Analysis of China and ASEAN Scientific Research Cooperation Status based on Bibliometrics Methods

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Abstract: At the beginning of the 14th Five-Year Plan, China will continue to promote the high-quality development of The Silk Road Economic Belt and the 21-Century Maritime Silk Road. Moreover, ASEAN, the core area of China's " the Belt and Road ", is a vital partner for China in scientific research. This paper uses Web of Science as the data source and selects the co-authored papers as the research object, and analyzes the scientific research cooperation between China and ASEAN from the perspectives of institutions, fields, countries, and cooperation patterns in the 12th and 13th Five-Year Plan periods. The study found that the total scale of co-authored papers has been increasing year by year, the level of scientific research output varies significantly among different countries, most of the participating institutions are universities and research institutes in different countries, and most of the cooperation fields focus on the good disciplines and particular fields of each country.

1 INTRODUCTION

After entering the 21st century, China's international science and technology exchanges and scientific research cooperation have also become more frequent. They increasingly play an essential role (Zhou, 2009), and more and more scholars have begun to pay attention to the progress and characteristics of China's international scientific research cooperation. In 2013, President Xi Jinping put forward the development concept of "One Belt and One Road" when he attended Central Asia and Southeast Asia. And in 2015, China officially released the "Vision and Action for Promoting the Construction of the Silk Road Economic Belt and the 21st Century Maritime Silk Road" guide. All of this shows that China, as a developing economic power, has taken the initiative to build a framework for cooperation and wants to work together with neighboring countries to seek progress. ASEAN is China's "Belt and Road" construction (Li, 2015). Under the leadership of "One Belt, One Road", the ties between China and ASEAN countries have become closer and closer.

Some scholars have long studied the issue of scientific and technological cooperation between China and ASEAN countries. From a disciplinary perspective, most studies focus on the collaboration between China and ASEAN in agriculture (Wang, 2015), oceanography (Tian, 2016), etc. From a regional perspective, some scholars have studied the cooperation between Chinese provinces and ASEAN, such as Guangxi (Cao, 2015) and Yunnan (Luo, 2019). However, most studies on the status of China-ASEAN research cooperation are often included in the analysis of the level of science and technology cooperation in countries along "the Belt and Road". This research conducts a bibliometric analysis based on the co-authored papers between China and ASEAN countries since the 12th and 13th Five-Year Plan periods. Through the detection of co-authored

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articles, quantitatively analyzes the research cooperation situation between China and ASEAN and reveals, to a certain extent, the development of research cooperation between China and ASEAN countries.

2 MATERIALS AND METHODS

In this paper, we use co-authored papers from any of the ASEAN countries as the research object in the Web of Science core collection, and use the country field (CU) to conduct an advanced search for articles of type Article, spanning 2011-2020, covering the entire 12th and 13th Five-Year Plan periods, and published in English.

Some co-authored papers contain only one ASEAN country in the obtained data. Even if the CU field contains countries not in ASEAN countries, they are regarded as bilateral co-authored papers between China and ASEAN countries; when more than one ASEAN country appears in the CU field, they are defined as multilateral co-authored papers between China and ASEAN countries. We use metrological software such as VOSviewer and CiteSpace, to grasp the overall dynamics of research cooperation between China and ten ASEAN countries over the past decade in general.

3 RESULTS & DISCUSSION

3.1 General Information on China-ASEAN Scientific Research Cooperation

Currently, ASEAN mainly includes ten countries, namely Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam, whose basic information is summarized in Table 1.

During 2011-2020, there were 50,151 scientific papers co-authored by China and ten ASEAN countries, from 2084 in 2011 to 9914 in 2020, an increase of 3.76 times, and the annual number of articles published has maintained a linear growth (Figure 1). Among them, the number of publications in the 13th Five-Year Plan period increased 125.47% compared with that in the 12th Five-Year Plan period. Looking at the annual growth rate of the number of articles issued, we can see that 2013 and 2019 are the two years with significant growth of 24.5% and 24.35%, respectively.

