random variable X is an infinite sum^[19] and can be described as Eq. (1).

$$E = \sum_{i=1}^n x_i p_i \quad (1)$$

Then we calculated the expected value of this paper as in Eq. (2).

$$i \neq j, X_{ij} = \frac{x_i y_i}{T - \sum_k \frac{x_k y_k}{T}}; i = j, x_{ij} = 0 \quad (2)$$

Where X_{ij} is the expected value, x_i the frequencies of IRRC with i -th first-authored region and 30 non-first-authored regions, and y_j those frequencies of j -th



non-first-authored region and 30 first-authored regions, respectively. T is the total sum of matrix **A**. Table 4 is the expected value of matrix **B**.

Table 4 Partial results of matrix **B**

| | | 1 Beijing | 2 Jiang su | 3 Shang hai | 4 Hubei | 5 Guang dong | 6 Si chuan | 7 Liao ning | 8 Shaan xi | 9 Zhe jiang | 10 Tian jin | ... |
|-----|-----------|--------------|------------------|-------------------|------------|--------------------|------------------|-------------------|------------------|-------------------|-------------------|-----|
| 1 | Beijing | | 698 | 554 | 498 | 405 | 404 | 361 | 296 | 317 | 305 | |
| 2 | Jiangsu | 641 | | 265 | 238 | 194 | 193 | 173 | 142 | 152 | 146 | |
| 3 | Shanghai | 543 | 283 | | 202 | 164 | 164 | 146 | 120 | 129 | 123 | |
| 4 | Hubei | 539 | 281 | 223 | | 163 | 163 | 145 | 119 | 128 | 123 | |
| 5 | Guangdong | 370 | 193 | 153 | 138 | | 112 | 100 | 82 | 88 | 84 | |
| 6 | Sichuan | 374 | 195 | 155 | 139 | 113 | | 101 | 83 | 89 | 85 | |
| 7 | Liaoning | 330 | 172 | 137 | 123 | 100 | 100 | | 73 | 78 | 75 | |
| 8 | Shaanxi | 286 | 149 | 118 | 106 | 86 | 86 | 77 | | 68 | 65 | |
| 9 | Zhejiang | 269 | 140 | 111 | 100 | 81 | 81 | 73 | 60 | | 61 | |
| 10 | Tianjin | 283 | 147 | 117 | 105 | 86 | 85 | 76 | 63 | 67 | | |
| ... | ... | | | | | | | | | | | |

3.2 Calculation of cooperation preference

Afterwards, we denoted the ratio of observed value to its corresponding expected value as r_{ij} , and $r_{ij} = x_{ij}/X_{ij}$. Based on r_{ij} , we created the ratio matrix **R**. Both the observed value x_{ij} and its corresponding expected value X_{ij} are dependent on r_{ij} . If $r_{ij} > 1$, x_{ij} is larger than X_{ij} , and *vice versa*. This means, the larger the r_{ij} , the closer the collaboration between i -th and j -th regions.

Table 5 Partial results of matrix **R**

| | | 1 Beijing | 2 Jiang su | 3 Shang hai | 4 Hubei | 5 Guang dong | 6 Si chuan | 7 Liao ning | 8 Shaan xi | 9 Zhe jiang | 10 Tian jin | ... |
|-----|-----------|--------------|------------------|-------------------|------------|--------------------|------------------|-------------------|------------------|-------------------|-------------------|-----|
| 1 | Beijing | | 1.11 | 1.18 | 1.22 | 1.03 | 1.14 | 1.47 | 1.37 | 1.02 | 1.27 | |
| 2 | Jiangsu | 1.28 | | 1.33 | 1.05 | 1.04 | 0.86 | 0.87 | 0.67 | 1.21 | 0.64 | |
| 3 | Shanghai | 1.09 | 1.31 | | 0.92 | 0.96 | 0.95 | 0.82 | 1.08 | 1.69 | 1.13 | |
| 4 | Hubei | 1.33 | 1.03 | 0.89 | | 1.26 | 1.11 | 0.76 | 0.97 | 1.15 | 0.62 | |
| 5 | Guangdong | 1.05 | 0.97 | 1.17 | 1.49 | | 1.35 | 0.99 | 0.98 | 1.12 | 0.68 | |
| 6 | Sichuan | 1.09 | 0.97 | 0.88 | 1.11 | 1.32 | | 0.77 | 1.05 | 0.90 | 0.67 | |
| 7 | Liaoning | 1.41 | 1.13 | 1.00 | 0.72 | 1.03 | 1.05 | | 1.21 | 0.81 | 1.18 | |
| 8 | Shaanxi | 1.33 | 0.98 | 1.05 | 0.71 | 1.12 | 1.30 | 1.06 | | 0.95 | 0.68 | |
| 9 | Zhejiang | 1.07 | 1.23 | 1.49 | 1.08 | 1.02 | 0.95 | 0.91 | 1.01 | | 0.72 | |
| 10 | Tianjin | 1.32 | 0.83 | 0.98 | 0.86 | 0.68 | 0.75 | 0.97 | 0.72 | 0.60 | | |
| ... | ... | | | | | | | | | | | |

