Research Progress and Prospects of Regional Coordinated Development Based on CiteSpace and VOSviewer (Postprint)

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Date: 2025-02-27T00:00:00+00:00

Abstract

Based on CiteSpace and VOSviewer software, quantitative analysis of visualization maps was conducted, using CNKI and Web of Science Core Collection databases as data sources. A total of 2,221 Chinese-language documents and 51 foreign-language documents from 1984–2023 were selected for visualization analysis of keyword co-occurrence, keyword timeline, keyword clustering density, keyword burst detection, author collaboration networks, and co-citation of English literature, thereby grasping the overall trends and hotspots in regional coordinated development research. The results indicate: (1) Research on regional coordinated development can be broadly divided into three stages: the embryonic stage (before 2004), the rapid development stage (2004–2017), and the steady development stage (2018–present). (2) Keyword co-occurrence analysis reveals focus areas including regional coordinated development, coordinated development, regional economy and coordinated development, overall planning, integration, digital economy, and scientific and technological innovation. Keyword burst detection indicates that after 2018, concepts such as the new era, urban agglomerations, Western Development, and digital economy have emerged as research frontiers in regional coordinated development. (3) Authors in the field of regional coordinated development research exhibit weak interconnections, with insufficient exchanges across regions, departments, universities, and research institutions. (4) International research on regional coordinated development emphasizes ecological and environmental protection during regional development processes. Currently, under national master planning and policy support, research on regional coordinated development continues to deepen alongside practice, aiming to address practical problems and ultimately feeding back into practice.

Full Text

Research Progress and Prospects of Regional Coordinated Development Based on CiteSpace and VOSviewer

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Abstract

Using CiteSpace and VOSviewer software, this study conducts quantitative visualization analysis of knowledge mapping. With data sourced from the CNKI and Web of Science core databases, 2,221 Chinese and 51 foreign-language documents from 1984 to 2023 were selected for visualization analysis of keyword co-occurrence, keyword timelines, keyword clustering density, keyword bursts, author collaboration networks, and English literature co-citation. The results reveal the overall trends and hotspots in regional coordinated development research. The findings indicate that: (1) Research on regional coordinated development can be divided into three phases: the embryonic stage (pre-2004), the rapid development stage (2004–2017), and the steady development stage (2018–present). (2) Keyword co-occurrence analysis identifies major themes including regional coordinated development, coordinated development, regional economy, overall planning, integration, digital economy, and technological innovation. Keyword burst analysis shows that since 2018, emerging topics such as the new era, urban agglomerations, western development, and digital economy have become research frontiers. (3) Authors in this field exhibit limited connectivity, lacking cross-regional, cross-departmental, cross-institutional, and cross-organizational exchanges. (4) Foreign research emphasizes ecological and environmental protection during regional development. Currently, under national planning and policy support, regional coordinated development research is deepening alongside practice, aiming to solve practical problems and ultimately returning to practical applications.

Keywords: regional coordinated development; VOSviewer; CiteSpace; mapping; visualization analysis

1. Introduction

Since 1978, China has adopted an unbalanced development strategy, with the eastern region rapidly emerging as the nation's growth engine. In 2018, the Central Committee of the Communist Party of China and the State Council issued

the "Opinions on Establishing a More Effective New Mechanism for Regional Coordinated Development." As one of the "Five Integrations" proposed at the Third Plenary Session of the 16th CPC Central Committee, the regional coordinated development strategy emphasizes improving market mechanisms, cooperation mechanisms, mutual assistance mechanisms, and support mechanisms to gradually reverse widening regional disparities and foster a new pattern of mutual promotion, complementary advantages, and common development among eastern, central, and western regions. In his report at the 19th National Congress, Comrade Xi Jinping pointed out the need to implement regional coordinated development strategies, increase support for revolutionary bases, ethnic minority areas, border areas, and impoverished regions, advance the western development strategy, deepen reforms to accelerate the revitalization of old industrial bases in Northeast China, leverage advantages to promote the rise of the central region, and lead the eastern region toward optimized development to establish a more effective new mechanism for regional coordinated development.