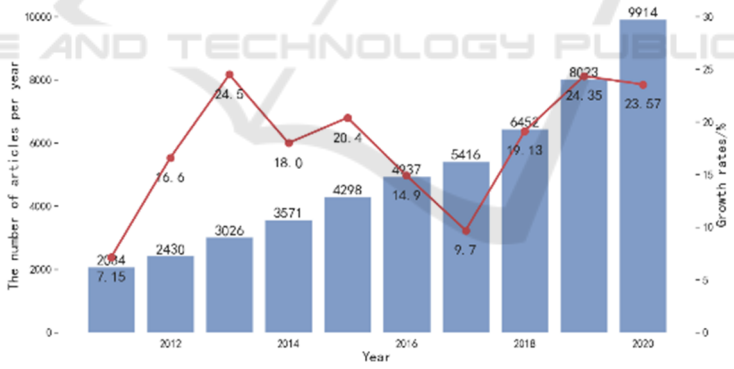

Figure 1: The number and growth rate of co-authored papers between China and ASEAN countries (2011-2020).

Although the overall scale of scientific research co-authored papers between China and ASEAN countries shows a year-on-year increase, the proportion of co-authored articles between China and ASEAN countries was only 5.77%, indicating that ASEAN has not yet become a key cooperation target for international scientific research cooperation in China.

Figure 2 shows the comparison between the economic power of the ten ASEAN countries and the number of co-authored papers. From the two discounted trends, we can easily see that the size of co-authored papers between China and ASEAN countries is uneven. Their data performance is not entirely consistent with the trend of economic power, so we infer that economic power may not be the dominant factor affecting research cooperation.

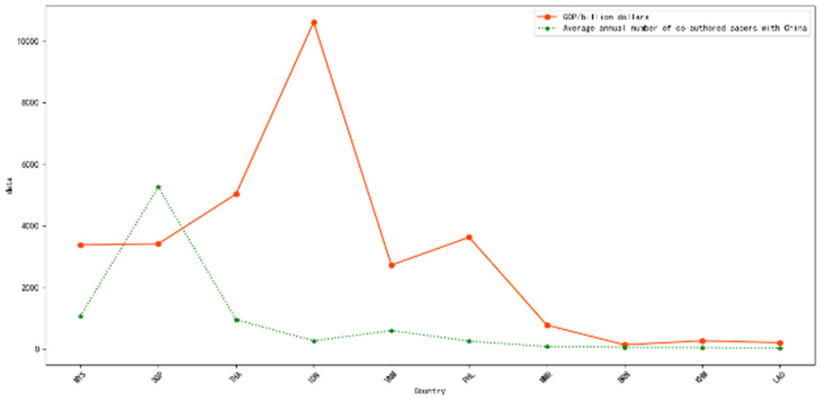

Figure 2: The economic strength and number of co-authored papers of ASEAN countries (2011-2020).

The highest point of the green dash is positioned in Singapore. In other words, the closest scientific research cooperation country with China in Singapore, accounting for 61.87% of the total number, which is nearly five times the amount of co-authored papers of Malaysia, which is in the second place. In contrast, the scientific cooperation between China and Laos is relatively small, with only 148 co-authored papers between 2011 and 2020.

Table 1: Basic Informations of ASEAN Countries.

Country codes	Country	GDP/billion dollars	papers	co-authored papers
MYS	Malaysia	3366.64	226729	10596
SGP	Singapore	3399.98	211842	52468
THA	Thailand	5017.95	140262	9418
IDN	Indonesia	10600	133582	2504
VNM	Vietnam	2711.58	64310	5851
PHL	Philippines	3614.89	26681	2421
MMR	Myanmar	761.86	3624	629
BRN	Brunei	120.16	3222	384
KHM	Cambodia	252.91	3767	383
LAO	Laos	191.36	2258	148

3.2 Analysis of China-ASEAN Scientific Research Cooperation Institutions

From high to low, the top 10 participating institutions are the National University of Singapore, Nanyang Technological University, Chinese Academy of Sciences, A*STAR, Zhejiang University, University of Malaysia, University of Hong Kong. Shanghai Jiao Tong University, The Chinese University of Hong Kong, and Peking University, respectively. Most of them are universities and research institutes in various countries.

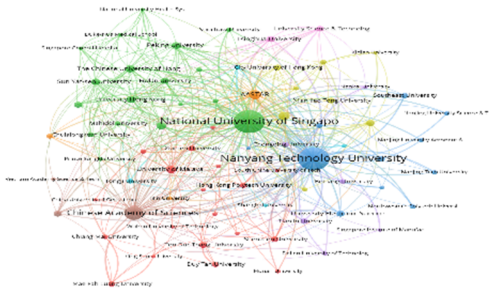

Figure 3: The institutional cooperation network for co-authored papers between China and ASEAN (2011-2020).

