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Study of the collaboration in the field of the Chinese humanities and social sciences

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Abstract This paper probes into the current status of collaboration regarding the field of the Chinese humanities and social sciences in respects of the degree of collaboration and the status of the relationships. It researches the status quo in humanities, the growth of social development science and cross-disciplinary social science, and the maturity of applied social science. In addition, it further highlights the important roles of economics, management, and library and information science in the collaboration network of humanities and social science with their extensive intra-disciplinary cooperation and crucial roles in the whole collaboration network.

Keywords Humanities and social science · Degree of collaboration · Cooperative relationships · Social network analysis · CSSCI

Introduction

Scientific research can help train a large number of outstanding talents, and promote the continuous development of national science and technology. However, against the backdrop of "Big Science", it is often multidisciplinary in nature, and requires huge investments as well as expensive and complex experimental equipment, to achieve ambitious research goals. The requirements for researcher to complete research projects have become so demanding that, scientific collaboration has gradually become essential for scientific research (Price 1963).

Similarly, "scientific collaboration" itself has also become an important area of research. Researchers have conducted multi-dimensional, statistical analysis of different disciplines, regions, countries, and periods based on papers in the database to discover the

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characteristics and laws of existing scientific collaborations, in order to guide future collaborations and increase productivity. However, with a survey on the existing research in accordance with the principles of convenience in data acquisition and usability of the data, plus the fact that focused areas vary among different researchers, there haven't been many studies on the collaboration regarding the field of Chinese humanities and social sciences.

This paper, based on the bibliographic data from 407 kinds of journals in the Chinese Social Sciences Citation Index (CSSCI) from 1998 to 2011, aims to study the status of collaboration regarding Chinese humanities and social sciences from the perspectives of the degree of collaboration and the nature of the cooperative relationship.

Literature review

How to study the changing trends of scientific collaboration was one of the concerns for early researchers. Smith (1985) stated that the increase in joint papers symbolized the increase in scientific cooperation. Later, joint papers became the major method for evaluating the cooperative relationship. Researchers analyzed different aspects of the status of cooperation between each discipline and region. Price (1963) explored the trend toward multiple authorship in chemistry with chemistry abstracts as the data set. He found that the proportion of cooperation increased from 20 % in 1910 to more than 60 % in 1960, and thus initially established the mainstream trend of scientific cooperation. With the furtherance of the research, many scientometric indicators (such as the cooperation index, the rate of collaboration, the intensity of cooperation and the scale of cooperation) was put forward and perfected over time. Those researches have laid a sound foundation for how to assess scientific cooperation.

The overall status of cooperation in the field of Chinese humanities and social science has caught the attention of many scholars. Zhong et al. (2000) drew the conclusion that the trend toward multiple authorship in the field of Chinese humanities and social science is on the rise by calculating the joint author rates of theses on Chinese humanities and social science. Gong and Zhao (2003) conducted the statistical analysis of the number of collaborations between authors based on 11,194 papers and compared it with the status of cooperation within international humanities, and social science, and domestic natural sciences. Jiang and Liang (2005) discussed the scale of cooperation, cooperation with institutions, regional cooperation, and characteristics of and causes for the trend toward multiple authorship in the field of humanities and social sciences, through investigating important periodicals of 17 subjects, compared their findings with the status of cooperation in natural science and foreign humanities and social sciences, and thus found the differences. With the nationalization of scientific research, Zheng (2007) explored the coauthor situation of the papers on Chinese humanities and social science from 1995 to 2004 based on the data bases of SSCI and A&HCI.

The degree of cooperation is the most basic way to describe scientific cooperation. And the rate of collaboration (Subramanyam and Stephens 1982) is the simplest and the most commonly used indicator to measure the degree of cooperation. It is defined as follows (Subramanyam 1983):

$$\text{Rate of collaboration } = (N_c / N_a) \times 100\%$$

Where N_c represents the number of collaborative papers, and N_a represents the total number of all papers.

Early studies mainly discussed around the increasing range of the rate of collaboration, in order to study the growth trends of scientific cooperation. Price (1963) found out the increasing status of scientific cooperation from the overall level by inspecting the rate of cooperation, and many scholars have also confirmed this phenomenon subsequently. Stefaniak (1989) found that the increasing speed of the rate of collaboration follows different patterns in specific disciplines. In his study, the rate of collaboration in the field of chemistry is far greater than in physics. Lindsey and Brown (Garfield, 1979) indicated that the rate of collaboration in disciplines under social sciences is relatively low in general. The rate turned out to be only 17–25 % in economy and sociology. In contrast, it ranged from 47 to 81 % in neurology, psychology and biochemistry.

The theory of social network research is being approached in greater depth and the methods are becoming mature, providing an alternative perspective to study the cooperation relationship in scientific research. Newman (2001) studied the network structure of scientific collaboration in such fields as biological medicine, physics, and computer science, and identified the most influential scientist in the network using betweenness centrality. Results showed that the scientific collaboration network is characterized by clustering and scientists of high betweenness centrality play a positive role in advancing scientific cooperation. In 2004, Krechemer made similar attempts. By analyzing the cooperation network of 62 COLLNET members, he obtained the characteristics of this cooperation network. Hou et al. (2008) revealed the status of collaboration shown in papers published in *Informetrics* from macro and micro perspectives by means of social network analysis, co-word analysis and word frequency analysis. Contemporarily, investigations on the cooperation relationship are mainly conducted through analyzing different levels of network structure. To measure the overall structure of the network, four types of indicators are commonly used, i.e., reflecting connectivity, sparsity, coherence, and homogeneity of the network, respectively (Albert and Barabási 2002). And cohesion subgroup analysis is usually applied to partition the sub-structure of the network, in order to reflect group behavior through relationships between nodes (Wasserman and Faust 1994).