Although the relative gap between eastern and western regions has narrowed, polarization effects outweigh trickle-down effects, and absolute gaps between western, central, northeastern, and eastern regions continue to widen. The eastern region' s vitality remains insufficient, with slower economic growth, while special-type regions face low levels of public services and resource constraints, making the urgency of regional coordinated development increasingly apparent. The 20th CPC National Congress report emphasizes the regional coordinated development strategy to promote high-quality development and common prosperity. Regional coordinated development has entered a new stage, with research continuously deepening and improving. As General Secretary Xi Jinping noted, "Imbalance is universal; we must promote relative balance through development. This is the dialectics of regional coordinated development."

Meanwhile, some foreign scholars have also focused on regional coordinated development, providing insights for addressing regional disparities and promoting balanced, long-term harmonious development. Existing research has accumulated substantial findings, often targeting specific regions for strategic positioning, policy barriers, and industrial structure optimization. Current studies frequently integrate the context of the digital economy and "dual circulation," examining finance, industry, environment, factors, and policy to identify problems and explore development pathways. However, relatively few studies have employed bibliometric methods and visualization tools to analyze research progress and hotspots in regional coordinated development. This paper uses CiteSpace and VOSviewer knowledge mapping to clarify the current status, hotspots, and trends of regional coordinated development research by analyzing keywords, authors, and their knowledge networks, aiming to provide scientific support for advancing research in this field.

1.1 Data Sources

To analyze the research progress and hotspots of regional coordinated development using CiteSpace and VOSviewer, this study selected the CNKI core database as the data source. In the advanced search interface, the subject term "regional coordinated development" was entered with Chinese as the language, spanning from January 1, 1984, to December 31, 2023, yielding 2,221 Chinese documents. For foreign literature, the Web of Science core database was searched using the title term "regional coordinated development" with English as the language, selecting Science Citation Index Expanded (SCI-EXPANDED) and Social Sciences Citation Index (SSCI), resulting in 51 documents. After manual screening to remove irrelevant documents, the final dataset comprised 2,221 Chinese and 51 English documents, exported in "Refworks" format and saved as "download_{XXX}.txt" files.

1.2 Research Methods

In the digital era, visualization mapping can generate knowledge graphics and genealogies, widely applied to analyze research history and frontiers of specific topics. These tools effectively process massive information, making regional coordinated development research more intuitive, graphical, and visual. CiteSpace, developed by Professor Chen Chaomei at Drexel University, is a scientific literature visualization tool that generates keyword co-occurrence maps, keyword timeline networks, and author collaboration networks. VOSviewer, developed by Van Eck and Waltman at Leiden University' s Centre for Science and Technology Studies, is visualization software for analyzing keyword co-occurrence, author publication density, and literature co-citation networks. Both tools are based on Java. This study employs bibliometric methods and visualization tools to conduct knowledge mapping analysis.

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2. Results and Analysis

2.1 Publication Volume and Timeline Analysis

Publication volume is a crucial indicator for evaluating development status in a field. The trend graph of regional coordinated development publications intuitively reveals research dynamics and accurately captures development trends. Analysis of 2,221 Chinese and 51 English documents shows that China' s total publication volume on regional coordinated development has grown annually, divided into three phases: embryonic (pre-2004), rapid development (2004–2017), and steady development (2018–present). Foreign research can be categorized into preparation (pre-2004), emergence (2004–2010), adjustment (2011–2017), and development (2018–present) phases.