Figure 3 shows the cooperative network of China-ASEAN co-authored papers participating institutions from 2011 to 2020. The larger the node, the higher the frequency of participation. Among the 74 institutions that entered the statistical ranks, there are also research institutions from the United States, Italy, and the United Kingdom, indicating that other countries also play a role in China-ASEAN research cooperation.

3.3 Analysis of China-ASEAN Scientific Research Cooperation Fields

According to the classification in Web of Science, there are 131 research fields in China and ASEAN countries (Figure 4), and the top ten research fields and their data are listed in Table 2. Since the China-ASEAN Science and Technology Partnership launch in 2012, China and ASEAN countries have been cooperating in 10 required technical fields, including engineering and materials science.

The cooperation between China and Singapore is mainly in the field of materials science, with a total of 3042 co-authored papers, and two institutions, the Chinese Academy of Sciences and Nanyang Technological University, have the highest frequency of cooperation in this field (Figure 4); meanwhile, these two institutions have also produced many scientific results in the field of applied physics. Physics, as a fundamental discipline, is a crucial area of cooperation between China and ASEAN countries, with a high output of co-authored papers in applied physics, particle and field physics, astrophysics and astrophysics, and interdisciplinary physics. For example, in Singapore, a country with a high level of economic and technological development, most of the papers co-authored by China focus on interdisciplinary materials science and electrical and electronic engineering; In contrast, some countries have more research on the natural environment and biological resources, for example, Vietnam has more co-authored papers on environmental science, Thailand has more co-authored papers on mycology and plant science.

Table 2: Top 10 research fields of co-authored papers between China and ASEAN (2011-2020).

Research fields	papers	percentage
Engineering	11498	22.9%
Chemistry	8439	16.8%
Physics	8403	16.8%
Materials Science	7907	15.8%
Materials Science, Multidisciplinary	6737	13.4%
Science & Technology-Other topics	6545	13.1%
Engineering, Electrical & Electronic	5611	11.2%
Computer Science	5314	10.6%
Physics, Applied	4486	8.9%
Chemistry, Physical	4223	8.4%

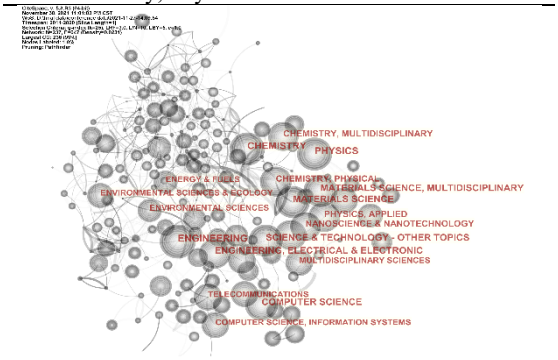

Figure 4: Primary research fields of co-authored papers between China and ASEAN (2011-2020).

3.4 The Research Cooperation Network between China and ASEAN

In order to more accurately reflect the overall dynamics of China-ASEAN countries' research cooperation, we use VOSviewer and social network analysis theory to analyze the China-ASEAN research cooperation network from 2011 to 2020. we set the minimum frequency of co-authored papers to 100 and plotted Figure 5, in which the network includes a total of 67 countries, including the United States, the United Kingdom, and Germany, in addition to China and the ten ASEAN countries. It can be seen that the scientific cooperation within ASEAN countries is much less than that with the outside. Apart from China and the US, ASEAN countries tend to cooperate more with European countries, connecting more with the UK, Germany, etc. This is partly related to the economic and scientific strength of European countries in the world and partly perhaps related to the establishment of the ASEA-UNINET organization. Meanwhile, some economically and technologically advanced countries are also the focus of cooperation among ASEAN countries, such as Japan, Korea, and Australia (Table 3). In addition, ASEAN countries also collaborate with countries with research expertise in certain fields, such as India and Brazil.