Research design

This paper selected 407 periodicals covering 23 subjects collected into the CSSCI from 2010 to 2011 as the data source, which can be mainly categorized into humanities and social sciences. Due to its extensive scope and coverage of many subjects, the latter can be subdivided into social developmental science, cross-disciplinary social science, and applied social science (see Table 1). In this paper, we used co-authorship as the evaluation criteria for collaboration, and probed into the status of cooperation in the field of Chinese humanities and social science in respects of degree of cooperation and cooperation relationship. We measured the degree of cooperation using the rate of collaboration, the simplest and most direct indicator that could describe the general status of cooperation preliminarily. And meanwhile, we expounded the cooperation relationship with social network analysis and visualization methods, and discussed it according to the topological structure of network and subgroup partition. The descriptions of indicators used in this paper are listed in Table 2. (Rate of collaboration is used to measure the degree of cooperation, and the rest of the indicators in Table 2 are restated and discussed in details in section "Topological structures of the collaboration networks of various subjects)"

Table 1 Number of subjects and journals from CSSCI

Category	Subject	Number of journals	Number of papers	Category	Subject	Number of journals	Number of papers
Humanities	Chinese literature	15	26,491	Cross-disciplinary social science	Journalism and communication	15	36,124
	Religious studies	3	6,148		Sociology	9	10,498
	Foreign literature	6	6,444		Education	37	72,603
	History	26	29,853		Library and information science	20	60,532
	Art	19	25,676		Economics	72	136,449
	Philosophy	12	18,532		Management	26	64,519
	Linguistics	22	19,373				
	Archaeology	7	7,868				
Social developmental science	Ethnology	13	17,997	Applied social science	Physical education	10	24,464
	Politics	39	51,560		Human and economic geography	7	13,382
	Law	21	29,648		Statistics	4	14,812
	Marxism	12	23,837		Environmental science	5	14,186
					Psychology	7	10,405

Table 2 Descriptions of indicators used in this paper

Indicator	Description/formula
Rate of collaboration	Rate of collaboration = (the number of collaborative papers/the total number of all papers) × 100 %
N	The number of authors
E	The cooperation relationship of authors in numeric sense
W	The number of components in the network, where components refer to connected sub-networks
G	The scale of the giant component, represented by the ratio of the number of authors in the giant component to all authors
N_i	The ratio of the number of isolated author to all authors
$<k>$	Average degree
D	Network density
C	Network clustering coefficient
$<d>$	Mean distance
e	The power exponent of the power-law distribution amount of nodes

The status of cooperation in each of the 23 subjects

Degree of cooperation in each of the 23 subjects

We investigated and counted the numbers of the joint papers in each subject under Chinese humanities and social science, and calculated the average rate of collaboration. By analyzing the variation trend of the rate of collaboration in each subject from 1998 to 2011, we found that there were two types of trends, i.e., "stable" and "increase". The rate of collaboration and the development trend relevant to those 23 subjects are shown in Table 3.

It can be seen from the table above that the degrees of cooperation in the humanities are relatively low and most of the papers are written by single authors. Significant differences exist in terms of research thoughts and approaches due to the impacts of personal cognitive factors. Besides, studies in this field focus on reflecting values and meanings possessed by human beings on the basis of personal feelings and epiphanies, so as to concrete individual perceptions, understandings and expressions, instead of acquiring the recognition from others or stereotyped ideas (Jiang and Liang 2005). However, the situation in archeology is a little different, because it enjoys a rate of collaboration of 41 %. The reason accounting for this is that it requires more field investigations, a lot of the researchers' energy, as well as support from relevant institutes to do archeological research. At the same time, the rate of collaboration in this subject remained stable from 1998 to 2011.

The degrees of cooperation in subjects under social sciences are different. With respect to subjects under social developmental science, relevant researches take the whole country as the object of study, focusing on the trends and evolution rules of the country's overall development. They require the guidance of general ideas and approaches, while in the academic circle scholars air their own opinions on different cases; and thus, in this field, the collaboration on the whole is not extensive. With respect to the subjects under the cross-disciplinary social science, relevant researches attach more importance to showing the phenomena and the rules behind concerning different systems and dimensions of social life, covering a broader area, and therefore, they calls for the cooperation between multiple

Table 3 Average rate of collaboration and changing trends relevant to subjects under humanities and social sciences

Subject	Average rate of collaboration (%)	Change in rate of collaboration	Subject	Average rate of collaboration (%)	Change in rate of collaboration
Chinese literature	9	Stable	Religious studies	11	Stable
Foreign literature	13	Stable	History	13	Stable
Art	14	Stable	Philosophy	19	Increase
Linguistics	24	Increase	Archaeology	41	Stable
Ethnology	20	Increase	Politics	21	Stable
Law	22	Stable	Marxism	23	Increase
Journalism and communication	25	Increase	Sociology	33	Increase
Education	38	Increase	Library and information science	39	Increase
Economics	43	Increase	Management	61	Increase
Physical education	60	Stable	Human and economic geography	62	Increase
Statistics	62	Increase	Environmental science	71	Increase
Psychology	85	Increase			

parties in order to address the issues comprehensively and thoroughly. In addition, in cross-disciplinary social science research, workers tend to combine qualitative and quantitative methods such as the use of questionnaire, and the data processing requires joint efforts. Due to constant development within and across the disciplines, research of social issues is no longer confined to small-scale investigations and interviews. Data support, method updating and the convenience of simulation make research more thorough and effective, and meanwhile the cooperation should be enhanced to ensure the success. Among those subjects, economics and management are of great concern to Chinese researchers in the past decade. As traditional research paradigms are not applicable to the current complex situation, for the development of economics and management, to promote exchanges between workers in different fields and learn interdisciplinary knowledge (such as sociology, psychology, system science, computer science, etc.) has become an important way. Therefore, the degree of cooperation in this subject is on the rise, showing consistency with the increase in the rate of collaboration (the rates of cooperation in management and economics are 39 and 34 % respectively). With respect to the subjects under applied social science, the degrees of cooperation are relatively high, all above 60 %, with the rate of collaboration reaching 85 % for psychology. Studies related to those subjects stress empirical or applied research. They share more similarities with the research of natural sciences in terms of the expression of concepts and application of methods, requiring laboratory equipment and a large amount of back-up empirical data, and thus it is difficult for a person to finish the research alone.

