Topic Mining and Evolution Analysis of Think Tank Reports on the Belt and Road Initiative

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Abstract

Purpose/Significance: As a crucial component of national "soft power" and "discourse power," think tanks exert profound influence on government decision-making, enterprise development, public opinion, and the dissemination of public knowledge. Regarding the understanding of the "Belt and Road" cooperation initiative, research outputs from think tanks and think tank experts play pivotal roles in foreign cooperation, public opinion guidance, project evaluation, and related domains, while simultaneously reflecting the work priorities and other pertinent information of the "Belt and Road" cooperation initiative. Through quantitative research on the thematic distribution and evolutionary trajectory of Chinese think tanks' research on the "Belt and Road" initiative, this study identifies the key focuses, research directions, and developmental patterns of the initiative from the perspective of Chinese think tanks, thereby providing systematic compilation and reference for the advancement of "Belt and Road" initiative-related research.

Method/Process: This study integrates the LDA2vec topic model with word vector semantic similarity computation methods to conduct thematic mining and evolution analysis on 3,052 reports concerning the "Belt and Road" initiative research produced between 2013 and 2020 by Chinese think tanks listed in the "Global Go To Think Tank Index Report 2020," accompanied by visual presentation and analysis of thematic content and evolutionary characteristics.

Results/Conclusions: The research hotspot themes of Chinese think tanks on the "Belt and Road" initiative have progressively encompassed domains including politics, economy, culture, society, military, and environment, characterized by distinct thematic tones such as "mutual benefit and trust," "connectivity," "community with a shared future," and "win-win." The thematic evolution process exhibits pronounced characteristics of thematic inheritance and thematic fusion, reflecting the gradually comprehensive development of the "Belt and

Road" initiative and demonstrating that domestic think tanks' research focuses on the initiative possess both continuity and expansiveness.

Full Text

Preamble

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Research on Topic Mining and Evolution of "Belt and Road Initiative" Reports in Think Tanks
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Abstract

[**Purpose/Significance**] As a crucial component of national "soft power" and "discourse power," think tanks exert profound influence on government decision-making, enterprise development, social opinion, and public knowledge dissemination. Regarding the "Belt and Road Initiative" (BRI), research outputs from think tanks and think tank experts play an indispensable role in foreign cooperation, public opinion guidance, and project evaluation, while also reflecting the initiative's priorities and key focus areas. Through quantitative analysis of the thematic distribution and evolution of BRI research by Chinese think tanks, this study identifies the priority concerns, research directions, and developmental trajectories of the BRI from a Chinese think tank perspective, providing systematic organization and reference for advancing BRI-related research. [**Method/Process**] This paper combines the LDA2vec topic model with word vector semantic similarity calculation methods to conduct topic mining and evolution analysis on 3,052 reports about the BRI published between 2013 and 2020 by Chinese think tanks listed in the *Global Think Tank Report 2020*. The results are visualized to analyze thematic content and evolution characteristics. [**Result/Conclusion**] Research hotspots on the BRI by Chinese think tanks have progressively covered political, economic, cultural, social, military, and environmental domains year by year, with distinctive underlying themes such as "mutual benefit and trust," "connectivity," "community of shared future," and "win-win cooperation." The thematic evolution demonstrates clear characteristics of inheritance and integration, reflecting the BRI's gradual and comprehensive development process and illustrating that domestic think tank research on the initiative possesses both continuity and expansiveness.

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1 Introduction

As an important component of national "soft power" and "discourse power," think tank research texts are characterized by authoritative content, high information density, and interdisciplinary integration, which better reflect the research value of the subjects under study. Analyzing think tank texts helps further explore the development direction of information science while playing a crucial role in advancing interdisciplinary research within the field. Examining think tanks' perspectives and views on international affairs is becoming an important means of studying the development and changes in international relations. Therefore, analyzing think tank research outputs can provide reasonable suggestions and insights for BRI system construction and future deepening of cooperation.

In 2013, Chinese President Xi Jinping proposed the top-level national cooperation initiative—the "Belt and Road Initiative"—which immediately attracted international attention and has drawn increasing numbers of countries to study and participate due to its cooperative features and developmental advantages. At the research level, the priorities and focus areas of think tank studies can reflect the BRI's overall development and strategic emphasis. In terms of BRI cognition and promotion, think tank research outputs play an indispensable role. This paper examines Chinese think tanks listed in the *Global Think Tank Report 2020* published by the University of Pennsylvania's Think Tanks and Civil Societies Program (TTCSP) [1] and their research reports on the BRI, applying topic mining and evolution-related text processing techniques to understand the research status, developmental trajectories, and interrelationships among research themes of the BRI in China, providing reference for BRI-related construction and exploring BRI studies from an information science perspective.

