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Analyzing the topic distribution and evolution of foreign relations from parliamentary debates: A framework and case study

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ABSTRACT

Parliamentary texts are records of discussions of domestic and international affairs, which reflect national attitudes and development trends in foreign relations. In this paper, a research framework is proposed to analyze foreign relations on the basis of parliamentary texts. First, topic words are extracted from parliamentary texts, and then a co-word network is constructed to represent the correlation structure of topic words. The basic statistics, calculation of network indicators, community detection, and visualization of network maps and evolution venation, as well as the depiction of a strategic diagram, elucidate deeper characteristics and connotations of foreign relations. This case study on UK-China relations during the period of 2011-2017 using British parliamentary texts reveals the following findings. Over this period, UK-China relations changed in terms of the topics involved, topics which are greatly unbalanced in distribution, but are quite concentrated. Five different directions exist, centering on Trade, Human rights, Nuclear, Steel, and Visa. The evolution of topics includes merging and differentiation. A minority of topics exhibit marked continuity, which constitute the main focal points discussed each year, such as Economy and Trade. Regarding development trends, themes related to trade and steel remain focal points in UK-China relations. Overall, the framework proposed in this paper is proven to be both effective and feasible, and its application through this case study can foster a deeper understanding of the status and development of UK-China relations.

1. Introduction

Elucidation the topic distribution and evolution of foreign relations is beneficial for understanding diplomatic situations and planning foreign policy (Kullaa, 2016). Foreign relations between countries or regions include international affairs referring to politics, economy, culture, military actions, etc. International affairs are also reflected in a corpus of records and official documents. For example, debates recorded in parliamentary texts comprise discussions of domestic and international affairs by government officials and related personnel (Schumacher, Hansen, van der Velden, & Kunst, 2019). Parliamentary texts constitute highly structured records of debates on current affairs that can accurately reflect real-time foreign relations (Ihalainen & Matikainen, 2016). They are published via a retrieval system by some countries, and can be mined and analyzed to advance our understanding of the status and development trends of foreign relations (Beelen et al., 2017).

In recent years, researchers have invested great efforts to study different aspects of foreign relations, including foreign policy attitudes, diplomatic differences, national interests, and international relations (Barnett et al., 2017; Gravelle, Reifler, & Scotto, 2017;

Jenichen, 2015; Kai & Spencer, 2013; Lee, 2016). The data sources used were official documents, survey data, news reports, and social media. Qualitative methods were applied in most of the extant literature, lacking quantitative analysis and objective interpretation. Recently, the increasing availability of parliament texts in digital format offers unprecedented opportunities to explore and mine parliamentary texts. Through the application of certain techniques, such as automatic text analysis, unsupervised and supervised methods, as well as word embeddings, the problems of rhetorical function in parliament topics, officials' emotion, topic and opinion polarity of parliamentary debate motions, and party embeddings have been examined (Abercrombie & Batista-Navarro, 2018a, 2018b; Rheault, Beelen, Cochrane, & Hirst, 2016; Rheault & Cochrane, 2019; Zhang, Spirling, & Danescu-Niculescu-Mizil, 2017). However, analyses and approaches for a deeper understanding and connotations of parliamentary texts remain undetermined.

Considering the importance and societal impact of foreign relations on governments and the public, a comprehensive and macro-perspective of foreign relations should be achieved, and its evolution venation needs to be explored, in order to elucidate its continuous development. Words used in various parts of a document, including the title, abstract, keywords, and paragraphs, are frequently utilized to analyze intellectual structure (Khasseh, Soheili, Moghaddam, & Chelak, 2017). In addition, co-word analysis, a well-established and broadly employed approach, has been proven effective for revealing latent connotation and evolution venation (Huang et al., 2015; Huang, Su, Xie, & Li, 2014; Muñoz, Bolívar, Cobo, & Viedma, 2017). Co-word analysis is a bibliometric technique that extracts topic words from connotation units (Small, 1999) (e.g., article, paragraph), and then constructs the co-word network based on the calculation of co-occurrence between topic words (Assefa & Rorissa, 2013). Results, mainly comprising network indicators (Zhao, Mao, & Lu, 2018) and visualization (Khasseh et al., 2017), can mine the deeper meaning of text contents through, for instance, topic word burst detection, correlation network indicators (overall and individual), topic community detection (direction), mapping of topic correlation structures, topic evolution venation, and strategic diagrams.