Cooperation relationship shown in each of the 23 subjects

Based on the data relevant to those 23 subjects collected in 14 years, we constructed the collaborative networks of various subjects, learnt the basic status of collaboration in subjects through overall structural analysis at the macro level, and clarified the interactivity between authors with in-depth exploration of substructures.

Topological structures of the collaboration networks of various subjects

The basic statistics of the collaboration networks of 23 subjects are shown in Table 4. Undoubtedly, there is the largest collaboration network in the discipline of economics (72,104 authors), because in CSSCI most of the literature deals with economics, which reflects the important role of economics in Chinese humanities and social sciences in a sense. And thus this discipline attracts a multitude of researchers who develop an immense collaboration network.

In terms of the connectivity of the networks, each subject consists of many components, the networks contain many connected nodes, and there exists a giant component that is comprised of most authors. But in terms of the ratio of the authors in the giant component to all the authors in the network, each subject differs from each other: the ratio for psychology is 86.2 % and for physical education 77.9 %. The two figures are far greater than those for other subjects. This indicates that in those two subjects, most authors have cooperated with others and there have been adequate academic exchanges. Meanwhile, the proportions for some subjects are lower (<10 %), with the lowest being history (1.3 %). However, by calculating the number of each component covered by those subjects, we found that the number of authors contained in the components at the second level is close to that in the giant component. For example, the numbers of authors contained in the components at the first four levels under history are 183, 120, 74, and 56 respectively. It shows that studies relevant to those disciplines are relatively independent, and thus form different schools and circles. Members of different schools or circles tend to communicate within their individual schools or circles, which leads to the lack of integration of different ideas. In terms of the percentages of isolated nodes, most subjects have high percentages and only subjects under the applied social science have a lower percentage. Newman pointed out that intellectual isolation from the mainstream of one's research area cannot often be a good thing (Newman 2004). However, compared with that of natural sciences, the research of humanities and social sciences attaches more importance to subjective cognizance and social response, thus forming network structures with different features.

All subjects have low network density, between 0.00003 and 0.00051, verifying the scarcity within the network as the collaboration between authors is not much. The average degree reflects the average number of joint authors for each subject, and the result shows that average degrees for 9 subjects are small (<1) and for 4 subjects greater than 3. The differences between the subjects result in the different possibilities of co-authorship in different subjects. The change in average degree over time can show the relation between the number of authors and the cooperation relationship within each subject. The result is shown in Fig. 1.

It was concluded from this figure that the average densities for most subjects increased steadily over time, with the exception of that for the religious studies, which rose considerably and then fell from 2001 to 2004. This showed that the growth rate of cooperation relationships exceeded that of the number of authors, and each subject gradually moved towards the relatively dense phase (still the sparse network). This also indicates that with

Table 4 Macro-statistical data from the 23 subjects

Subject	N	E	W	G (%)	N_i (%)	<k>	D	C	<d>	e
Chinese literature	11,239	3,347	8,760	6.2	67.9	0.60	0.00005	0.51	5.41	2.04
Religious studies	3,321	917	2,660	5.4	71.0	0.55	0.00017	0.64	4.63	1.82
Foreign literature	3,274	955	2,435	1.6	59.8	0.58	0.00018	0.56	2.70	1.99
History	14,258	4,785	10,502	1.3	62.0	0.67	0.00005	0.57	5.37	2.27
Art	12,457	6,150	8,795	13.0	60.4	0.99	0.00008	0.59	5.95	1.86
Philosophy	9,350	4,035	5,987	6.7	50.2	0.86	0.00009	0.54	8.73	2.17
Linguistics	10,218	5,472	5,828	20.1	45.4	1.07	0.00010	0.52	10.74	2.36
Archaeology	4,948	4,690	2,351	20.6	37.5	1.90	0.00038	0.74	7.03	1.94
Ethnology	12,053	4,865	8,130	3.9	51.8	0.81	0.00007	0.63	7.96	2.48
Politics	29,139	13,358	18,818	6.5	50.4	0.92	0.00003	0.57	11.63	2.50
Law	12,910	7,057	7,063	23.9	42.4	1.09	0.00008	0.42	10.83	2.40
Marxism	13,788	6,635	8,377	9.2	45.9	0.96	0.00007	0.56	10.33	2.58
Journalism and communication	20,469	14,323	11,576	21.5	46.2	1.40	0.00007	0.68	10.90	2.29
Sociology	8,209	5,993	4,295	16.8	36.9	1.46	0.00018	0.74	7.05	2.16
Education	44,442	45,150	17,117	43.8	28.8	2.03	0.00005	0.68	8.19	2.57
Library and information science	31,347	36,019	11,148	50.4	27.8	2.30	0.00007	0.65	7.09	2.37
Economics	72,104	77,875	23,625	55.7	25.4	2.16	0.00003	0.56	7.56	2.66
Management	46,878	60,562	12,157	61.2	18.2	2.58	0.00006	0.66	7.13	2.45
Physical education	18,072	38,073	14,079	77.9	10.9	4.21	0.00023	0.69	6.00	2.30
Human and economic geography	12,252	18,748	2,568	60.9	12.0	3.06	0.00025	0.75	6.88	2.28
Statistics	16,403	15,140	5,579	29.8	17.3	1.85	0.00011	0.72	11.76	2.70
Environmental science	18,955	35,600	3,320	62.8	9.3	3.76	0.00020	0.81	7.63	2.38
Psychology	8,716	19,471	583	86.2	3.5	4.47	0.00051	0.77	5.45	1.98

N represents the number of authors, E the cooperation relationship of authors in numeric sense, W component number, G the ratio of the number of authors in the giant component to all authors, N_i the ratio of the number of isolated author to all authors, <k> average degree, D network density, C network clustering coefficient, <d> the mean distance, and e the power exponent of the power-law distribution amount of nodes

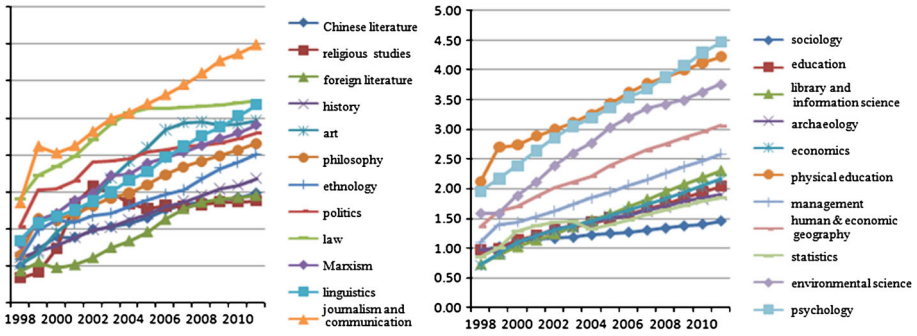

Fig. 1 Change in the average degree for each subject from 1998 to 2011

the advance of scientific research, authors in different subjects tend to collaborate with others.

