The Supply Chain Finance Research in China: Present Situation, Research Hotspot and Research Frontier——Visualization Analysis Based on CiteSpace and VOSviewer

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Abstract: *To fully understand the research status of Chinese academic circles in the supply chain finance(SCF), using CiteSpace and VOSviewer visualization analysis software to draw Mapping Knowledge Domain of 653 papers of supply chain finance from core journal databases in CNKI(China National Knowledge Infrastructure), publication and cooperation, citation and cooperation, research hotspots and research frontier are fully explored, and bibiometric analysis are also used. Through analysis result, it can be found that research on SCF at different stages have different emphasis. Finally, the research subject analysis of SCF in the last three years between China and foreign countries are given by comparing subjects ,hot keywords and the research front, to find the differences between Chinese and foreign SCF research focuses, which provide help for the SCF research innovation.*

Keywords: *bibliometrics, information visualization, research front, research hotspot, supply chain finance*

I. Introduction

SCF aims to optimize financial flows at an inter-organizational level[1] through solutions implemented by financial institutions[2] or technology providers[3]. The ultimate objective is to align financial flows with product and information flows within the supply chain, improving cash flow management from a supply chain perspective[4]. The benefits of the SCF approach lie in not only strengthening cooperation among participants within the supply chain, which can bring lower debt costs, but also obtaining more financing opportunities and reducing working capital within the supply chain. Moreover, the SCF approach reduce the operating cost of the supply chain, which in turn can improve the profitability of the entire supply chain[5].

China's practice in the field of SCF can be traced back to 2006. The Shenzhen Development Bank first introduced supply chain financial products into the banking business, and made a useful exploration to solve the financing of small and medium-sized enterprises(SMEs) and expand the business of small and medium-sized commercial banks[6]. In the context of the high integration of modern market economy and the specialization of supply chain, SCF has gradually evolved into a pattern that bank (financial institution) links core enterprises in the supply chain with upstream and downstream companies which utilize transactions or credit rating to provide a financing method for flexible financial products and services. China's academic circles have pay attention to SCF and have achieved a series of academic achievements. At present, it is urgent to sort out and review the progress of research in this area for exploring current research hotspots and research trends, which plays a very important role in the guiding development of SCF innovations.

II. Data Sources and Research Methods

The collection of metadata is a key step in the analysis, and the high-quality data is critical to research results accuracy[7]. The studied papers are from SCI journals, core journals and CSSCI in CNKI, with the theme "Supply Chain Finance or Title=Supply Chain Finance or v_subject=Chinese and English expansion (supply chain finance, Chinese and English comparison) or (keyword = supply chain finance or Keyword =Chinese and English expansion (supply chain finance, Chinese and English)") as search conditions in unlimited time span, and search time is on December 1st, 2018. After repeated searching, screenings, and proofreading, 656 high-quality academic papers were obtained.

This research mainly uses CiteSpaceV.5.3.R4 and VOSviewer (version 1.6.9) software. CiteSpace is a visual research software developed by Dr. Chen Chaomei from Drexel University in the United States. It can display the clustering status, key nodes and co-citation networks of a certain knowledge field through Mapping Knowledge Domain such as clustergram, time zone chart and timeline graph[8]. VOSviewer is a bibliometric

analysis software developed by Nees Jan van Eck and Ludo Waltman of Leiden University in the Netherlands to map scientific knowledge in various fields. VOSviewer can do a map analysis that shows more different states than CiteSpace. This paper comprehensively uses two kinds of visual analysis methods to display the research results.