By adopting Salton index^[15] for relative collaborative strength of two regions, we measured the collaborative intensity in 31 regions as follows with Eq. (3).

$$S_{ij} = \frac{n_{ij}}{\sqrt{c_i c_j}} \quad (3)$$

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Where n_{ij} is the collaboration frequency of i -th and j -th regions, c_i the total collaboration frequency of i -th region. The mean collaboration intensity of every region was calculated with Eq. (4).

$$m_i = \frac{\sum_{j=1}^{31} S_{ij}}{30}, j \neq i, i = 1, 2, 3, \dots, 31 \quad (4)$$

Where m_i is the mean collaboration intensity of i -th region.

4 Analysis

4.1 Regional productivity distribution

As shown in Table 1, most productive regions are situated in the middle and eastern parts of China. On average, there are 2,966 (i.e. the total co-authored paper amount 91,922 is divided by the total region number) collaboration papers in 31 regions of China, among which 11 regions are above the mean value.

Beijing ranks the first with 18,369 collaboration papers, followed by Province Jiangsu (9,347), Municipality Shanghai (7,319), Provinces Hubei (6,622), Guangdong (4,870), Sichuan (4,620), Liaoning (3,944), Shaanxi (3,751), Zhejiang (3,595), Municipality Tianjin (3,367), Provinces Hunan (3,312) and Shandong (2,960), successively.

Thirty-one regions are divided into three groups with a rough interval of 10 regions. As shown in Table 1, all regions are ordered in a descending order of the cooperated papers, and the three groups represent the high, medium and low productive regions, respectively.

4.2 Collaboration tendencies and regional scientific productivity

Both intra-regional papers and IRRC papers are concentrated in the first group, i.e., in the top 11 productive regions. The number of total papers of the first group is 188,985, accounting for 70.02% of the total papers of 31 regions. In addition, this group has produced 34,166 intra-regional papers, which takes 74.83% of the total intra-regional papers of 31 regions. Similar result has been proved by Liang's study^[9] on natural sciences in 2002, in which their first group inter-regional cooperative regions are Municipalities Beijing and Shanghai, Provinces Jiangsu, Guangdong, Hubei, Shaanxi, Shandong, Sichuan, Liaoning and Zhejiang. That is to say, in Liang's study, Shandong did not squeeze into the top 10, while in this study, Shandong ranks 12th and Tianjin 10th position.

From Table 1 we can also see that the mean collaborative ratio of 31 regions is 34.06% over the past decade, in which the collaborative ratios of the three groups are 34.82%, 32.85% and 29.95%, respectively. As the scientific productivity



decreased, the mean collaborative ratio decreased steadily, which shows a difference from Liang's study^[9]. In her study, the first-authored mean collaborative ratio of the high productive group is 48.08%, while those for the middle- and low-productive groups are 55.27% and 59.16%, respectively. This means, the first-authored mean collaborative ratio increased as scientific productivity decreased.

4.2.1 Collaboration preference between Beijing and other regions

During the period of 2003–2012, authors from Beijing produced 18,369 co-authored papers, accounting for 19.98% of total papers of 31 regions. Beijing's first-authored papers are 8,381, which amounts to 18.12% of all IRRC papers of 31 regions. Similarly, Beijing's total frequency of IRRC reaches 15,010 times, about 17.85% of that of 31 regions.