Nonetheless, up to now, research on foreign relations has not utilized co-word analysis. Topics of parliamentary debates are related to the economy, official affairs, people's livelihoods, war, diplomacy, etc. Co-word analysis and related tools could assist us to determine the major topics existing in foreign relations, in addition to their semantic structure and evolution throughout consecutive periods of time (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011a, 2011b).

Therefore, this paper aims to conduct a co-word analysis, taking parliamentary debate texts as its sample, and reveal latent connotations related to foreign relations. This approach enables us to quantify and visualize the thematic evolution of foreign relations. It also provides important theoretical and methodological insights for research on foreign relations, and contributes to the objective interpretation of parliamentary texts and foreign policy-making for governments.

To achieve the primary aim of this paper, we attempt to explore an overall proposal for analyzing characteristics of topics in foreign relations. UK-China relations are selected for the case study using British parliamentary debates. In recent years, the UK and China have engaged in dialogue and cooperation in various fields, and interactions involving both sides are increasingly close. Indeed, China has also become the largest source of foreign students in the UK, and the UK is China's second-largest trading partner and first-largest destination of investment in the EU. Correspondingly, the study of foreign relations between the UK and China has attracted great attention from both governments and researchers (Chow, Han, & Li, 2019; Brown, 2018). This case study on UK-China relations will contribute to deepen the understanding of international relations between the two countries, so as to provide valuable references and suggestions for the government and researchers. Specifically, this study will validate the research framework, and identify characteristics and patterns of UK-China relations. Furthermore, the findings can substantially increase our knowledge of UK-China relations, and especially their focal points and development trends. Overall, the current paper attempts to address the following three research questions:

RQ1. What is the focus and distribution of topics related to UK-China foreign relations in Parliament?
RQ2. What is the correlation structure of topic words related to UK-China foreign relations?
RQ3. What are the development tendencies, evolution venation, and rules of topics related to UK-China foreign relations?

2. Literature review

This section mainly reviews previous literature that focuses on textual analysis of foreign relations, mining and analysis of parliament texts, as well as topic analysis based on linguistic elements.

2.1. Research on foreign relations

Research on foreign relations is critical for optimal adjustment of international relations, and has thus received much attention from scholars and governments. Published debates (Kai & Spencer, 2013), official documents of diplomatic activities (Jenichen, 2015), national survey data (Gravelle, Reifler, & Scotto, 2017), etc., are frequently used as samples to illuminate foreign relations. Methods in previous studies involve cognitive analysis, structural equation models, discourse analysis, etc., to examine, for instance, the UK's changing diplomatic relations surrounding international terrorism and the anti-terrorism war (Kai & Spencer, 2013), the evolution of national attitudes on diplomacy between the U.S. and the UK (Gravelle, Reifler, & Scotto, 2017), and diplomatic differences between Europe and the U.S. concerning religious issues, especially those related to Muslims (Jenichen, 2015). Moreover, news reports of historical events and social media conversations also constitute important data sources for analyzing foreign relations. For example, news reports about the formation, maintenance, and termination of the South Korea-U.S. alliance reflect changing diplomatic relations and implications, as well as factors influencing both (Kim, 2012). A large number of news

reports in China and India involve border issues, and critical discourse analysis has identified national security to be the main focus between the two countries (Lee, 2016). Furthermore, over 1.8 billion Facebook postings in English and 51 million Weibo postings in Chinese have been used for inferring international relations perceived by the general public (Barnett et al., 2017).

2.2. Analysis of parliament text

Government data are increasingly open globally due to the "open data" movement, and innovative exploration of data is increasingly encouraged. In particular, content on parliamentary debates in many countries (for example, the UK, the U.S., Germany, Russia, and Canada) has been preprocessed and published in structured formats (e.g., XML, Jason). In addition, text mining and exploration of parliamentary texts have been performed and analyzed. For example, Rheault et al. (2016) conducted automatic text analysis on the U.K. House of Commons debates (1909-2013). They found that overall change in officials' emotion was significantly related to economic recession. Zhang et al. (2017) utilized an unsupervised method to analyze rhetorical function in parliament topics, which is a method that can be valuable for categorizing parliamentary texts. Abercrombie and Batista-Navarro (2018a) presented a dataset of UK parliamentary debate motions labelled with both topic and opinion polarity, a supervised classifier was then trained to detect opinion topics, and agreement on opinion polarities of the motions between policy positions and manual annotations was examined. A two-step classification model was also introduced to classify the sentiment polarity of speakers on transcripts of UK parliamentary debates (Abercrombie & Batista-Navarro, 2018b).