III. The Analysis of Research Result

3.1 Issue and cooperation analysis

3.1.1 Issuing time series analysis

As shown in Fig. 1, where PN represents the total amount of publications related to SCF on the CNKI, PN* means the number of publications selected from core database, and PN% indicates the proportion of core publications accounting for the total publications per year recently. As can be seen from Fig. 1, the China's academic community's attention to SCF began in 2006, and the absolute value of the number of total publications and core publications gradually increased as the time going. Until 2018, The total number of articles related to SCF reached 2,630, but the growth trend of the total number of posts and core posts tends to be gentle; Before 2011, the proportion of core publications increased rapidly, and the proportion of core publications reached the highest point in history in 2011. But in 2012, the total number of publications was almost the same as that of the previous year, and the proportion of core publications rapidly dropped from 40% to around 30%. This downward trend continued until 2015. After 2015, the core issues ratio has remained at around 20%. Generally speaking, attention to the SCF filed in China tends to be gentle with the increase of time span, but the number of core issues maintains a certain proportion, indicating that the research on SCF can not be ignored. Therefore, it is urgent to find new innovations and breakthroughs in SCF in order to provide better serve to the financial market system.
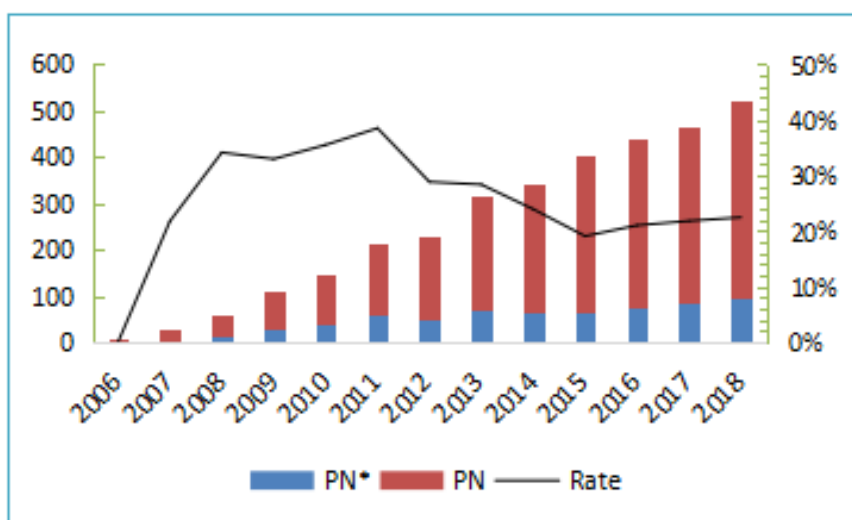

Figure 1. Time distribution of publication

3.1.2 Periodicals analysis

Fig. 2 shows the periodicals distribution by VOSviewer, including 209 core journals, among which 31 journals on SCF with more than 5 journals, and 15 journals with more than 10 journals. The main journals include 《*Logistics Technology*》(40 articles), 《*China Finance*》(27 articles), etc. Before 2014, research on SCF was biased towards supply chain and logistics management. But after 2016, comprehensive financial journals such as 《*The Banker*》 and 《*Southern Finance*》 receive more articles about SCF. According to the evolution of the periodicals at different time, we can conclude that the research on SCF further combines the actual business situation, fully considering applying SCF as a financing tool, and conducts practical innovation in financial institutions such as banks.

3.1.3 Institution analysis

As shown in Fig. 3, from 2006 to 2018, there were 620 institutions that published topics related to SCF, and 124 institutions that issued more than 2 articles, only 9 institutions with more than 6 publications about SCF, and mostly issuing organizations are university research institutions, such as Business School of Renmin University of China (17 articles), School of Management of Shanghai University (9 articles) and Xi'an Jiaotong University (8 articles).

3.1.4 Author analysis

There are 653 articles in total, 53 scholars have published more than 3 articles, and only 8 scholars who have published more than 6 articles. Fig. 4 shows the author collaboration map drawn by CiteSpace. The dots in the figure represent the author. The size of the dot indicates his(or her) articles amount. The connection between the authors indicates the cooperation relationship and the thickness of the line indicates the closeness of cooperation. It can be seen that the scholars' cooperation on the subject of SCF is relatively sparse, mainly focusing on individual scholars with a large number. For example, Professor Song Hua and Yang Lan and others have a relatively thick cooperation line, indicating that cooperation is close.

Figure 2. Periodicals time distribution map

Figure 3. Distribution map of the issuing institutions

3.2 Cited times and cooperation analysis
3.2.1 Distribution of cited journals

Table 1 displays the distribution of the top 20 journals cited with the highest frequency. It can be seen that the number of citations varies from 236 to 1042, and the difference is so large. The number of published documents is not proportional to times cited. For example, 《*Commercial Economic Research*》 published 43 articles, but the citations are only 433 times, but 《*Financial Research*》 only published 4 related documents, the number of citations is highly up to 720 times; the number of citations varies from 10.07 to 180 times, indicating that some publications citation rate is extremely high, such as an article titled "Supply Chain Finance: Background, Innovation and Concept Definition(in Chinese)" , written by Hu Yuefei and Huang Shaoqing[9], published in the 《*Financial Research*》 of which downloads up to 15040 times and being cited 497 times.