As shown in Table 1, Beijing is the most productive region in scientific research of China, and the collaborative relationship between Beijing and different productive groups could reflect the collaborative preference between different productive regions. According to the classification of high, middle and low productive regions based on Table 1, matrixes **A** and **B** could be divided into the following 16 cells as Beijing-Beijing, Beijing-high, Beijing-middle, Beijing-low, high-Beijing, high-high, high-middle, high-low, middle-Beijing, middle-high, middle-middle, middle-low, low-Beijing, low-high, low-middle and low-low cells. The cooperation preference between Beijing and three different productive regions is calculated according to matrixes **A** and **B** and is presented as in Table 6.

Table 6 Cooperation preference between Beijing and different productive groups

| | | Beijing | High cell (No.2–10) | Middle cell (No.11–20) | Low cell (No.21–31) |
|------------------------|-------------------|---------|------------------------|---------------------------|------------------------|
| Beijing | Observed value | | 4,561 | 2,396 | 707 |
| | Expected value | | 2,700 | 2,303 | 753 |
| | Cooperation ratio | | 1.69 | 1.04 | 0.94 |
| High cell (No.2–10) | Observed value | 4,436 | | 5,552 | 1,536 |
| | Expected value | 2,869 | | 3,464 | 1,132 |
| | Cooperation ratio | 1.55 | | 1.60 | 1.36 |
| Middle cell (No.11–20) | Observed value | 2,290 | 4,751 | | 656 |
| | Expected value | 1,916 | 2,711 | | 756 |
| | Cooperation ratio | 1.20 | 1.75 | | 0.87 |
| Low cell (No.21–31) | Observed value | 620 | 1,083 | 921 | |
| | Expected value | 653 | 924 | 789 | |
| | Cooperation ratio | 0.95 | 1.17 | 1.16 | |

In the Beijing-high cell of Table 6, the observed value (4,561) is greater than the expected value (2,700). In the Beijing-middle cell, the observed value (2,396) is almost similar with the expected value (2,303). In the Beijing-low cell, the observed



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value (707) is smaller than the expected value (753). That is to say, authors from Beijing prefer to select authors from high productive regions as the cooperation partner. When the productivity descends, so does the cooperation preference of Beijing authors. This result is opposite to Liang et al.'s study^[10]. In the high-Beijing (4,439), middle-Beijing (2,290) and low-Beijing cells (620), it seems that as the productivity descends, the preference to choose Beijing as a co-partner descends, too.

4.2.2 Collaboration preference between different productive groups

As shown in Table 7, four cells' values are larger than 1. That is, four observed values are greater than the expected values, including high-middle (1.11), high-low (1.08), middle-high (1.11) and low-high (1.08) cells. This means, high productive regions prefer to collaborate with the partners from middle and low productive regions, while middle and low productive regions prefer to collaborate with high productive regions. It should be mentioned that two cells' values, i.e. middle-low (0.82) and low-middle (0.81), are much less than 1, which means that middle productive regions normally do not collaborate with the partners from low productive regions, and similarly, low productive regions usually do not choose the middle productive region as their co-partners.

Table 7 Cooperation preference of different productive groups

| | High cell (No.1-10) | Middle cell (No.11-20) | Low cell (No.21-31) |
|------------------------|---------------------|------------------------|---------------------|
| High cell (No.1-10) | | 1.11 | 1.08 |
| Middle cell (No.11-20) | 1.11 | | 0.82 |
| Low cell (No. 21-31) | 1.08 | 0.81 | |

4.2.3 Regional productivity and collaborative strength

As shown in Fig. 1, there are positive correlation between regional productivity and collaborative strength. If we take the correlation between IRRC and regional scientific productivity as a bi-logarithmic coordinate system $\log x - \log y$, with the ordinates y being the measures of IRRC, and the abscissas x the indicator of regional productivity, we found that Fig. 1(b) has a similar pattern as in Fig. 1(a), the point ranges in these two bi-logarithm coordinate systems show the same trend. That is, as the regional scientific productivity ascends, the mean collaborative strength ascends, too.

In Fig. 1, there is an isolated point in the up-right corner, which shows that Beijing has the superior position in the regional collaboration: It has the highest productivity, the highest collaborative capacity and the largest mean collaborative strength. Its regression equation in Fig. 1(a) is $y = 0.0046 \times x^{0.52}$, $R^2 = 0.985$, while for Fig. 1(b), $y = 0.0028 \times x^{0.58}$, $R^2 = 0.986$.