2 Research Status

In studying think tank perceptions and focus areas regarding the BRI, Shen Zhongxiu selected research reports from nine major Indian think tanks as samples to analyze their cognition of "Digital Silk Road" construction and influencing factors, offering recommendations for strengthening China-India cooperation in this area [2]. Jiang Yutong and Feng Weiguo analyzed 16 research documents published by nine U.S. think tanks, examining American think tanks' focus on the "Silk Road of Health" and proposing countermeasures against their negative evaluations [3]. Wang Fei and Hu Wei used Latin American think tanks as the analytical subject to understand Latin American countries' cognition of and participation in the BRI, summarizing the current situation and challenges in China-Latin America cooperation under the initiative [4]. Gan Baozhu and Li Yujing examined Japanese think tanks' BRI research, focusing on relevant evaluations to understand the cognition and transformation process of various sectors in Japan regarding the initiative, providing more entry points for promoting China-Japan cooperation [5]. Chen Yuan analyzed documents related to the BRI from the Netherlands Institute of International Relations, summa-

rizing its attitudes and causes, and proposing communication strategies for the initiative [6]. Vangeli Anastas applied the concept of idea diffusion to study China-Central and Eastern European think tank cooperation at the social and policy levels, proposing a theoretical framework based on the counter-effect of diffusion on society [7].

In topic mining and evolution research within the think tank field, Qi Xin used data from U.S. think tank experts' analyses of China on Twitter as research objects, analyzing their topics and popularity changes based on the LDA topic model to explore American perspectives on China [8]. Qi Xin also investigated the information acquisition channels of U.S. think tank experts' China-related tweets, analyzing information sources and access points [9]. Wang Xiwei et al. constructed a netizen emotion evolution model under emergency situations based on LDA topic mining and social network analysis, tracking thematic and emotional evolution during public opinion stages [10]. Sun Ruiying et al. adopted a multi-scholar hierarchical model to conduct comparative analysis of research themes in university think tank literature across different periods, dynamically grasping the patterns of thematic evolution [11]. Wang Fudong et al. conducted topic mining on domestic BRI-related scientific and technological literature using the LDA topic model and studied thematic cross-evolution from the perspective of keyword co-occurrence [12]. Hu Qian et al. established an intelligent recommendation method for virtual communities using a user-theme association matrix research method, integrating data mining and information recommendation approaches [13].

In summary, existing research on BRI think tanks primarily focuses on overseas think tanks' cognition of the initiative, with more summary and qualitative analyses. There is limited research combining topic mining and evolution perspectives on think tank studies of the BRI. Topic mining and evolution research in the think tank field mainly employs the LDA topic model and keyword co-occurrence methods [14], with network- and graph-based thematic association and evolution studies [15] also showing good application potential. However, more precise and granular quantitative analysis of BRI think tank research is scarce, and exploration in deeper and more accurate dimensions should be further enhanced, particularly through the use of deep learning models [16] and algorithms. This paper employs machine learning and deep learning-based text information processing techniques, combining the LDA2vec topic model and semantic similarity calculation, to study the topics and evolution of Chinese think tank reports on the BRI, innovatively adopting word vectors and semantic dimensions to provide exploratory experience for related research.

3 LDA2vec-Based Topic Mining and Analysis of BRI Think Tanks

3.1 LDA2vec Topic Model

The LDA2vec topic model, proposed by Chris Moody et al. in 2016, is a deep learning-based topic model that combines the LDA topic model with the word2vec word vector model for topic measurement. Currently, the LDA topic model has the widest application range and performs well in extracting interpretable document topics. Word2vec representation methods, through Skip-gram and CBOW models, train word vectors and are widely used to improve text representation effects. The LDA2vec topic model combines the advantages of both LDA and Word2vec, enabling optimized combination of word vectors, topic vectors, and document vectors. The introduction of neural networks from deep learning concepts also allows LDA2vec to more accurately reflect document topic clustering and relationships between topic words. Currently, the application fields of LDA2vec are continuously expanding, and model improvements are ongoing.

The main concept of the LDA2vec topic model is illustrated in Figure 1 [Figure 1: see original paper], which uses the thematic probability distribution of text content to learn vector embeddings and obtains topic extraction results through vector matching and calculation.