3.2.2 Reference cited distribution

Table 2 shows the top 15 high-cited reference in the field of SCF. The highest one was written by Yan J H & Xu X Q[10], which was cited reached 903 times, and annually cited up to 82.09 times. Yan Junhong mainly studied three basic financing ways concluding accounts receivable financing, confirming warehouse

financing and financing warehouse financing, which provides a new way to solve financing difficulties for SMEs in China. Xiong X et al[11] with second highest 514 times cited. It reveals that the risk system involved in the SCF financing model is different from the traditional risk assessment system, and studies the credit risk evaluation under the supply chain financial model, expanding the scope of credit reporting for commercial banks to alleviate the dilemma of SMEs with insufficient capitals. Through Table 2, high-cited authors can also be found. For example, Hu Yuefei and Yan Junhong earliest studied supply chain finance, and totally cited 1,065 times and 903 times respectively.

Figure 4. The publishing and cooperation map

Table 1. Periodicals cited distribution in SCF research from 2006 to 2018

No.	Publication	Number of Documents	Citation Frequency	Citation Percentage (%)	Citations Per Document
1	*Shanghai Finance*	8	1042	11.83	130.25
2	*Journal of Finance Research*	4	720	8.18	180.00
3	*Finance Forum*	5	675	7.67	135.00
4	*Financial theory and practice*	19	673	7.64	35.42
5	*Nankai Business Review*	3	547	6.21	182.33
6	*New Finance*	9	511	5.80	56.78
7	*China Finance*	17	467	5.30	27.47
8	*Journal of Commercial Economics*	43	433	4.92	10.07
9	*Journal of Business Economics*	4	408	4.63	102.00
10	*Commercial Research*	7	379	4.30	54.14
11	*China Business and Market*	18	361	4.10	20.06
12	*Economic Theory and Business Management*	4	339	3.85	84.75
13	*Enterprise Economy*	13	329	3.74	25.31
14	*On Economic Problems*	9	305	3.46	33.89
15	*Chinese Journal of Management Science*	14	298	3.38	21.29
16	*Research on Financial and Economic Issues*	2	277	3.15	138.50
17	*China logistics & Purchasing*	9	276	3.13	30.67
18	*Journal of Central University of Finance & Economics*	4	271	3.08	67.75
19	*Finance and Accounting Monthly*	30	259	2.94	8.63
20	*Soft Science*	4	236	2.68	59.00

Table 2. Top 15 cited documents in SCF from 2006 to 2018

Rank	Author	Total Citaton	Year	AUN	Source	Citation Per Year
1	Yan J H & Xu X Q	903	2007	2	Shanghai Finance	82.09
2	Xiong X et al	514	2009	5	Nankai Business Review	57.11
3	Hu Y F et al	497	2009	2	Journal of Finance Research	55.22
4	Yang Y Z[12]	400	2007	1	Finance Forum	36.36
5	Hu Y F	300	2007	1	China Finance	27.27
6	Hu Y F et al	268	2009	2	Research on Financial and Economic Issues	223.22
7	Xie S Q et al[13]	244	2013	2	Economic Theory and Business Management	48.8
8	Li Y X[14]	226	2011	1	Journal of Central University of Finance & Economics	32.29
9	Guo J E et al[15]	226	2014	3	Journal of Business Economics	56.5

10	Liu Z N[16]	224	2007	1	China Logistics & Purchasing	20.36
11	Hu H Q et al[17]	206	2012	3	Business Review	34.33
12	Wan D H[18]	203	2008	1	On Economic Problems	20.3
13	Feng Y[19]	197	2008	1	New Finance	19.7
14	Lu Q H et al[20]	191	2012	3	Journal of Management Sciences in China	31.83
15	Yan G L[21]	188	2011	1	Enterprise Economy	26.86

3.2.3 Author cited distribution

Table 3 demonstrates the distribution of the top 20 authors with the highest times cited. More than 90% of the authors have no more than 2 articles, indicating that these articles are classic articles in the field of SCF, and the academic term of SCF first appeared in the bank, and gradually was paid attention to by university scholars who became main groups studying the subject later.