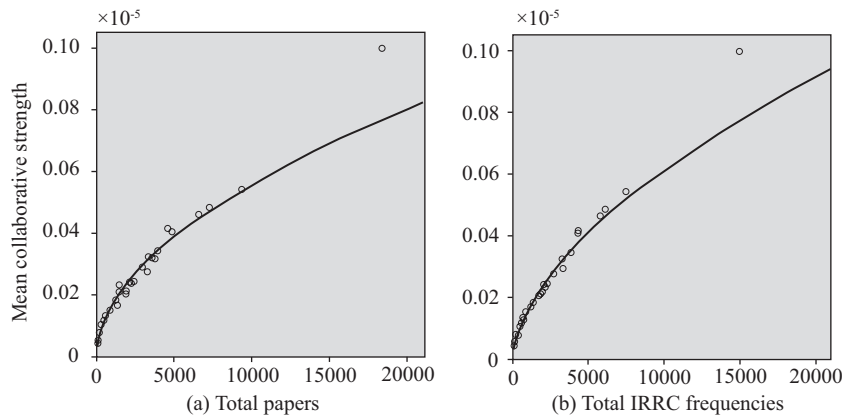


Fig. 1 (a) Relationship between regional productivity and collaborative strength of the i -th region; (b) regional collaborative capacity and collaborative strength of the i -th region by Salton's formula. $i = 1, 2, 3, \dots, 31$.

4.3 Collaboration tendencies and geographical proximity

In order to acquire a holistic overview of the relationship between IRRC and geographical proximity quantitatively, we used the distance indicator d_{ij} to denote the distance between the region i and region j . All together, we have obtained 465 distance data for any two of 31 regions.

4.3.1 Collaboration preference and geographical proximity

Figures 2 and 3 show the correlations between IRRC and geographical proximity in a bi-logarithmic coordinate system $\log x - \log y$. The ordinates y refers to the measures of IRRC, and the abscissas x the indicators of geographical proximity. Different from Fig. 1, all points of Fig. 2 flow from up-left towards right-down, this means, there is a negative correlation between collaboration preference and geographical proximity.

All the 465 distance data are arranged in an ascending order, and they are formed into 12 groups of 40 by 40, in which the last group contains the remaining 25 distance data. d_i is the mean distance of 40 (25) in each group, $i = 1, 2, 3, \dots, 12$. The regression equation of Fig. 2(a) is $y = 1.09 - 0.007x + 2.99e^{-7}x^2 - 4.13e^{-11}x^3$, $R^2 = 0.967$, while that for Fig. 2(b), $y = 1.15 - 0.008x + 3.31e^{-7}x^2 - 4.35e^{-11}x^3$, $R^2 = 0.921$.

Among the 465 distances between any two regions, the longest is 3,558.08 km, the shortest is 103.61 km, and their difference is 3,454.47 km. We divided 3,454.47 km into 12 equal intervals with a distance of 287.88 km (i.e. 103.61 km–391.48 km, 391.48 km–679.35 km, ..., 3,270.18 km–3,558.08 km), and D_i ($i = 1, 2, 3, 4, 5, 6$) denotes the mean distance of each group, in which every pair interval contains 83, 147, 129, 61, 28, 17 distance data, respectively (Fig. 2(b)).



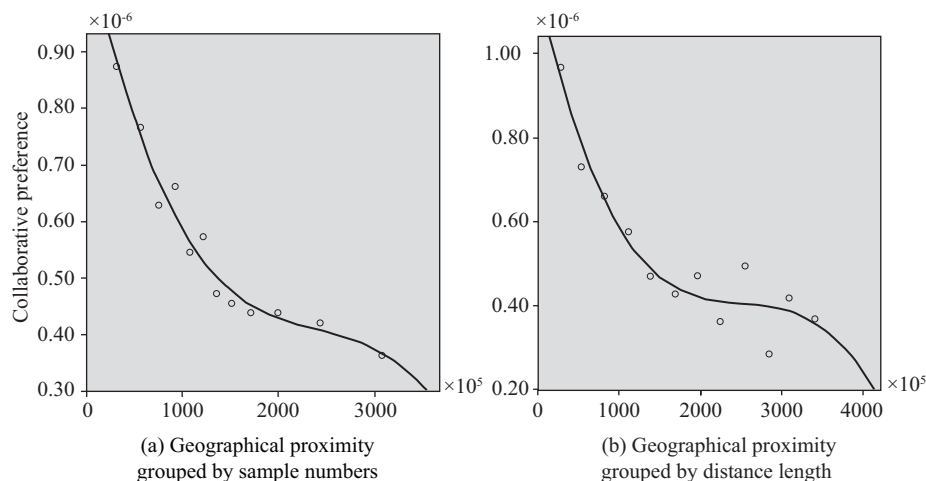


Fig. 2 Relationship between geographical proximity and collaborative preference of (a) sample numbers or (b) distance length.