In addition, the corpus of the Dutch parliament has been transformed from semi-structured to XML format, and an information retrieval system of parliamentary texts has been developed for the public (Kaptein & Marx, 2010). The Canadian House of Commons debates have also been digitized and annotated using XML and OCR techniques, and an online platform designed as a hub for archiving Canadian political data has been developed for the public and scientific research (Beelen et al., 2017). Recently, models of word embeddings have been introduced into the mining of parliamentary texts. For example, Rheault and Cochrane (2019) proposed a model of word embeddings augmented with political metadata and trained on large-scale parliamentary corpora from the UK, Canada, and the U.S., which can be utilized to produce scaling estimates of ideological placement and other quantities of interest for political research.

2.3. Topic analysis based on linguistic elements

Some scholars have focused on vocabulary or keywords in documents to analyze conceptual structure and scientific evolution based on the correlation network established by these words (Bornmann, Haunschild, & Hug, 2018; Cobo et al., 2011b; Muñoz et al., 2017). For instance, Huang et al. (2014) collected 4,707 Chinese S&T policies, labeled the topics of each policy with two to six keywords, and used co-word analysis to map the topics of those policies. Jiang, Barnett, and Taylor (2016) selected 150 of the most frequently occurring words from international news coverage, and performed semantic network analysis to investigate the news frames of international coverage between the U.S. and China, as well as the dynamics of the framing process. Chowdhury and Koya (2017) calculated term frequency within four key UN policy documents, and carried out thematic analysis of sustainable development. Jiang, Barnett, Taylor, and Feng (2018) employed semantic network analysis to investigate the dynamic co-evolutions of peace frames embedded in news coverage based on frequently occurring words.

Several scholars have also proposed a general work flow of topic analysis based on linguistic elements. For example, Martínez et al. (2015) stated that the steps of science mapping analysis include data retrieval, preprocessing, network extraction, normalization, mapping, analysis, visualization and interpretation, and this work flow was successfully employed in analyzing the scientific evolution of social work. A similar work flow has also been used to analyze the scientific evolution of e-Government (Alcaide–Muñoz et al., 2017). Huang et al. (2018) proposed that the main components of the policy change analysis framework comprise data collection, patterns identification, network construction, eigenvector centrality calculation, and topic changes analysis based on shifts in network centrality.

Overall, parliamentary debates are important sources for analyzing foreign relations since they record direct and actual information about diplomatic activities. However, analysis of these data is limited, and especially topics' distribution and evolution of foreign relations remain understudied. Topic analysis based on linguistic elements enables researchers to elucidate the field's structure and evolution, and the general work flow proposed by the scholars mentioned above provide a useful reference for this paper. In this research, we have attempted to analyze foreign relations based on topic words extracted from parliamentary debates and the correlation structure of topic words. The major difference of this study compared to most extant ones is an attempt to analyze topic distribution and evolution of foreign relations, and provide a comprehensive understanding of UK-China foreign relations contained in parliamentary debates. To the best of our knowledge, this study is the first to utilize co-word analysis and science mapping techniques to analyze foreign relations.