LDA2vec primarily relies on context vectors for topic prediction and extraction. Context vectors are generated with word vectors and document vectors as core components. Word vectors use the Skip-gram model to input words; Skip-gram, as a neural network, can predict the context words of input words. Through the INPUT layer, word W(t) is input, and vector space mapping is achieved via the neural network in the projection layer, with the OUTPUT layer producing predictions for context words such as W(t+1), W(t–1), etc. Document vectors are aggregates that fuse document weight vectors and topic matrices, where document weight vectors represent the weight of each topic in a document, and topic matrices are the corresponding vector representations of each topic. The collaborative generation of document vectors and word vectors provides context vectors for each word. Thus, LDA2vec can characterize topics and documents while training embeddings for word and context vector combinations, with model training results also improving the accuracy of topic extraction and data utilization.

3.2 LDA2vec-Based Topic Mining of BRI Think Tanks

3.2.1 Data Collection This study selected eight Chinese think tanks listed in the *Global Think Tank Report 2020*. We crawled various research information from these think tanks' official websites, including research reports, expert opinions, and analytical reviews, using search terms "一带一路," "Belt and Road," and "B&R" for the period 2013–2020. Search results encompassing analytical reports, expert viewpoints, information evaluations, and special comments were

all identified as BRI think tank research outputs, with crawled results uniformly saved as CSV files in our established BRI think tank research report database. We obtained 3,239 Chinese think tank research reports, and after classification, organization, and manual screening to remove irrelevant and duplicate data, we obtained 3,052 sample reports totaling 312,223 characters. Data sources are shown in Table 1 .

3.2.2 Text Preprocessing Since the initially integrated text data was relatively mixed, disordered, and large in volume, it could not be directly used in the LDA2vec topic model. Therefore, text preprocessing operations including word segmentation, stop word dictionary construction, stop word removal, and part-of-speech tagging were required. This study primarily deals with Chinese text, using Python's jieba Chinese word segmentation library for segmentation. Stop word removal automatically filters meaningless words from text data, an important method for improving data utilization efficiency and enhancing topic model performance and result accuracy. Stop word dictionary construction is the foundation for stop word removal, also called a stop word list, which serves as the basis for screening and retaining words. Stop word lists generally require combination of basic and specialized word lists. This study selected a Chinese stop word list from GitHub as the basic stop word list, with the specialized stop word list continuously updated and refined according to model iterations in the experiments.

Text after stop word processing filters out a large number of meaningless words. Through part-of-speech tagging, words with high information density can be selected for research convenience. Part-of-speech tagging classifies text data according to word characteristics, primarily based on grammatical features. There are two main categories: content words (including nouns, verbs, pronouns, adjectives, etc.) and function words (including prepositions, conjunctions, auxiliary words, etc.). This study primarily integrates content words for further analysis.

3.2.3 Topic Extraction Results and Analysis After text preprocessing, the data was sorted chronologically from 2013 to 2020, and the LDA2vec model was iteratively trained to obtain topics and topic words from Chinese think tank research reports. Based on multi-round experimental results, topic relevance considerations, and the lowest perplexity values of the model, the number of topics for each year's text was determined, with 15 most relevant topic words uniformly selected for each topic and 25 iterations achieving optimal results. The final topic extraction results are shown in Table 2 .

The results indicate that Chinese think tank research themes on the BRI show a trend of initial enrichment followed by integration, which can be divided into two phases: the first phase (2013–2017) features gradually increasing and expanding research themes, demonstrating continuous development; the second phase (2017–2020) shows fewer research themes but continuously improving comprehensiveness and integration, with stronger thematic synthesis, indicat-

ing research maturity and stability.

In the first phase, beginning with the BRI's proposal in 2013, research focused on regional economic cooperation and impact, primarily trade and economic cooperation in Asia, emphasizing stable development and concentrating on trade between China and countries like Russia and India, reflecting the initial stage of BRI economic cooperation. In 2014, research hotspots began to increase. Beyond economic and trade cooperation, political, social, and other domains expanded, while infrastructure construction became an important research theme in the BRI's economic sphere, reflecting the initiative's transition to concrete measures. In 2015, under the main tone of mutual benefit, trust, and practical cooperation, research hotspots included trade partnerships, employment and entrepreneurship, financial management, and talent introduction, highlighting the BRI's domestic impact. Other research themes closely integrated with international situations, involving military conflicts in Central Asia, territorial disputes, domestic situations, and counter-terrorism. Research hotspots such as the U.S.-Japan alliance and Russia-Ukraine conflicts also reflected contemporary characteristics. In 2016, think tank research continued deepening in economic, military, and political domains, emphasizing manufacturing and financial development, deepening opening-up and cooperation, and demonstrating the expanding international influence of the BRI. Notably, cultural domain research was added, including academic exchanges, cultural dialogue, and university cooperation, showing the expansion of BRI cooperation fields. In 2017, economic domain research hotspots were numerous, focusing on equal cooperation, energy trade, e-commerce, and material circulation, analyzing the signing of trade agreements among BRI leaders in Asia and Europe and emphasizing the challenge of addressing protectionism. Similarly, themes analyzing risks and challenges included financial crisis response, trade conflict response, and trade negotiations. The emergence of such risk analysis themes may relate to obstacles encountered in BRI advancement, which were particularly significant in 2017, possibly explaining the richness of research hotspots that year.