4.3.2 Collaboration strength and geographical proximity

Similar to Fig. 2, there is a negative correlation between geographical proximity and collaborative strength, the mean collaborative strength of 40 (25) pair regions (Fig. 3(a), corresponding to 40 (25) distance length (Fig. 3(b)) in each group was calculated by Eq. (3), and the mean distance D_i in Fig. 3(b) is defined the same as in Fig. 2(b). The regression equation of Fig. 3 is $y = 0.06e^{-0.0006x}$, for Fig. 3(a), $R^2 = 0.952$, while for Fig. 3(b), $R^2 = 0.939$.

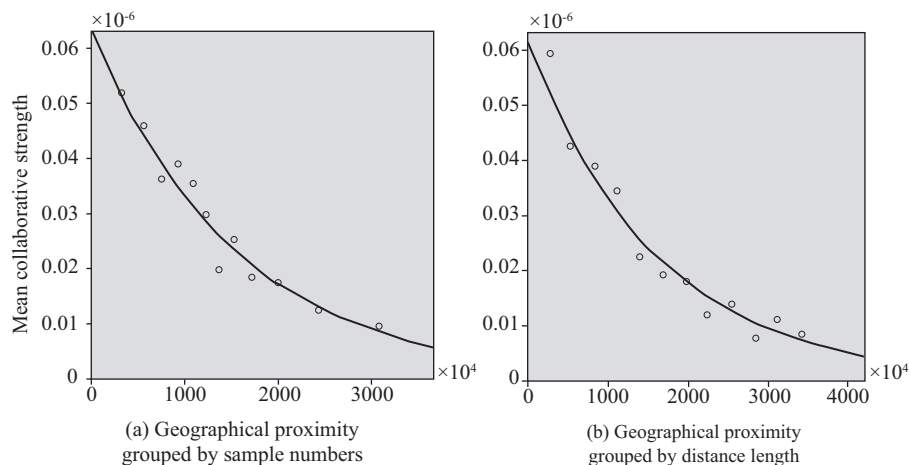


Fig. 3 Relationship between geographical proximity and collaborative strength by (a) sample number or (b) distance length.



From Figs. 2 and 3 we can see that the greater the distance between regions, the lower the mean collaborative strength and collaborative capacity. That is to say, the distance is an important factor which affects the collaborative capacity of different regions, but there are exceptions. We know that the distance between Beijing Municipality and Jiangsu Province is 900.19 km, ranking the 9th shortest distance in 31 studied regions, but the collaboration frequency 1,594 (shown as in Table 2) is the biggest among all 31 regions. The same phenomena have been observed between Beijing and Hubei (1,327 times), and between Shanghai and Liaoning (257 times) as well.

5 Conclusions

- First, there exist regional tendencies of research collaboration of social sciences in China.
- Second, there is positive correlation between collaborative tendency and regional scientific productivity. That means, every productive region would like to cooperate with high productive regions, and high productive regions tend to form collaborations within the circle of the regions.
- Third, geographical proximity is an important factor affecting China's IRRC.

However, though there are many other external factors, such as the economic power, the educational level and R&D input, which have influenced the regional research collaboration, but not all of them have been taken into account in this study. In the future, more influence factors should be taken into account. For instance, the influence of Chinese traditional culture and psychological factors are difficult to measure, but analysis of these factors would be interesting to explore the nature of scientific cooperation.

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The 2014 annual meeting of Global Research Council will be held in Beijing

The Annual Meeting of Global Research Council 2014 will take place in Beijing hosted by the Chinese Academy of Sciences (CAS) and the Natural Sciences and Engineering Research Council of Canada (NSERC).