3. Framework and methodology

A research framework or a processing flow, shown in Fig. 1, is proposed for the study of foreign relations based on parliamentary debates.
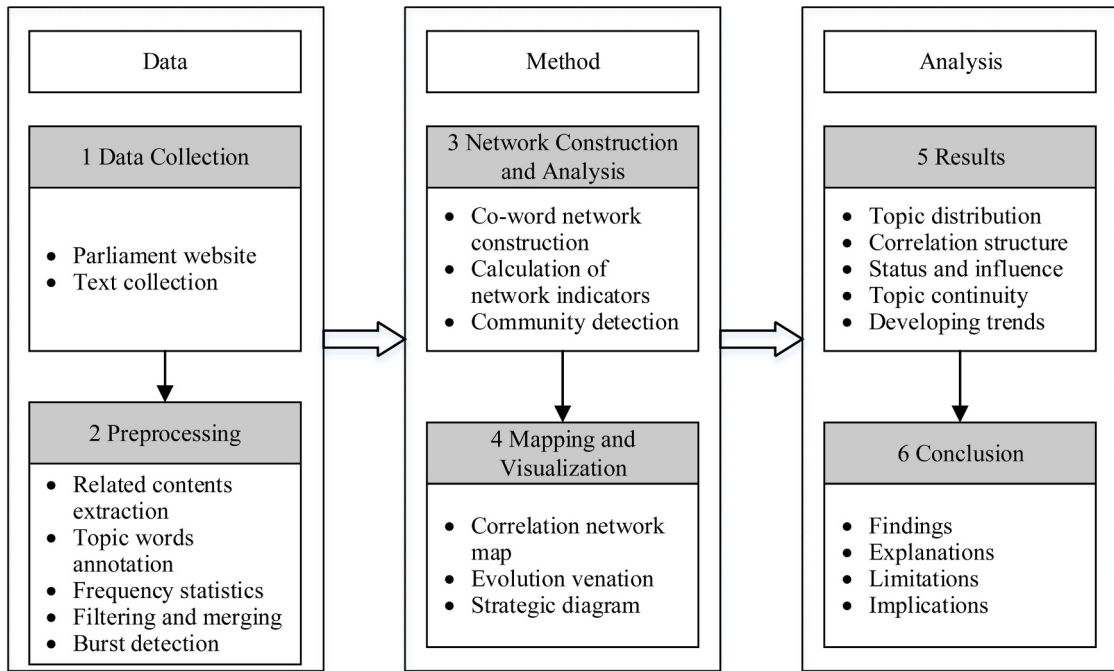
Data	Method	Analysis
1 Data Collection • Parliament website • Text collection	**3 Network Construction and Analysis** • Co-word network construction • Calculation of network indicators • Community detection	**5 Results** • Topic distribution • Correlation structure • Status and influence • Topic continuity • Developing trends
2 Preprocessing • Related contents extraction • Topic words annotation • Frequency statistics • Filtering and merging • Burst detection	**4 Mapping and Visualization** • Correlation network map • Evolution venation • Strategic diagram	**6 Conclusion** • Findings • Explanations • Limitations • Implications

Fig. 1. The framework for foreign relations topic analysis.

3.1. Data collection and preprocessing

Currently, increasing numbers of countries have implemented digitalization of parliament records. They are all accessed through government websites or independent portals, as shown in Table 1. These parliamentary records are mostly text files in TXT, XML and PDF formats, which facilitate further analysis of parliamentary content.

Topic analysis cannot be directly applied to original parliamentary texts prior to text preprocessing. Parliamentary texts related to politicians' speeches, parliament activity records, etc., are unstructured or semi-structured, but generally include many fields, such as time, topic, speaker, and speech content. These fields are extracted and stored in a database. Topic words reflect the purposes or intentions of speech contents by speakers in parliamentary texts, and they are all annotated manually. In this study, topic words with high frequency, due to their importance, can be used to conduct subsequent analyses. Thus, the threshold of occurrence frequency is established according to the accumulation of frequency and its proportion to the sum. Topic words with a frequency lower than the threshold will be merged with their synonyms or hypernyms. Finally, the processed frequency list of topic words is generated.

Influenced by the international and domestic environment, the chronological characteristics of parliamentary contents are obvious. Some words appear in bursts, reflecting a sharp increase in related concerns in international affairs. In this paper, the Kleinberg burst detection algorithm (Kleinberg, 2003) embedded in SCI2[1] (an information measurement and knowledge mapping analysis software) is adopted to calculate the burst weight of topic words. A list of burst words is generated by SCI2, as well as a bar graph of words to intuitively display bursting status.

3.2. Network construction and analysis

Co-word networks have proved beneficial for discovering a text's focus and latent connotation, even for chronological evolution venation (Lozano et al., 2019; Rodríguez-Bolívar, Alcaide-Muño, & Cobo, 2018), which thus constitute the core of science mapping analysis. In this paper, a paragraph in a parliamentary text is set as one connotation unit and used for calculation of the co-occurrence of topic words. Specifically, "co-word" refers to the co-occurrence of words in the same paragraph, and "co-word frequency" equals the number of paragraphs that contain these two words. SCI2 is used to count the number of topic words, and generate a co-word network file (.net format) that contains topic words and their corresponding frequency, as well as co-word relations and their corresponding frequency.