2.1.1 Domestic Regional Coordinated Development Phases During the embryonic stage, regional coordinated development literature was relatively scarce. After 2004, when China proposed multiple regional development strategies, scholars began focusing on this area. In the rapid development phase (2004–2017), publication numbers increased significantly, yielding numerous high-quality outputs. Wang Yeqiang et al. examined the relationship between technological innovation and regional disparities, proposing innovation-driven pathways for coordinated development. Li Chongfeng explored urban function positioning in the Liaozhongnan urban agglomeration from a coordinated development perspective. He Chun et al. evaluated western development policy effects, while Luo Liping analyzed regional gaps and intervention strategies using Changsha County as a case study. Fan Jie et al. used statistical data to examine regional development patterns driven by investment and export-oriented economies, concluding that technological innovation significantly influenced regional patterns during the 13th Five-Year Plan period. Yang Yuhuan et al. quantitatively analyzed spatial differentiation characteristics of agricultural-cultural-tourism coupling coordination, revealing an "advanced culture-tourism, lagging agriculture" pattern affecting regional coordination. Research evolved from macro-level to more specific, precise analyses focusing on practical regional issues, producing literature aimed at breaking development barriers and stimulating economic growth.

In the steady development phase (2018–present), regional coordinated development has received heightened attention with surging publication numbers. Zou Deling et al. measured spatiotemporal evolution and influencing factors of industrial agglomeration in small towns of the Yangtze River Delta. Yao Changcheng et al. constructed an evaluation index system to systematically analyze coordinated development of environment, tourism, and economy in western Hunan, finding ecological advantages but economic weaknesses requiring optimization. Cheng K et al. studied Heilongjiang' s food security under coordinated development principles, emphasizing technology-policy integration. Li Yurong et al. explored China' s regional development patterns from the perspective of coordinated development among new industrialization, informatization, urbanization, and agricultural modernization. Research trends have shifted from macro to micro scales, from general to specific, with increased focus on analyzing actual regional conditions.

2.1.2 Foreign Regional Coordinated Development Phases Foreign publication volumes have also risen continuously, divided into preparation (pre-2004), emergence (2004–2010), adjustment (2011–2017), and development (2018–present) phases. During preparation, English publications were scarce. In the emergence phase, publication numbers began increasing. The adjustment phase saw further growth, with scholars emphasizing regional coordination for sustainable urbanization in Southeast Asia. Studies found that while gaps between eastern, central, and western China declined, intra-regional gaps within central and western regions increased. Research examined ecological-economic coordi-

nation in Guangzhou, carbon emission responsibility allocation across provinces, and regional logistics system coordination. Huang S.N. et al. found that Shanghai' s regional development and low-carbon economy composite system had entered a highly coordinated initial stage, though growth had slowed due to institutional, technical, and energy conversion factors. After 2018, foreign publication volumes increased significantly, with heightened scholarly attention to regional coordinated development.

2.2 Keyword Analysis

2.2.1 Keyword Co-occurrence Analysis Keywords distill and summarize literature content, representing the core and origin of articles. Using CiteSpace for visualization analysis of keywords with co-occurrence frequency greater than 5, and VOSviewer for clustering, five main clusters emerge: (1) Yellow cluster centers on regional coordinated development, supplemented by the scientific development concept; (2) Pink cluster focuses on regional coordination at the social level, emphasizing coordination, overall planning, and integration for unbalanced regions like the Yangtze River Delta and Pearl River Delta; (3) Purple cluster centers on regional economy and coordinated development, promoting development through institutional innovation and government cooperation; (4) Brown cluster addresses the contemporary background and market environment, focusing on digital economy, market segmentation, and industrial structure upgrading; (5) Blue cluster centers on technological innovation, supplemented by spatial pattern studies.

In the keyword density map, node size indicates keyword frequency and contribution to the field, while link strength between nodes reflects keyword relationships. Warm color blocks (red) indicate higher co-occurrence frequency, while cool colors (blue) indicate lower frequency. The research has gradually formed a core around regional coordinated development, horizontally connecting central, eastern, and western regions, and vertically advancing from economic, social, factor, and political dimensions to propose pathways for breaking high-quality development dilemmas. Many scholars focus on micro-scale studies of metropolitan areas and urban agglomerations. Cao Chen et al. analyzed factor flow intensity in the Yellow River' s "Ji" character bend metropolitan area, examining spatially unbalanced network structures and coordination levels. Current research shows a shift from macro to micro scales and from general to specific analyses.