The 2nd Annual Global Meeting of the Global Research Council (GRC) has ended in Berlin on 29 May 2013. Over three days, the heads of about 70 science and research councils around the world as well as high-ranking guests from science and research, science administration and research policy attended the meeting. The topics of discussion and endorsement were an Action Plan towards Open Access, a high-level Statement of Principles for Research Integrity as well as new statutes for the GRC.

The outcomes of the meeting's discussions as well as the endorsed documents were presented at a press conference on 29 May 2013 in the Berlin-Brandenburgische Akademie der Wissenschaften in Berlin. DFG-President Professor Peter Strohschneider stressed the relevance of "Open Access" to publications as a main paradigm of scientific communication in the following years. The participants agreed that sharing research publications openly is a means to increase the quality of research communication and thus of research itself. The endorsed Action Plan includes activities by which GRC member organisations can foster the open exchange of research results with a high degree of flexibility. Therefore the plan specifies three basic principles: Encouragement, awareness rising, and support for researchers that wish to provide their results in Open Access. The implementation requires engaging a number of stakeholders, for instance, scientists and scholars themselves, universities, science organisations, libraries, and publishers.

The endorsed Principles for Research Integrity point out that researchers and institutions themselves remain ultimately responsible for undertaking research with integrity on the one hand. On the other hand, research funding agencies have an obligation to ensure that supported research corresponds to the highest standards possible, as CNPq-President Professor Glaucius Oliva stated.

Hosted jointly by the German Research Foundation (DFG) and the National Council of Technological and Scientific Development (CNPq) of Brazil, the 2nd Annual Global Meeting was the largest of its kind so far and represented some 80 percent of the world's public, non-ministerial research potential.

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Chinese Journal of Library and Information Science (CJLIS) is the first and only English-language academic journal in the field of Library and Information Science (LIS) that has been published in Mainland China so far. It aims to establish a platform for students, researchers and professionals in LIS and archive science to engage in intellectual dialogs and to share best professional practices of their experience.

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Submission Guidelines

◆ Aims

Chinese journal of Library and Information Science (CJLIS), being sponsored by the Chinese Academy of Sciences (CAS) and published quarterly by the National Science Library of CAS, is a scholarly journal in the field of library and information science (LIS). Its aim is to provide an international communication link between researchers, educators, administrators, and information professionals.

With the publication of the research results both from China and from other foreign countries, the Journal *CJLIS* strikes a balance between theory and practice. With its goal to provide an open forum for Chinese and international scholars in this field to exchange their research results, *CJLIS* also offers new possibilities in the advancement of Chinese library operations. The *CJLIS* tries to establish a platform for LIS students, researchers and library staff all over the world to engage in intellectual dialog and also to improve library services so as to promote even more quickened and substantial development of LIS in China.

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Striving toward academic excellence, innovation, and practicality, the *CJLIS* mainly includes research papers both on the theoretical as well as on the practical fronts in all aspects of the field. More specifically, it includes but not limited to informatics, library management, information technology application, knowledge organization system, knowledge management, archives, permanent preservation of library resources, LIS education, and so on.

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Articles and papers covering the topics or themes mentioned above will be refereed through a double-blind peer review process.

◆ Editorial Advisory Board

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As the first English-language academic journal on LIS published in Mainland China, the *CJLIS* will take a proactive attitude to trace and report the prevailing hot issues in the field around the globe as well as the more serious scholarly communications. As such, the submitted manuscripts are classified into constant categories and unfixed categories. In the former category, research papers, library practice and progress reports are the essential components. In the latter, book reviews, biographical sketches, anecdotes, reminiscence of prominent librarians and brief communications will appear occasionally.

Research papers represent original research work or a comprehensive and in-depth analysis of a topic. More than 3,000 words are considered as a proper length for such manuscripts, with a structured abstract ca. 200 words.

Library practice covers the latest development and application in any segment of library field work and information service. The length of the manuscript is preferred to be more than 3,000 words, with a structured abstract ca. 200 words.

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All papers can be submitted either in English or in Chinese (or both) with a double-line space. For the assurance that all the materials of the to-be-submitted are included, please check the following:

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A guide for authors and other relevant information, including submitting papers online, is available at the website of the Editorial Office of the *CJLIS* (<http://www.chinalibraries.net>). For any questions, you can e-mail the Office or directly to:

Prof. ZHANG Xiaolin

Editor-in-Chief of *CJLIS*

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