

Scientometric Analysis of International Collaboration Research on Chinese Tacit Knowledge: Postprint

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Abstract

[Purpose / Significance] To investigate the development characteristics and trends of China's tacit knowledge international collaboration over the past 15 years, and to identify the shortcomings and strengths of domestic research. [Method / Process] Using data from international collaborative papers on tacit knowledge indexed in the SCI-E and SSCI databases of Web of Science from 2001-2015 as the data source, this study systematically measures and analyzes the current status of China's tacit knowledge international collaboration from five aspects: collaborative output, collaborative structure, collaborative partners, collaborative impact, and collaborative position, employing bibliometric methods and indicators, social network analysis techniques, etc. [Results / Conclusions] Research on China's tacit knowledge international collaboration has developed rapidly, with bilateral cooperation dominating, collaborative relationships becoming increasingly extensive, and collaboration rates continuously rising. Collaboration is primarily with developed countries in Europe and America, while domestic research remains at the periphery of the network, with relatively low network influence and control.

Full Text

Preamble

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A Scientometric Analysis of Transnational Collaborative Research on Tacit Knowledge in China

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Abstract

[Purpose/Significance] This study aims to understand the development characteristics and trends of China's transnational collaboration in tacit knowledge research over the past 15 years, and to identify its weaknesses and strengths.

[Method/Process] Using international collaboration papers on tacit knowledge from the SCI-E and SSCI databases in Web of Science (2001–2015) as data sources, this study systematically measures and analyzes the current state of China's transnational collaboration in tacit knowledge research from five dimensions: collaborative output, collaborative structure, collaborative partners, collaborative influence, and collaborative status, employing bibliometric methods, indicators, and social network analysis techniques.

[Result/Conclusion] China's transnational collaborative research on tacit knowledge has developed rapidly, with bilateral cooperation dominating, collaborative relationships becoming increasingly extensive, and collaboration rates continuously rising. Collaboration primarily occurs with developed European and American countries. However, China's domestic research consistently occupies a peripheral position in the network, with low network influence and control.

Keywords: tacit knowledge, transnational collaboration, scientometric analysis

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Introduction

The concept of tacit knowledge, first proposed by Polanyi, has evolved for over 50 years [?]. That tacit knowledge serves as the foundation and source for innovation, entrepreneurship, and organizational core competitiveness has gained widespread recognition in both academia and industry [?]. Scholars have conducted extensive and fruitful research on the concept, classification, transformation, sharing, and application of tacit knowledge from various perspectives and using different research methods. As international collaboration in scientific research has become the primary mode of social science research output and a crucial component of national science and technology development strategies, and as tacit knowledge research continues to deepen from diversified perspectives, cross-national or cross-regional collaboration has become an inevitable path for tacit knowledge research. How do the characteristics and development trends of China's transnational collaborative research on tacit knowledge manifest? What position does China hold in the international landscape of tacit knowledge scientific research? These questions reflect, from a side perspective, whether China possesses the capacity to maintain and promote sustained, rapid

economic and technological development in the 21st-century knowledge economy era, making them important subjects worthy of investigation.

A literature review reveals that the limited existing studies only touch upon scientometric analyses of tacit knowledge in specific fields or single countries, with narrow data sources and lacking an international perspective [?]. To date, no systematic research has explored the issue of China's transnational collaborative research on tacit knowledge. In light of this, this paper employs bibliometric methods and indicators, social network analysis techniques, and other approaches to systematically measure and analyze the current state of China's transnational collaboration in tacit knowledge research from five aspects: collaborative output, collaborative structure, collaborative partners, collaborative influence, and collaborative status. The aim is to understand the development status and trends of China's transnational collaborative research on tacit knowledge, providing quantitative scientific evidence for policy formulation, promoting scientific collaboration on tacit knowledge, and thereby enhancing research standards.

2 Data Sources and Research Methods

Data were sourced from the SCI-E and SSCI databases in Web of Science, covering literature on tacit knowledge research based on web data from 2001–2015. The search query was (TS="tacit knowledge"); the time span was 2001–2015; the document language was English; and the article type was Article. The literature search was conducted on April 15, 2016. After data cleaning, a total of 1,470 papers on tacit knowledge research based on web data were obtained for the period 2001–2015, of which 279 involved two or more different countries. Bibliometric methods and social network analysis techniques were employed for statistical analysis.

It is worth noting that in this study, China's transnational collaborative papers on tacit knowledge refer to papers whose author addresses include China (including Taiwan region) and other countries. The four independent research units of England, Scotland, Wales, and Northern Ireland in Web of Science were merged and treated as the United Kingdom.