Small-world phenomenon prevails in the collaboration network. Despite the differences in the clustering coefficients and mean distances between different networks, the collaboration networks related to the 23 subjects were all small-world networks compared with the stochastic network with different scales of authors.

The network clustering coefficients are relatively high, between 0.42 and 0.81, which manifests the possibility for co-authorship between two authors engaged in the field of Chinese humanities and social sciences is high if they both have cooperated with a third author. The measured mean distance for foreign literature is 2.70, while the figure for statistics is 11.76, and for 13 subjects the mean distances are within the range from 5 to 8. The mean distances for many collaboration networks are also within this range in the previous studies in this regard (Yan et al. 2010). We hold that the mean distance, which takes on different characteristics according to the development of the subject, can reflect the development of the subject to some extent. In 2010, Lee analyzed the collaboration networks related to the research with complex networks, and found that the evolution of the mean distance in a giant component within the collaboration network can be divided into three stages. In the first stage, the scale of the giant component is small, and often only a few authors form the network with small mean distances. In the second stage, as the collaboration increases, small networks are gradually connected, and the mean distances increase exponentially; however, the collaboration among authors is not mature, and the network at this stage takes on a tree-like structure. The third stage is a mature and stable network, featuring widespread cooperation, constant expansion of the giant component, and more obvious small-world phenomenon, While the mean distance decreases and stabilizes at a certain fixed value (Lee et al. 2010). Therefore, this paper, through the analysis of the mean distances of the collaboration network of 23 subjects in the past 14 years, concludes that there are mainly four situations representing change (see Fig. 2).

It can be concluded from the above figure that there are four changing patterns regarding the mean distances for the networks related to subjects under Chinese humanities and social sciences: (a) "increasing-stable" pattern: the mean distance at first increased and then stabilized within a certain range, which was represented by humanities. The stable mean distances for different subjects also differ: law stabilized at about 11 while foreign literature stabilized at 3; (b) "stable–increasing" pattern: the mean distance at first stabilized and later increased gradually, which is represented only by religious studies, history and Marxism; (c) "stable–increasing–decreasing" pattern: compared with Pattern b, this pattern registered obvious fall and ultimately stayed around 11 in the last two or three years; (d) "increasing–decreasing" pattern: obvious increase was observed in the first few years followed by gradual decline later, which involved 8 subjects with mean distances all holding at about 7.

The "stable–increasing–decreasing" pattern conforms to the stage proposed by Lee. Actually, due to different levels of development within each discipline, we hold that Patterns b and d partially reflect the changes in mean distance. For subjects under the social developmental science, their networks are still expanding because of a lack of collaboration at the initial stage and increased cooperation in recent years, and meanwhile, due to the mutual integration of different communities, the mean distance is still on the rise. For subjects under the applied social science, as they have entered a mature development phase, and there was relatively extensive cooperation in the early years, the collaboration has increased rapidly and led to exponential increase in the mean distance. However, as the giant component stabilized, the cooperation relationship was established more within the

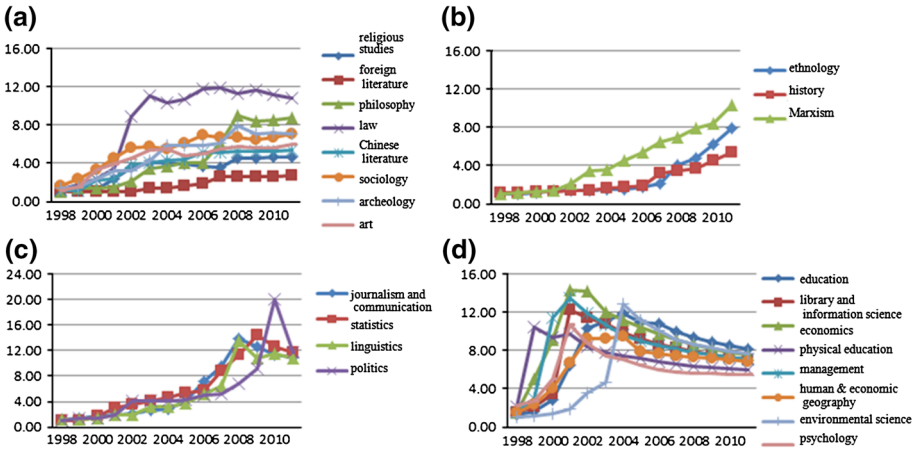

Fig. 2 Variation trends of mean distance for each subject from 1998 to 2011

giant component; therefore, the mean distance decreased. At the same time, the mean distance for subjects of this type remained at around 7, indicating that the mean distance of the level of cooperation in the humanities and social science is 7. It can be concluded that close ties were established among the authors and the academic exchange is easy to conduct. However, unlike the above rules, the collaboration network in Chinese humanities and social sciences presents another characteristic, namely, there is not any significant decrease in humanities and most increases are followed by stability. This is because this type of subjects involve smaller scope of collaboration, the giant component usually consists of less than 100 members, and the cooperation relationship is stable.