3.2.4 Subjects cited Analysis

Table 4 illustrates the distribution of subjects that refer to topics related to SCF. It can be seen from the table that the number of documents involved varies from 1 to 454, and the difference is huge. The subjects are cited mainly in finance, business and macroeconomic management and sustainability, and fits the theme of SCF area.

Table 3. The top 20 scholars with high citations and citation ratio

Rank	Authors	Documents	Institution	Citations	Citation Percentage
1	Hu Y F	3	Shenzhen Development Bank	1064	10.43%
2	Xu X Q	1	Northwestern Polytechnical University	903	8.85%
3	Yan J H	1	Northwestern Polytechnical University	903	8.85%
4	Huang S Q	2	China Europe International Business School	765	7.50%
5	Wang X Y	2	Tianjin University	545	5.34%
6	Xiong X	2	Tianjin University	545	5.34%
7	Zhao W J	2	Shenzhen Development Bank	545	5.34%
8	Ma J	2	Tianjin University	545	5.34%
9	Shi J Z	6	Xi'an Jiaotong University	526	5.15%
10	Zhang J	1	Tianjin University of Finance and Economics	515	5.05%
11	Guo J e	3	Xi'an Jiaotong University	409	4.01%
12	Yang Y Z	1	Industrial and Commercial Bank of China, Henan Branch	400	3.92%
13	Zhang L	2	Xi'an University of Technology	383	3.75%
14	Hu H Q	2	Xi'an University of Technology	383	3.75%
15	Zhang D H	2	Xi'an University of Technology	383	3.75%
16	Li Y X	3	Jiangxi University Of Finance And Economics	317	3.11%
17	Li Y X	3	Academy of Mathematics and Systems Science Chinese Academy Science	317	3.11%
18	He J	7	Southwest Jiaotong University	258	2.53%
19	Zeng L F	3	Zhejiang Gongshang University	256	2.51%
20	Xie S Q	1	Peking University	244	2.39%

Table 4. Distribution of main subjects cited on SCF research in China

No.	Subject	Documents Quantity	Citations	Citations Per Paper
1	Finance	454	12000	26.43
2	Business Economic	336	9581	28.51
3	Macroeconomic Management and Sustainable Development	137	4804	35.07
4	Mathematics	24	1936	80.67
5	Investment	41	1023	24.95
6	Trade Economics	61	702	11.51
7	Information Economy and Postal Economy	11	370	33.64
8	Agricultural Economy	33	322	9.76
9	Industrial Economy	29	320	11.03
10	Securities	16	316	19.75
11	Computer Software and Computer Applications	6	264	44.00
12	Accounting	15	143	9.53
13	Market Research and Information	12	126	10.50
14	Automotive Industry	6	99	16.50
15	Civil and Commercial Law	4	48	12.00
16	Service Economy	1	47	47.00
17	Economic Law	6	32	5.33
18	Automatic Technology	2	27	13.50
19	Mineral Engineering	2	23	11.50
20	Culture	2	22	11.00

IV. Research Hotspots Analysis

Research hotspots identification: Fig. 5 shows the keyword minimum clustering map of SCF research, which comprehensively depicts the landscape of SCF area from 2006 to 2018. The map mainly focuses on the development of supply chain finance as the keyword. It is mainly divided into five parts. The first part is mainly about supply chain finance (533 times), the main hot keywords are supply chain financing, risk management and financing mode. The second part is about supply chain (35 times) and co-occurrence keywords are supply chain management, SMEs and enterprise management. The third part involves in credit risk (29 times), mainly related to key risks such as credit risk assessment, moral hazard and trade financing. The fourth part is about agricultural supply chain finance (23 times), mainly involving co-occurrence keywords such as guarantee, logistics network and modern logistics. The fifth part is financial innovation (9 times). The main hot keywords are Internet supply chain finance, big data and model innovation.