3.1 Transnational Collaborative Output

Figure 1 [Figure 1: see original paper] depicts the dynamic evolution of China's share of total tacit knowledge research papers and transnational collaborative papers under 3-year time windows (2001–2003, 2004–2006, 2007–2009, 2013–2015). The overall trend in Figure 1 shows that both China's world share of tacit knowledge research papers and its world share of transnational collaborative papers exhibit upward trajectories to varying degrees. China's world share of transnational collaborative tacit knowledge papers exceeds its world share of total papers, indicating that over the past 15 years, the growth rate of China's transnational collaborative tacit knowledge papers has outpaced that of its over-

all tacit knowledge research papers. China's transnational collaborative tacit knowledge papers account for approximately 20%–35% of its domestic output, while representing about 5%–15% of the world total, suggesting that China's transnational collaborative tacit knowledge papers still have considerable room for development.

3.2 Transnational Collaborative Structure

To further clarify the structure of China's transnational collaborative research on tacit knowledge, Table 1 presents the collaboration modes, partner countries, and collaboration rates across three time windows. In terms of collaboration modes, bilateral cooperation has developed rapidly and occupies a dominant position, while multilateral cooperation urgently requires further development, indicating that the academic atmosphere for China's transnational collaborative tacit knowledge research remains insufficiently robust. Regarding partner countries, China has begun establishing transnational collaborative research relationships on tacit knowledge with an increasing number of countries. In terms of collaboration rates, China's transnational collaboration rate in tacit knowledge research continues to rise, demonstrating that China exhibits relatively active international cooperation in this field.

3.3 Transnational Collaborative Partners

Figure 2 [Figure 2: see original paper] displays the geographical distribution of countries collaborating with China on tacit knowledge research, visually reflecting the regional layout characteristics of China's transnational collaboration network through a digital world map. The color intensity in the figure represents the volume of transnational collaborative papers on tacit knowledge. As shown in Figure 2, the United States, United Kingdom, France, and Spain are among China's important collaborative partners in tacit knowledge research. Figure 3 [Figure 3: see original paper] presents the top 5 countries with the highest collaborative output with China in tacit knowledge research, with the United States being China's most significant collaborative partner.

Synthesizing the two figures reveals that major participants in transnational tacit knowledge collaboration are primarily distributed in developed European and American regions, where countries have relatively high levels of knowledge-based economic development. This indicates that China is committed to advancing its own tacit knowledge development through transnational collaboration with these developed European and American regions, thereby adapting to the changing demands of today's knowledge economy era.

3.4 Transnational Collaborative Influence

Citation rate is a crucial indicator representing research influence or quality in scientometrics. To eliminate the effects of scale, citation practices, citation motivations, and other factors, this study adopts Relative Citation Impact (RCI)

to measure the influence of transnational collaborative research on tacit knowledge. RCI represents the ratio of the average citation count per paper for a given country in a specific discipline to the average citation count per paper for all countries worldwide in that discipline [?]. In this study, RCI is defined as follows: $RCI = (\text{average citation frequency of a country's transnational collaborative papers in the tacit knowledge field}) / (\text{average citation frequency of worldwide transnational collaborative papers in the tacit knowledge field})$. $RCI = 1$ indicates that the quality of a country's transnational collaborative papers in the given field is equivalent to the world average; $RCI > 1$ indicates quality above the world average; $RCI < 1$ indicates quality below the world average.

To examine the level of China's transnational collaboration in tacit knowledge research, this study employs the International Collaborative Index (ICI). ICI refers to the ratio of a country's international collaborative papers to its total papers in a given discipline [?]. In this study, ICI is defined as: $ICI = (\text{collaboration rate of a country's transnational collaborative papers in the tacit knowledge field}) / (\text{collaboration rate of worldwide transnational collaborative papers in the tacit knowledge field})$. $ICI = 1$ indicates that a country's transnational collaboration activity level in the given field is equivalent to the world average; $ICI > 1$ indicates activity above the world average; $ICI < 1$ indicates activity below the world average.

Using ICI as the horizontal axis and RCI as the vertical axis, a technical quadrant diagram for transnational collaborative research on tacit knowledge is constructed. As shown in Figure 4 [Figure 4: see original paper], the first quadrant represents the “dual-high” type (high collaboration, high impact), indicating a leading position in the field that should be maintained and consolidated in the future. The second quadrant represents the “low-high” type (low collaboration, high impact), indicating relatively inactive international collaboration with a focus on independent research but high influence. The third quadrant represents the “dual-low” type (low collaboration, low impact), indicating extremely backward development and a disadvantaged position. The fourth quadrant represents the “high-low” type (high collaboration, low impact), indicating active international collaboration but low influence.