The keyword timeline map reveals temporal changes in keywords. Research on regional coordinated development intensified significantly after 2004. Before 2004, the field was in its embryonic stage with "western development" as the main keyword. During 2004–2017, keywords exploded, featuring scientific development concept, institutional innovation, regional policy, and central region rise. Since 2018, research has entered a steady period with more keywords and broader research fields, including regional coordinated development, common prosperity, new urbanization, technological innovation, digital economy, and new development patterns. This phase emphasizes multi-party collaboration

and industrial-driven coordinated development.

The keyword co-occurrence network shows that "regional coordinated development," "coordinated development," "regional economy," "common prosperity," and "urban agglomeration" appear most frequently with dense connections. High-frequency terms closely relate to national planning concepts and regional names, indicating that research strictly follows central government documents, analyzing regional strengths and weaknesses, focusing on cross-regional factor flows and overall planning to achieve high-quality, sustainable regional integration through precise coordination where high-gradient regions drive low-gradient ones.

2.2.2 Keyword Burst and Timeline Analysis Keyword bursts indicate sudden scholarly attention to certain terms during specific periods, revealing research hotspots and frontiers. Using CiteSpace to analyze 18 burst keywords from 1984–2023, the visualization chart shows that burst duration is represented by arc span, while node numbers represent internal keyword connections. Time zones include regional coordinated development, coordinated development, regional economy, common prosperity, and threshold effects. Regional coordinated development and coordinated development show the largest cross-temporal spans. Regional economy serves as the foundation for coordinated development, while common prosperity represents the goal, complementing regional strategies like central region rise, western development, and northeast revitalization.

Before 2004, keywords like "development" and "western development" changed most dramatically, focusing on urban-rural and western development. As regional development strategies advanced, research shifted toward comprehensive benefits, emphasizing coordinated development, regional policy, scientific development concepts, transportation, and agriculture. Since 2018, research has focused on digital economy, new development patterns, and regional economic connections, emphasizing resource industrial upgrading and green development. Under new era conditions, research hotspots closely connect with contemporary contexts, with Yangtze River Delta and urban agglomerations becoming active themes that will continue influencing future research.

2.2.3 Author Collaboration Network Analysis Using CiteSpace and VOSviewer to analyze authors of regional coordinated development literature reveals key research teams and collaboration networks. Setting collaboration frequency greater than 2 in CiteSpace and using VOSviewer yields author collaboration network maps where node size represents publication count and connections reflect collaboration intensity. The field shows limited author connectivity, with most scholars working independently. While internal team connections are strong (e.g., teams led by Fan Hengshan, Zhang Junkuo, Liang Jianrong, Sun Jiuwen), inter-team exchanges are scarce, indicating insufficient cross-regional, cross-departmental, cross-institutional, and cross-organizational

communication.

The author timeline network map shows scholars active over time. Scholars like Yang Yinkai, Zhou Baoyan, and Yang Ping contributed significantly around 2004, while Zhang Junkuo, An Husen, and Xiao Jincheng were active around 2010. Recent contributors include Sun Jiuwen, Zhong Wen, and Ye Zhenyu. Publication density maps using color warmth indicate that Sun Jiuwen, Xiao Jincheng, and Yang Yinkai are major contributors, while peripheral scholars show lower publication volumes.

2.3 English Literature Analysis

2.3.1 Main Themes in English Literature Based on the Web of Science core database, English literature keywords cluster into six groups: (1) Dark blue cluster centers on coordinated development with cities, inequality, and energy consumption; (2) Green cluster focuses on urbanization with carbon neutrality, coordination degree, and development indices; (3) Red cluster emphasizes integration from spatial perspectives; (4) Light blue cluster centers on coordinated development with ecology and economy; (5) Orange cluster focuses on efficiency with carbon emission limits; (6) Yellow cluster emphasizes sustainability with industrialization and provincial-level studies.