Then we analyzed the distribution of node degree using the power-law regression, and found that the distribution of the degrees for each subject conforms to the power-law distribution with power exponent less than 3, which indicates that the collaboration network is a typical scale-free one. The network shows significant heterogeneity, which means a few authors have many partners while most authors establish few partnerships with others. In addition, the higher the power exponent is, the more significant the centrality is, which can be represented by statistics and economics. The situation is slightly different in terms of the power exponent for the complex network. Price analyzed the citation network in 1965 and obtained a power exponent range of 2.5–3 (Price 1965). However, the power exponent of the distribution of degrees for the collaboration network in the humanities and social sciences we obtained in this paper ranges from 2 to 2.5; and the centrality is less significant than that of a citation network.

Substructure division of the collaboration networks in each of the 23 subjects

We used the k-core analysis method in this paper to divide the overall structures of the collaboration networks in those 23 subjects, visualized them, and obtained the network diagrams (see Fig. 3). The subgroup structures of subjects are shown directly in the figure and there are mainly four types as follows:

(1) The "independent type". There are not many links among subgroups and no obvious core subgroups. The subjects belonging to this type include ethnology, religious

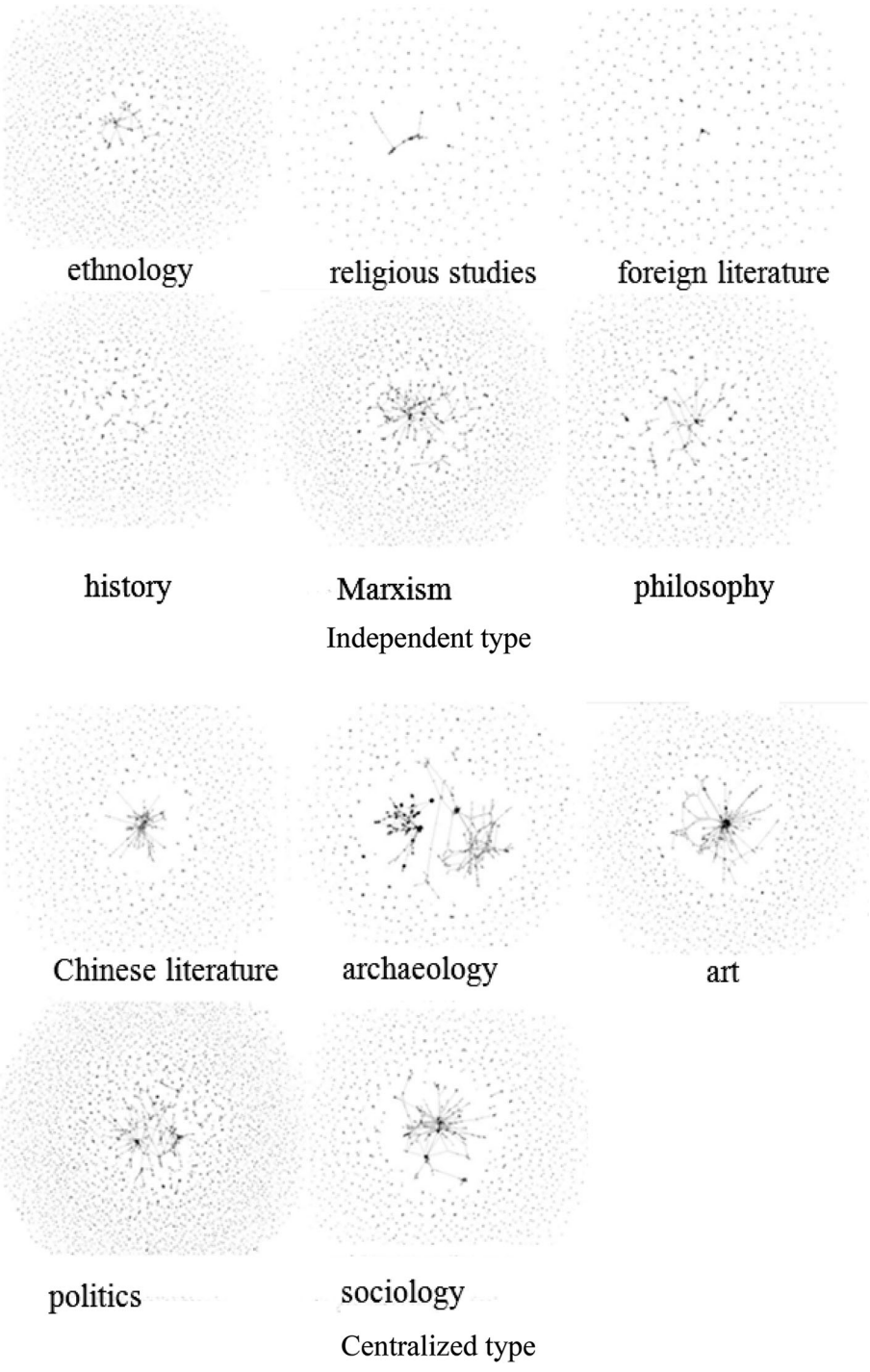

Fig. 3 k-core structure for each of the 23 subjects

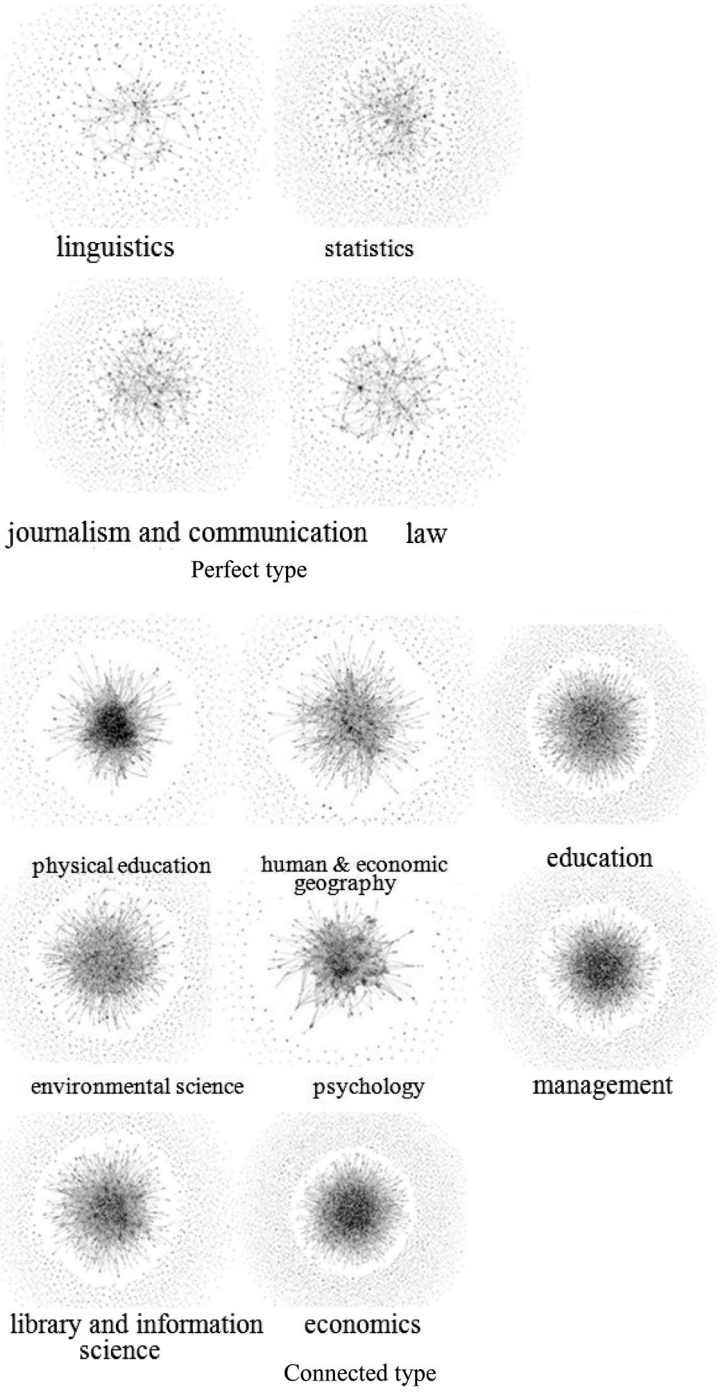

Fig. 3 continued

studies, foreign literature, history, Marxism, and philosophy. Their networks do not contain subgroups with many authors, and no significant circle with core authors has been formed, and therefore, the researchers are more independent.

(2) The "centralized type". Chinese literature, archaeology, art, politics, and sociology show subgroup networks of this type, which features an obvious single or multiple kernel circles in the network and dendritic morphology of the cooperation relationship. Among these subjects, Chinese literature and art have only one obvious kernel circle; politics, art, and archaeology have two closely linked core subgroups (the two subgroups in archaeology are not connected). The subjects of this type form a small community for collaboration, but the community does not exchange with other communities.

(3) The "perfect type". This type of networks features a connected network of a certain scale without significant dense areas. The network diagrams for such subjects as linguistics, statistics, journalism and communication, and law all have such features. The subgroups in these networks are closely linked with each other and establish a certain cooperative relationship with other subgroups, and all the connected network subgroups are relatively evenly distributed, resembling a perfect network of subgroups.

(4) The "connected type". The center of a network diagram is the connected network formed by the vast majority of authors, and there are altogether 8 subjects included in this group, namely, physical education, human and economic geography, education, environmental science, psychology, management, library and information science, and economics. These subjects are at maturer development stage and enjoy a high degree of collaboration within themselves, resulting in complex cooperation relationships. Authors in these subjects are more inclined to cooperation, which is facilitated by convenience and accessibility.