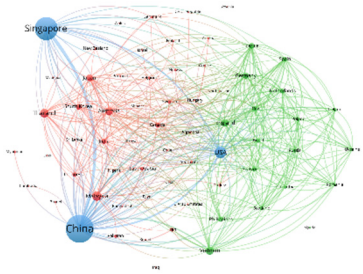

Figure 5: All country cooperation networks in co-authored papers (2011-2020).

It is easy to see that Singapore is the pivot of the ASEAN research cooperation network, and China is its key cooperation target. Thailand, Malaysia, the Philippines, and Indonesia frequently cooperate within ASEAN, while Myanmar, Cambodia, Brunei, and Laos are relatively weak in scientific research, and the number of cooperation with both internal and external ASEAN countries is low.

Table 3: TOP 10 countries of China-ASEAN co-authored papers.

country	The number of paper	Total citations
China	48212	1401521
Singapore	33345	1074146
USA	8196	22627
Malaysia	5514	132566
Thailand	4938	98752
Vietnam	4143	377478
Australia	3899	168784
England	3527	187431
Japan	2704	134860
Germany	2380	138799

3.5 Analysis of China-ASEAN Research Cooperation Patter

Today, in the context of scientific and technological globalization, multilateral cooperation is a major trend. We define the mode of cooperation between countries as bilateral cooperation or multilateral cooperation. In the 2011-2020 data, we observe that multinational co-authored papers account for only 9.99% of the total size of all co-authored papers between China and ASEAN countries. This reflects that China prefers the bilateral cooperation model in the process of cooperation with ASEAN countries, and the intensity of multinational cooperation within the China-ASEAN community of destiny is still low. Figure 6 shows the changes in the rate of multilateral cooperation in China-ASEAN co-authored papers by year from 2011 to 2020. The situation of insufficient multilateral cooperation is improving year by year. From Table 4, we can see that the rate of multilateral cooperation in research between China and Singapore is the lowest, which indicates that Singapore prefers bilateral exchanges with China to scientific cooperation with multiple ASEAN countries. Meanwhile, Cambodia has the highest rate of multilateral cooperation with China.

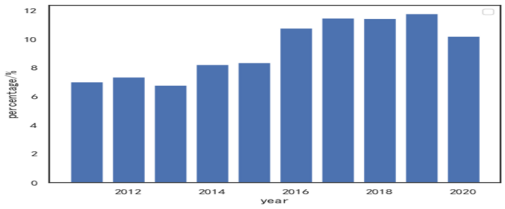

Figure 6: Multilateral cooperation rate of co-authored paper (2011-2020).

Table 4: Multilateral cooperation rates of ASEAN countries (2011-2020).

country	multilateral cooperation rates
Singapore	3.50%
Vietnam	26.58%
Myanmar	27.64%
Malaysia	30.03%
Brunei	32.02%
Thailand	32.65%
Philippines	54.65%
Laos	55.42%
Indonesia	57.93%
Cambodia	64.13%

4 CONCLUSIONS

Using data from Web of Science, this paper exhaustively analyzes the research cooperation dynamics between China and ten ASEAN countries from 2011 to 2020, and we have drawn the following conclusions. Firstly, from an overall perspective, the scientific cooperation between China and ASEAN countries has been deepening year by year, and the number of co-authored papers has increased significantly, and the collaboration has become increasingly close; secondly, the scale of the scientific output of the ten ASEAN countries varies greatly and shows an uneven distribution; at the same time, almost all institutions involved in co-authoring are universities and research institutes in each

country, publishing papers based on project cooperation or academic exchanges between countries; different countries combine their advantageous disciplines and characteristic fields to carry out scientific research cooperation with China, mainly in science and technology, while collaboration in humanities and social sciences is less; the level of international cooperation between the ten countries varies greatly, with most countries having a low intensity of cooperation and a high rate of multilateral cooperation.

Based on the analysis results, the following suggestions are made for strengthening China-ASEAN scientific research cooperation and achieving further joint development. First, according to the current situation of scientific research cooperation between China and the ten ASEAN countries, we will strengthen scientific research cooperation in a targeted manner. Second, China should actively explore the new situation of science and technology cooperation and broaden the field of scientific research cooperation. At the same time, actively develop cooperation channels, encourage and guide non-governmental entities to actively participate in science and technology cooperation. More importantly, we will take advantage of the "Belt and Road" policy and take advantage of the radiation effect to promote the extensive development of multilateral cooperative research.

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