Foreign research highlights environmental and ecological benefits, pursuing economic growth while protecting ecosystems. The research peak occurred around 2010, but has recently become a domestic and international focus. Current hotspots include regional economy, urbanization, integration, low-carbon economy, and carbon neutrality, emphasizing common development across economic, social, and ecological domains.

2.3.2 Co-citation Analysis Co-citation analysis reflects citation frequency, with higher frequency indicating greater recognition. Using VOSviewer for co-citation analysis of 50 references with frequency greater than 2, English literature co-citation clusters include: (1) Green cluster centered on Bothmann; (2) Dark blue cluster on Dang Jingjing; (3) Red cluster on Ariken. Co-citation density concentrates on works by Shan Haojie, Gao Feng, Wu Jun, and Dang Jingjing, indicating these authors' influential contributions that reflect research hotspots and provide references for other scholars.

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3. Discussion

3.1 Research Conclusions and Development Trends

Regarding development phases, China' s research started late but developed rapidly through embryonic, rapid, and steady stages. Currently in the steady development phase, research emphasizes multi-dimensional, multi-level, and wide-ranging coordinated development with greater focus on equity and humanistic

concerns. Content-wise, current research integrates digital economy with regional realities to address development challenges and propose solutions. While individual scholars produce substantial publications, limited connectivity exists between scholars and research groups, with insufficient interdisciplinary integration and underdeveloped core author communities.

Foreign research can be divided into preparation (pre-2004), emergence (2004–2010), adjustment (2011–2017), and development (2018–present) phases, emphasizing ecological protection, sustainability, efficiency-equity balance, and high-quality development.

Since the 18th CPC National Congress, China has achieved remarkable results in regional coordinated development, with significantly enhanced balance across regional plates, continuously improving equalization of basic public services, more balanced infrastructure accessibility, strengthened engine roles of growth source regions, and rapid development of important functional zones and special-type regions with improved regional openness. Internationally, the Russia-Ukraine conflict continues, COVID-19' s economic impact persists, and global economic growth remains sluggish. Domestically, urban-rural gaps, east-west disparities, insufficient northern development vitality, and special region development issues require urgent solutions.

3.2 Research Prospects and Development Pathways

3.2.1 Stimulating Enterprise and Social Organization Initiative
China' s regional development has followed the principle of "opening the front line while controlling the second line" to enhance openness in the Yangtze River Delta and free trade zones, strengthen national unified market construction, and promote factor mobility. New-era regional coordinated development emphasizes specificity, effectiveness, differentiation, and institutional innovation to break barriers. Current research focuses on breaking institutional constraints while neglecting market and social forces. Enterprises and social organizations can revitalize market vitality to drive economic and social progress in both developed and underdeveloped regions. Future research should examine enterprise behaviors, perceptions, and willingness, combining market and government roles to stimulate vitality and promote comprehensive regional coordinated development from macro to micro perspectives.

3.2.2 Combining Experience Summaries with Econometric Methods
Early Chinese research primarily used qualitative methods and experience-based summaries. Recent studies consciously combine qualitative and quantitative approaches. Future research should strengthen empirical methods like structural equation modeling for feasibility analysis to enhance scientific rigor while avoiding positivism traps. Qualitative analysis will integrate structuralism, emphasizing overall benefits and humanistic care, multi-level theoretical improvement, and qualitative-quantitative complementarity as future trends.

3.2.3 Strengthening Scholarly Exchange At the current stage, regional coordinated development research suffers from low collaboration, insufficient exchange, and fragmented systems that hinder theoretical innovation. Future efforts should enhance cross-disciplinary exchanges, promote cross-departmental, cross-regional, and cross-institutional cooperation, enrich theories to guide practice, and refine theories through practice. Enhanced academic exchange represents an important trend that will promote theoretical improvement and practical application.

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