The results are consistent with the analysis of average distances in the networks. As those subjects are at different levels of development, and show different demands, there are differences in the formed collaboration networks and subgroups.

The holistic status of cooperation in the field of Chinese humanities and social sciences

Degree of cooperation in Chinese humanities and social sciences

In the past 14 years, the average rate of collaboration in the field of Chinese humanities and social science stands only at 36 %, with a slight year-on-year increase. The overall rate of collaboration in 2011 was still below 50 %. This result is similar to that found by other scholars. The rate of collaboration was found to be 34 % in the quantitative study by Jiang and Liang (2005) based on 17 kinds of humanities and social sciences journals from CNKI (1995–2004). Su and Zhou (2008) studied the bibliographic records from 2004 to 2006 with the database of CSSCI, and obtained that the rate of collaboration was 31 %. They also found that it was very common to see a teacher and his/her student co-author a paper. Therefore, we gained the conclusion that the degree of cooperation in the field of Chinese humanities and social science is relatively low.

As different subjects show varied natures and levels of development in different regions, the laws of cooperation for domestic and foreign natural sciences and humanities and social sciences also differs. The degrees of cooperation within subjects in the past research

are partially shown below (Wang 1990; Han 1998; Zhong et al. 2005; Gong and Zhao 2003; Moody 2004; Zheng 2007) (See Table 5).

We found through comparison that the degree of cooperation for Chinese humanities and social sciences on the whole is low, far below that for Chinese natural science, and there exists a certain gap compared to that for international humanities and social sciences. The collaboration displays different features, but there is a lot of room for improvement, despite the features of those subjects and the influence of China's basic national conditions (incentive systems, training programs, etc.).

Cooperation relationship shown in the networks related to Chinese humanities and social sciences

The overall collaboration network consisting of those 23 subjects is a larger sparse network with less cooperation among authors, a large proportion of cooperation within the same institution and a high concentration in certain fields. Therefore, this paper only focuses on the top 1 % of authors (3,863) in each subject to construct the institutional cooperation network for Chinese humanities and social sciences, so as to reflect the overall status of collaboration in the field of humanities and social sciences.

The topological structure of the institutional collaboration network

According to the statistics related to the macro-index of the institutional collaboration network in humanities and social sciences, the network covers 4,694 institutions, 4,157 pairs of partnerships, and 1,510 connected components. In the giant component, there are 2,525 institutions; the component at the second level involves 10 institutions; components at lower levels consist of less than 10 institutions; and there are 1,031 independent institutions. On the whole, the connectivity of this network is relatively good, and the giant component covers the vast majority of the authors (53.79 %).