4.1 Evolution of research trends

Fig. 6 is the keyword evolution map. It can be seen that research in China on SCF will have new research hot words in each time zone, expressing as a dynamic evolution process. According to the changes of keywords and the depth of research, this paper can roughly divide SCF research in China into three stages: initial stage, development stage and innovation stage. 2006 is the beginning of initial stage, and the keywords are SCF services and commercial credit, which indicate that this stage focuses on analysis and implementation of financial institutions such as banks. Development stage began at about 2012. The emergence of new keywords such as information asymmetry and risk management indicate that the research on SCF has gradually shifted from the provider of funds to the whole supply chain. From 2016 to the present (innovation stage), the research on traditional supply chain finance towards saturation, the emerging keywords during this period are Internet finance, block chain, and supply chain business processes and financial performance linkages. In short, from the introduction of financial institutions' financing tools to the exploration of the supply chain coordination, and then to the integration of innovative integration applying in the actual financial market environment for different financing channels, research on SCF in China presents an increasingly in-depth research trend.
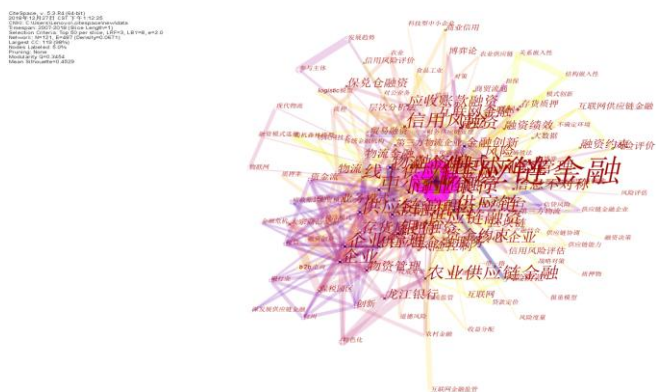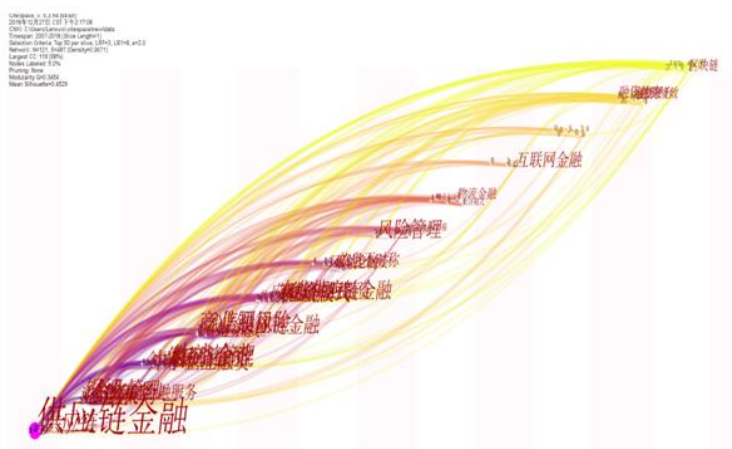

Figure 5. Keyword minimum clustering map

Figure 6. Evolution of SCF research trend in China

4.2 Keywords emerging time distribution

Fig. 7 is an analysis of keywords emerging time from 2007 to 2018, indicating that the scholars have given special attention to the keywords in a certain period. According to literature analysis, the keywords in a particular period reflect the research hotspots at that time. It is worth noting that due to the time limit of data acquisition, the research hotspots until 2018 may continue to be paid attention in the future. The emerging of SCF services, logistics enterprises and enterprise management as the keywords appeared at the earliest time, and the research on logistics enterprises lasted for a long time (2008-2013). The research hotspots are inventory pledge financing and online supply chain finance and Internet finance recently.

Keywords	Year	Strength	Begin	End	2007 - 2018
供应链金融服务	2007	3.217	**2008**	2010	
物流企业	2007	2.7296	**2008**	2013	
企业管理	2007	4.4851	**2008**	2010	
企业	2007	4.6366	**2008**	2010	
融资	2007	2.7735	**2009**	2011	
中小企业融资	2007	3.5509	**2009**	2011	
龙江银行	2007	4.1741	**2011**	2012	
存货质押融资	2007	2.6277	**2013**	2016	
线上供应链金融	2007	4.9185	**2015**	2016	
互联网金融	2007	3.1099	**2015**	2018	

Figure 7. Keyword emergence time distribution

V. Research Frontiers Analysis

To further explore the research frontiers in the SCF field, this part compares and analyzes the domestic and foreign literature on SCF. By comparing the research hotspots from 2016 to 2018, we can grasp the research frontier, and know the difference between China and foreign countries, and provide some reference for SCF research and innovation in China.