In the second phase, 2018 research hotspots were distributed across diplomatic relations in the political domain, infrastructure construction and technological innovation development in the economic domain, and environmental governance, with the emergence of green governance themes indicating research advancement toward high-quality, scientifically coordinated development. In 2019, research themes continued deepening in infrastructure construction and green development, with cultural domains re-emerging as hotspots focusing on cultural industry development, indicating effective progress in cultural cooperation. Economic domain research themes included industrial transfer, related to national industrial changes brought by the BRI and demonstrating the initiative's profound impact on national development. In 2020, research hotspots such as high-quality economic development, global governance, and connectivity were more integrated summaries of previous research, representing the overall impact and achievements of the BRI. Infrastructure construction research remained prominent in 2020, continuously deepening and demonstrating China's

outstanding advantages in this area.

Overall, Chinese think tank research fields on the BRI show a yearly enrichment trend with distinct contemporary characteristics, starting from economic research and gradually expanding to political, military, social, cultural, and technological domains. The emergence of military domain themes is also closely related to contemporary international situations. Chinese think tank research hotspots are closely connected to the BRI's connotations and key measures. For example, when the concept of a "community of shared future for mankind" emerged, research priorities also featured cooperation and exchange themes; when "connectivity" became a key concept, themes such as mutual benefit, trust, and coordination appeared concurrently.

4 Topic Evolution Analysis of BRI Think Tank Research

4.1 Semantic Similarity Calculation

Semantic similarity calculation can discover associations between statements from deeper semantic dimensions, moving beyond superficial text measurement. Introducing semantic dimensions into thematic evolution analysis, combined with basic temporal dimensions, brings vector space semantic information into thematic evolution research [12], enabling more accurate presentation of thematic evolution trajectories and discovering associations between topics from more granular perspectives.

Cosine similarity calculation is a method for calculating semantic similarity based on the cosine value of vectors, currently showing good model adaptability. When using the cosine similarity algorithm for semantic dimension-based thematic evolution research, similarity data for each theme can measure thematic evolution relationships, including theme fusion, theme splitting, and theme continuation, which are important aspects of this paper's combination of temporal and semantic dimensions for thematic evolution research.

Cosine similarity calculates directional differences between two words in vector space, i.e., the cosine value, to obtain similarity. The smaller the angle, the closer the cosine value is to 1, indicating greater vector similarity, and vice versa. Therefore, cosine values range from -1 to 1. The cosine similarity calculation formula is shown in formula (1), where A and B represent the vector sets being calculated.

To address the issue of negative values in calculation results that are difficult to compare intuitively, this paper improves the cosine similarity calculation results by introducing the definition of Cosine_{distance}, which subtracts the obtained Cosine_{similarity} from 1, as shown in formula (2).

Cosine_{distance} = 1 – Cosine_{similarity} (2)

Cosine_{distance} can solve the negative value problem, unifying similarity calculation results into a value domain of [0, 2]. For research convenience, this

paper limits the value domain to [0, 1], using Cosine_{similarity}/2 to represent a value range of [0, 1], where smaller calculation results indicate smaller cosine distance and greater similarity between calculation samples. When completely identical, the cosine distance is 0; otherwise, it is 1.

4.2 Visual Analysis of Topic Evolution Trends

Based on semantic similarity calculation results and refined indicators, thematic evolution relationships for each year were summarized and visualized using Pyecharts. For presentation convenience, the overall evolution image was divided into two parts, as shown in Figure 2 [Figure 2: see original paper] and Figure 3 [Figure 3: see original paper]. Figure 2 shows the thematic evolution trend from 2013–2017, while Figure 3 shows the evolution trend from 2017–2020.

As seen in Figures 2 and 3, the thematic evolution trends of Chinese think tank BRI research, combined with semantic dimensions, show distinct phased characteristics.