The density of the overall collaboration network is 0.00038, which means the network is quite sparse. There is not much cooperation among institutions due to the wide areas involved, and the fact that different institutions conduct research in varied disciplines with different focuses. The clustering coefficient is 0.2236, far greater than that of the

Table 5 Degree of cooperation shown in the past research

Subject/field	Country	Time	Degree of cooperation (%)	References
Natural science	China	1988	86.8	Wang (1990)
Natural science	China	1994	84.2	Han (1998)
Natural science	China	1988–1997	58.5	Zhong et al. (2000)
Humanities and social science	China	1988–1997	16.9	Zhong et al. (2000)
Humanities and social science	China	1997–1999	14.1	Gong and Zhao (2003)
Humanities and social science	International	1997–1999	32.0	Gong and Zhao (2003)
Humanities and social science	International	1963–1999	33.2	Moody (2004)

corresponding stochastic network (0.0009). The average distance stands at 6.18. Thus, this network registers the characteristics of small-world network.

The average degree related to the network is 1.7708, which indicates that each institution on average has two partners. The distribution diagram of the degree values of all institutions is obtained by regression analysis, in which x-axis and y-axis are both logarithmic coordinates, and the fitting results show $e = 2.0585(R^2 = 0.9651)$. That is to say, the distribution diagram of the degree values of all institutions is a power-law distribution and the network is scale-free. It is thus concluded that some institutions in this network enjoy extensive cooperation with others and their very existence creates indirect links between many other institutions.

Subgroup divisions of the institutional collaboration network

We used the method of k-core analysis to divide the overall structure of institutional collaboration network, and visualized the giant component. According to the type of institutions, we specified the subjects involved in the research by institutions showing significant clustering (see Fig. 4).

It can be seen from the above figure that institutions of the same type show closer relationship and the connections between subjects are complex. Firstly, for some subjects like literature and linguistics, there is no direct substructure group shown in the figure, as those subjects have little, internal cooperation and few connections with other subjects. Secondly, many subjects appear in the margin of the overall institutional collaboration network such as ethnology, archaeology, history, education, psychology, and physical education, and they have little interaction with other subjects, and thus no close network is forming. However, physical education is a little special, which has complex internal connections, but is isolated from the whole network, forming relatively distinct small groups. Thirdly, some subjects in the center of the institutional collaboration network are closely connected, such as economics, management and library and information science, sociology and politics, etc. These subjects are mutually integrated and enjoy a high degree of cooperation.

This paper also investigated the Blondel community division of the network containing the giant component, and divided the giant component into 514 communities with each focusing on different subject, including 22 communities consisting of over 50 institutions. This paper analyzed the first 10 communities in details and obtained the main research fields of each community as shown in Table 6.

The links among the subjects can be clearly viewed from the above table, which is in consistent with Fig. 4. Economics and management are the major areas of research in the humanities and social sciences. They cooperate frequently with each other and some research displays strong connections with library and information science and statistics due to their different emphases. Humanities appear in a few communities with internal connections such as Community 507. Though the rate of collaboration in developmental social science is comparatively low, there is a significant trend of concentration in terms of the level of closeness regarding the institutional collaboration. The connections between subjects are close, and the concentration appear near the center of the overall network. Applied sciences are relatively independent. For example, most of the institutions in Community 314 are related to physical education; the two subjects, environmental science as well as human and economic geography, usually appear in one community. In addition, there are some other subjects showing close relations with each other, such as psychology and education, and art and journalism and communication. The closeness is resulted from the same research trend in those subjects.

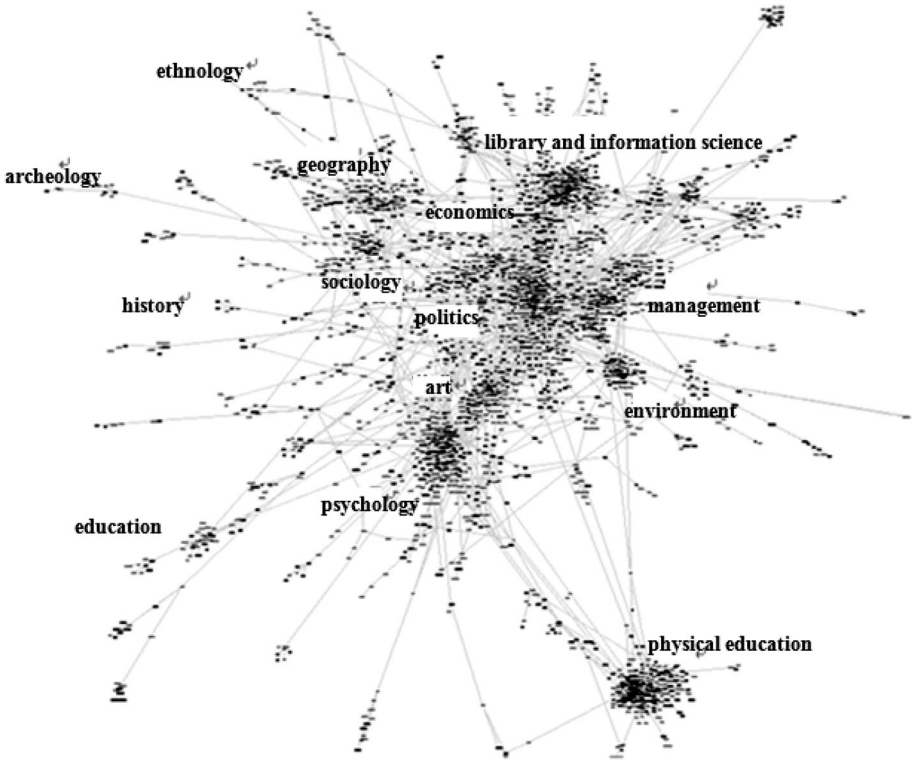

Fig. 4 k-core structure of the giant component in the institutional collaboration network in humanities and social sciences

Table 6 Blondel community division of the institutional collaboration network and corresponding fields

Community	Node	Field
330	230	Human and economic geography, environmental science
408	193	Psychology, education
439	166	Economics, management, library and information science
165	141	Politics, sociology, law, Marxism
314	129	Physical education
456	126	Art, journalism and communication
33	122	Statistics, economics, management
175	117	Economics, management
507	116	Linguistics, literature, history
147	108	Education, human and economic geography

Discussion

This paper analyzes the status of collaboration in Chinese humanities and social sciences. On the one hand, it explores the characteristics of cooperation within the 23 subjects by

statistics and analysis; on the other hand, it makes bibliometric analysis on the overall situation of cooperation in humanities and social science, attempting to explain from the perspective of interdisciplinary collaboration.