5.1 International research hotspots

Describing the research frontier of SCF accurately have to depend on high quality of data. The papers selected are from core journals including the Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), and Conference Proceedings Citation Index-Science (CPCI-S) databases in Web of Science (WoS). The search was conducted under the theme or title ="Supply Chain Finance". The time span is 2016-2018, and 86 core documents were retrieved, including 36 articles and 43 conference articles.

5.1.1 Subjects distribution

The international research hotspots have mainly focused on the fields like business economics, engineering, other topics in social sciences, and operations management science. Especially business economics has become a major research hotspot in the field of SCF in the international academic community(Fig. 8).
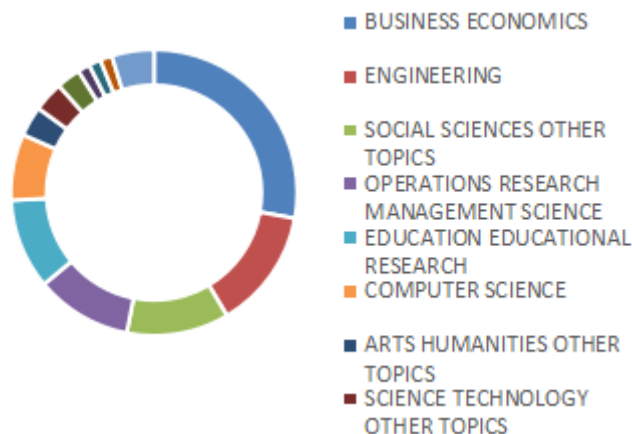

- BUSINESS ECONOMICS
- ENGINEERING
- SOCIAL SCIENCES OTHER TOPICS
- OPERATIONS RESEARCH MANAGEMENT SCIENCE
- EDUCATION EDUCATIONAL RESEARCH
- COMPUTER SCIENCE
- ARTS HUMANITIES OTHER TOPICS
- SCIENCE TECHNOLOGY OTHER TOPICS

Figure 8. Distribution of foreign SCF research subjects in 2016-2018

5.1.2 Research hotspot keyword analysis

Fig. 9 depicts the hotspot keyword visualization result of international research related to SCF. Most popular hot keywords are "credit risk", "inventory performance", "operational and financial decision" and "capital-constrained", further indicating that the research on SCF has mainly focused on business economics area. Especially the research direction of supply chain risk management and inventory performance considering capital flow, shows that the international research on SCF focuses on the supply chain coordination management.

5.2 Research hotspots in China

According to the method of data screening introduced earlier in this paper, 255 high-quality literatures related to SCF from 2016 to 2018 in CNKI are selected.

5.2.1 Subjects distribution

Through statistical analysis of research subjects distribution, it can be seen that the main subjects distribute in supply chain finance, financial institutions, supply chains and commercial banks. Recently, research on SCF not only focuses on further studying traditional supply chain management, but also many innovative research directions, such as E-commerce platform and online SCF(Fig. 10).
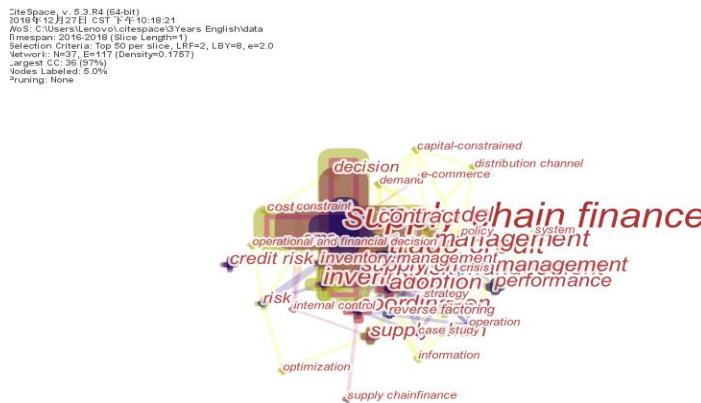