The first phase (2013–2017) features relatively small-scale thematic evolution, occurring in economic, political, cultural, and military domains. From 2013–2016, thematic evolution showed gradual enrichment, with expanding research fields. By 2017, although there were many research themes, fewer themes underwent evolution, and the scale of thematic evolution decreased, indicating continuous development in Chinese think tank BRI research and correspondingly expanding influence domains of the BRI.

In the 2013–2017 evolution, 2013 began with economic domain research, focusing on Asian regional economic cooperation. In 2014, two directions split from 2013's research themes: one was infrastructure construction and investment, deepening economic domain research and representing the BRI's main advantage; the other was cultural exchange and social cooperation, extending from economic to cultural cooperation and marking expanded research coverage. In 2015, research themes in political and economic domains evolved through fusion from 2014's themes, including political cooperation and practical partnerships, and financial industry regulation in the economic domain. In 2015, military domain research themes expanded, focusing on national security and counter-terrorism measures in BRI countries, territorial disputes, and military conflicts, which fused to form 2016's military domain research on military disputes and counter-terrorism along BRI routes. Other 2016 research themes partially inherited from 2014 and 2015, including cultural exchange and cooperation, and opening-up and mutual benefit. The economic domain continued financial research, combined with political cooperation, analyzing manufacturing development and cooperation in BRI countries. Based on 2016's manufacturing and financial market operation and opening-up cooperation themes, 2017's research themes included building a new pattern of equality and mutual benefit, financial crisis and trade competition, e-commerce and logistics, and energy trade. The BRI trade node connectivity theme also integrated 2016's academic exchange

and cultural cooperation theme, indicating more comprehensive research on BRI trade hub construction.

The second phase (2018–2020) shows stable research fields and rich thematic evolution, marking maturity in Chinese think tank BRI research and stable, deepening BRI advancement. Thematic evolution was most extensive between 2018 and 2019, indicating consistent research directions and stable, sustained research hotspots during 2018–2020. In this evolution stage, 2018's research themes evolved from 2017's mutual benefit cooperation and trade coordination, including high-quality opening-up, political alliances, economic development, and infrastructure construction research, expanding into green development systems and technological innovation. 2019's themes were highly correlated with 2018's, evolving from 2018's political diplomacy, green development, and infrastructure themes. Cultural and economic domain research themes in 2019 also integrated 2018's technological innovation research, indicating synergistic development between BRI infrastructure construction and technological advancement. Additionally, 2019's economic domain research themes, such as infrastructure, market trade, and financial systems, all inherited 2018's high-quality opening-up research theme. 2020's research themes can be summarized as high-quality economic development and community of shared future construction, covering political, economic, and cultural domains, all inherited and fused from 2019's research themes as continuations of 2018 and 2019 research. Thematic evolution in this period mostly demonstrates inheritance and fusion, with good research continuity and stability, marking research maturity.

Overall, Chinese think tank BRI research thematic evolution from 2013–2020 shows characteristics of gradual enrichment and continuous development, with sustained deepening and expansion of BRI think tank research. Research fields show initial expansion and enrichment followed by deepening and refinement. During evolution, hotspot themes under research domains have diversified yearly, with thematic evolution mainly concentrated in political, economic, and cultural domains, consistent with hotspot domains reflected in topic extraction results. This demonstrates that the BRI's actual coverage domains continuously expand, influence levels gradually increase, and the BRI cooperation initiative has achieved remarkable results.

5 Summary and Outlook

Based on 3,052 Chinese think tank BRI research reports, this paper conducted systematic organization and evolution analysis of research hotspots using topic mining and evolution theories and methods. The innovation lies in introducing the deep learning-based LDA2vec model and word vector-based text similarity calculation methods from the perspective of topic mining and evolution analysis, employing more refined and quantitative approaches to 梳理 research hotspots and developmental trajectories from a Chinese think tank perspective.

The study found that Chinese think tank research themes on the BRI are dis-

tinctive, with each year's themes having unique characteristics. Research domains progressively cover political, economic, cultural, technological, military, and social fields, emphasizing cooperation, mutual benefit, community of shared future, win-win outcomes, and infrastructure construction, with clear focus on China's manufacturing, financial, and cultural industries. Themes across years are interrelated, undergoing processes of theme splitting, evolution, inheritance, and innovation, indicating mutual reference and disciplinary integration in Chinese think tank BRI research. The thematic development process shows minor fluctuations, with stable main research domains and phased evolution characteristics.

Future research will introduce more semantic dimensions such as topic intensity and topic sentiment, further deepening the study of think tank characteristics and related text features to explore additional research dimensions.

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Author Contributions

Qi Ruihua: Guidance on theoretical framework and experimental methods;
Fu Hao: Experiment implementation and paper writing.

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