Contrastive analysis of collaboration in humanities and social science

This paper investigates the status of collaboration within 23 subjects in the past 14 years through analyzing the degree of cooperation and the cooperative relationship. Due to the wide coverage of subjects and their different focuses, their status of cooperation also differs greatly. Their respective features are explained as follows:

(1) The particularity of humanities. Unlike the situation of other disciplines, the rate of collaboration for the humanities is quite low and the sub-network is relatively independent. And in recent years there is no significant change in those regards, and the status quo of writing papers independently is basically maintained (there is more collaboration in archaeology research group). We hold that the humanities research differ from common scientific research, because subjects relevant to this field emphasize more on human consciousness and such irrational methods as introspection, imagination, experience and intuition are employed for the study. The researchers tend to use individual cases and take self-awareness as the subject, focusing on the existence, happiness, culture, beliefs and values, and ideals of human beings. It is difficult for them to obtain from their studies the universal rules or relevant extrapolation (Wang 2009). Therefore, with respect to the exploration into humanity and culture, the scientific achievements are characterized by difference-seeking, which means that researchers stress finding out unique research perspective and image, leading to diverse studies on the same subject. Thus, writing papers independently is undoubtedly the better research approach in this special academic atmosphere.

(2) The growth property of social developmental science and cross-disciplinary social science. Social developmental science and cross-disciplinary social science both belong to social sciences, which focus on objective social phenomena and laws (Wang 1999) with the former studying the mode of operation and system regarding the development of the whole society and the latter dealing with the interpersonal relationship. Their different emphases lead to their different characteristics. Currently, the cooperation level of social developmental science is relatively low, while the cooperation in cross-disciplinary social science is intensive with adequate exchanges between researchers. However, considering the development trend, they both register a rising tendency in cooperation. Social science research, for the most part, is deductions based on the complexity and extensive nature of facts about society. Therefore, in addition to relevant data (questionnaire data, information system data, etc.) needed for the research, more scientific and objective experimental methods are also needed. So it is difficult to complete the research alone, and cooperation between researchers becomes a necessity for development within the discipline.

(3) The maturity of applied social science. As early as 1998, cooperation had already become the main way to conduct scientific research in this field. Cooperation remained constant to date. Although applied social science is under the category of social sciences, its research focuses on quantitative and simulation analysis with more complex research objects, sharing more similarities with the research in natural

sciences in terms of nature. This kind of discipline attaches greater importance to the objectivity of content, the logical nature of theory and universal application, thus interpreting the objective world (Ma 2006). Therefore, advanced research facilities, research methods which can reflect the reality are indispensable in research. More often than not, the research goals are achieved by joint efforts (such as research groups, experimental groups, etc.) with each member responsible for a part of the research design.

Therefore, to pursue higher rate of collaboration blindly is not the best option for scientific development. If we allocate researchers in accordance with the nature of the discipline, we can further enhance the efficiency of the research and create more benefits. This experience will provide helpful references for applying funding programs for national, natural sciences and social sciences, and building research teams in colleges and universities.

The overall status of collaboration in humanities and social science

The structural features of the overall network can shed light on the relations between various fields in China. Humanities are comparably independent with few links to other fields. With respect to the developmental social sciences, the research contents are quite similar, the research institutions are relatively concentrated, and the inter-institutional relationship is rather close. Cross-disciplinary social science covers wide areas with many research achievements, thus becoming an important part of Chinese humanities and social science. The research contents related to this field are quite comprehensive; the research methods are multiple; and collaboration with other disciplines is significant. With respect to the applied social science, although there is a tendency to close cooperation, the cooperation exists mostly within the same subject and the papers are often written by one author.

In the overall network, economics and management as well as library and information science play a prominent role in the exchange related to scientific research. Economics and management bridge the network with mature subjects, many research communities and various approaches to cooperation; the development of library and information science is still at the exploration stage, and theories and methods of other subjects are introduced in its research, making it more prone to be at the center of the extensive collaboration network. This conclusion is similar to the results of the analysis of the citation network for Chinese humanities and social sciences. Zhao et al. (2012) constructed a network covering 82 fields based on the citation data from 2001 to 2010 to analyze the issue of the diffusion of knowledge in humanities and social sciences, and confirmed the fundamentality of education, politics and economics, the central role of economics and management, and the activeness of library and information science.

Conclusion

This paper analyzes the status of cooperation in Chinese humanities and social science with a holistic view, and has discovered the particularity of humanities, the growth property of social developmental science, and cross-disciplinary social science and the maturity of applied social science. The crucial role of economics and management, and library and information science in the collaboration network in Chinese humanities and social sciences

has also been identified. The core status of economics and management is beyond doubt due to its wide coverage, extensive scope, obvious overlapping with other subjects, and its cooperation with other subjects. The reasons accounting for the importance of library and information science in the overall collaboration network are perhaps as follows: (1) the editing of periodicals on library and information science is more standard, and there are relatively more papers regarding this subjects shortlisted in CSSCI; (2) some periodicals on information science intersect with management, resulting in the phenomenon that scholars in the two fields publish papers on journals of the two subjects, which leads to the central role of literature on information science in the collaboration network in Chinese humanities and social sciences.

However, there are still some things to be improved and further explored in the research: detailing the object of study, conducting more thorough and concrete studies on the collaboration in important subjects, and enhancing the contrasts between cooperation networks of various types, such as diachronic approach to cooperation (citation), potential approach to cooperation (co-citation, citation or keyword coupling). As networks of different types have different focuses in reflecting the law of disciplinary development, there is still a lot of work to do concerning establishing an applicable holistic measuring method.

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