Figure 4 Technical Quadrant Diagram of Transnational Collaborative Research on Tacit Knowledge

Based on the above technical quadrant diagram, a comparative analysis of the 10 most productive countries in transnational collaborative tacit knowledge research is presented. As shown in Figure 5 [Figure 5: see original paper], the transnational collaborative research of the most productive countries primarily falls in the fourth quadrant (high collaboration, low impact). China's transnational collaborative research on tacit knowledge is also located in the fourth quadrant, but its collaborative output exhibits lower influence compared to the other nine countries.

This indicates that while China is relatively active in transnational tacit knowl-

edge collaboration, its influence remains low. This lower influence may stem from a lack or insufficiency of innovation, which warrants particular attention and reflection from China.

3.5.1 Evolution Analysis of Transnational Collaborative Network Position

Three network diagrams were constructed using 5-year time windows (2001–2005, 2006–2010, 2011–2015) to explore the dynamic evolution of transnational collaboration on tacit knowledge. The visualization results of the three-stage transnational collaborative networks are shown in Figures 6 [Figure 6: see original paper], 7 [Figure 7: see original paper], and 8 [Figure 8: see original paper]. Node size and connection line width are proportional to degree centrality and connection strength, respectively, while color intensity represents the magnitude of total node degree. In the transnational collaborative network on tacit knowledge, China consistently occupies a peripheral position, with slow movement toward the network core.

It should be noted that the network was pruned to retain only nodes with a total degree greater than or equal to 1.

3.5.2 Centrality Measures of Transnational Collaborative Networks

Centrality is a key focus in social network research, encompassing two important measurement methods: centrality degree and centralization. Centrality degree reflects the extent to which a node occupies a core position in the network, while centralization describes the tightness or consistency of the entire graph, that is, the centralization of a network. This study primarily employs two indicators: degree centrality and betweenness centrality. In social network analysis, degree centrality reflects the extent to which network cohesion is organized around certain nodes and whether a node occupies a central position in the collaboration network. Betweenness centrality means that if an actor lies on many paths in the communication network, this actor can be considered to hold an important position because they possess the ability to control others' communication, reflecting the actor's control over resource information.

As shown in Table 2, China's relative degree centrality in the transnational collaborative network on tacit knowledge is higher than the world average but lower than that of the United States, which occupies the network's core position. Notably, China's degree centrality continues to increase, but the gap with the United States remains substantial. On one hand, this indicates that China is slowly moving toward the network core; on the other hand, it suggests that the transnational collaborative network is trending toward equilibrium. China's betweenness centrality in the transnational collaborative network on tacit knowledge is lower than both the world average and that of the United

States, indicating that China still occupies a non-critical position in the transnational collaborative network.

Conclusions

Through systematic analysis of China's transnational collaborative research on tacit knowledge from five aspects—collaborative output, collaborative structure, collaborative partners, collaborative influence, and collaborative status—the following conclusions are drawn:

- (1) China's transnational collaborative output on tacit knowledge exhibits characteristics of rapid growth. Comparative analysis of the development trends of China's total tacit knowledge papers and its transnational collaborative papers reveals upward trajectories for both, with the growth rate of transnational collaborative tacit knowledge research papers exceeding that of overall tacit knowledge research papers, indicating substantial room for further development.
- (2) Bilateral collaboration has developed rapidly and occupies a dominant position, while multilateral collaboration urgently requires further development, suggesting that the academic atmosphere for China's transnational collaborative tacit knowledge research remains insufficiently robust. China has begun establishing transnational collaborative research relationships on tacit knowledge with an increasing number of countries, with continuously rising collaboration rates.
- (3) China's transnational collaborative partners in tacit knowledge research are primarily distributed in developed European and American regions, with the United States being China's most important collaborative partner. Going forward, while maintaining collaboration with developed European and American countries as the primary focus, China should continuously deepen cooperation with neighboring Asian countries or regions, moving toward multi-regional collaboration.
- (4) China's transnational collaborative research on tacit knowledge belongs to the high-collaboration, low-impact type, occupying a peripheral position in the transnational collaborative network on tacit knowledge with low resource control capability. This indicates that China needs to maintain a high level of international collaboration activity going forward. While promoting steady growth in the quantity of transnational collaborative tacit knowledge papers, China should also emphasize quality improvement, encouraging more original and novel research outcomes on tacit knowledge to continuously enhance its international academic influence.

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

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