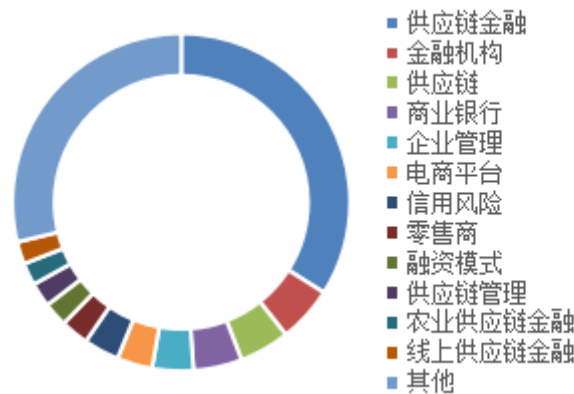**Figure 9.** The minimum clustering map of foreign SCF keywords in 2016-2018

Figure 10. Distribution of SCF research subjects of China in 2016-2108

5.2.2 Research hot keyword analysis

Fig. 11 demonstrates a hot keyword map of SCF research in China. The most frequent keywords are credit risk, financing constraints, online supply chain finance and financing models. Comparing to Fig. 9, research on SCF of China is consistent with international academic research, but the emerging keywords, such as agricultural supply chain finance and internet finance, indicate that research of China mainly concentrate on supply chain innovation in the field of SCF applications.

VI. Conclusion

This paper mainly uses CiteSpace and VOSviewer visual knowledge mapping software[22] to analyze the 656 papers on the "supply chain finance" in the core journals of CNKI, from the aspects of time distribution, journals, institutions, authors publications and cooperation, cited distribution, research hotspots and research frontiers[23]. The following research conclusions are obtained.

6.1 Journals and cooperation analysis

The journals is widely distributed, and with the time going, major journals are also changing. In the earlier time, the papers mainly published on journals about supply chain management, but comprehensive financial journals in the past two years. Institutions shifted from financial institution to mainly university research. The authors of papers were scattered, mainly concentrated in 1-2 people in colleges, and the core author group has not yet formed. There is less cooperation between authors, and even less cooperation across institutions.
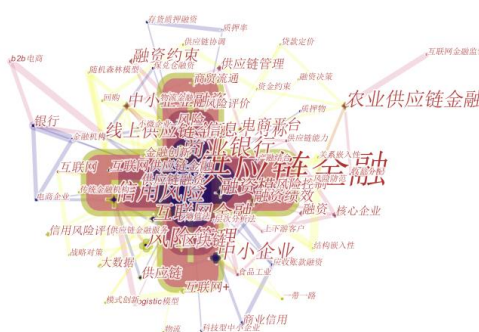

Figure 11. The minimum clustering map of foreign SCF research keywords in 2016-2018

6.2 Cited and cooperative analysis

There is a big difference between the category of the cited journal and that of the published journal, the distribution of cited times is uneven, and the relationship between published literature numbers and cited times is not obvious. The number of articles published by the main cited authors ranges from 1 to 7. There are many references published by Tianjin University and Xi'an Jiaotong University, but mainly among a few researchers. The cited subjects are widely distributed, most actively in the field of finance, followed by the fields of enterprise economy and macroeconomic management and sustainable development. The distribution of other cited subjects is basically equal.

6.3 Research hotspots and research frontiers

The keyword minimum clustering map software, the keyword co-occurrence area map and the keyword emerging time distribution produced by CiteSpace can reveal the research hotspots and trend evolution annually. There are mainly five highest frequent keywords, namely "supply chain finance", "supply chain", "credit risk", "agricultural supply chain finance" and "financial innovation". Research on supply chain finance in China is mainly divided into three stages: the initial stage and development stage and innovation stage. The emerging keyword reflects that research hotspots in the most recent period are mainly concentrated in the Internet finance field. Using the keywords of the core publications in the last three years, the co-occurrence map and the main subjects distribution map capture the recent research frontiers. Through keyword visualization analysis, the research hotspots have been slightly different between China and foreign countries. Foreign countries mainly emphasize the financing means of SCF, paying attention to the overall performance and coordination of the supply chain, but the research on SCF in China is more inclined to the innovation in the application field. From the original traditional supply chain to the current agricultural supply chain, the effect of the implementation of supply chain financial tools will be further analyzed based on the new application field.

Note: This paper mainly analyzes the research status of SCF in China. The input data of the software are all in Chinese, so most of the output pictures are presented in Chinese.

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