Pajek is an effective tool for calculating the attributes of one network, and is commonly applied in social network analysis (Brusco & Doreian, 2019). In this paper, indicators of a co-word network are calculated by Pajek, including centralization (centrality) (Freeman, 1979), density (Yan, Ding, & Zhu, 2010), clustering coefficient (Leydesdorff, Park, & Wagner, 2014), etc. These indicators can reveal the correlation structure of topic words, and the position and function of each topic word in the whole network. It reflects

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[1] https://sci2.cns.iu.edu

Table 1

Countries and URLs with access to parliament records.

Country	URL
United Kingdom	http://theyworkforyou.com
United States	https://www.congress.gov
Germany	http://www.bundestag.de
Canada	http://www.lipad.ca
Russia	http://www.council.gov.ru (House of Commons)
	http://www.duma.gov.ru (House of Lords)
European Union	http://www.europarl.europa.eu/activities/plenary/home.do

the connotation of a parliamentary text, as well as the status and development of foreign relations.

It is worth noting that the presence of topic words with a high degree of correlation between them means that they have the same or a very similar connotation. They are linked with high co-occurrence frequency in a co-word network, and possess the feature of aggregation. They are divided into a highly correlated topic cluster within the network in a process that can be conducted by a community detection algorithm. The Louvain algorithm embedded in Pajek, for example, is broadly employed and has been proven to be effective in previous studies (Blondel, Guillaume, Lambiotte, & Lefebvre, 2008; Hu & Zhang, 2017a). The divided or detected clusters and communities represent different focal points or directions debated by speakers in Parliament. They also convey different connotations hidden in foreign relations. Indicators for each community, such as density and average degree centrality, can identify its relative development status and tendency.

3.3. Mapping and visualization

Mapping of the co-word network of parliamentary texts, including the whole network and each community, can display the correlation between topic words more intuitively and vividly. It is also beneficial to deeply understand different connotations in foreign relations. Based on findings of numerous investigations, VOSviewer (Eck & Waltman, 2010) is chosen to generate the network maps, including the network within and between communities. In the map, the node represents the corresponding topic word or community, and its size is proportionate to the frequency. The link represents the corresponding co-occurrence relationship between any two topic words, and its width is proportionate to the number of co-occurrences. Furthermore, nodes and links in the map are colored differently according to the community.

Foreign relations change chronologically due to rapidly changing global affairs between countries. These changes are reflected in topic words in parliamentary texts every year. Consequently, the changing of foreign relations equals that of topic words over years, and could be observed through the evolution venation of topic words. In this paper, co-word networks for parliamentary texts for each year are constructed, and then community detection is conducted in each co-word network by the Louvain algorithm. Cortext (Hu & Zhang, 2017b; Rosvall & Bergstrom, 2010) can depict the evolution venation of topic words through tubes with different colors. The tubes show the evolution venation of topic words through continuity, confluence, differentiation, etc., which reflect changes in foreign relations over time (Leydesdorff & Goldstone, 2014).

As mentioned above, density and average degree of communities, representing the degree of maturity and centrality, respectively, indicate their relative development trend. If these communities are projected onto a two-dimensional diagram with four quadrants, known as the strategic diagram (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011a), their relative development trends are intuitively demonstrated. In the strategic diagram, the X-axis represents centrality, and the Y-axis represents density. The axes' origin is determined by the mean values of centrality and density. Thus, communities representing directions of foreign relations are obviously distinguished in terms of whether they are mature and focused.

4. A case study of UK-China relations

The study of UK-China relations in this paper is conducted based on British parliamentary debates as a case to verify the above research framework. It also assists to advance our understanding of the development of UK-China relations, and even facilitates an accurate comprehension of the connotation of their relations.

4.1. Topic statistics and distribution of UK-China relations

We find that a large number of debates exist related to China in the Parliament of the United Kingdom (House of Lords and Commons). 3,001 parliamentary texts from 2011 to 2017 were downloaded in XML format. Different contents, such as time, speaker, theme, and speech content, etc., are marked-up beginning with the character "<" and ending with ">" in these documents. The label "<p>&</p>" represents a paragraph of speech contents by speakers in parliamentary texts. If a paragraph contains a country name or a city name of China, such as "China", "Chinese", "Beijing", "Shanghai", etc., it will be deemed as relevant to China. Finally, 6,311 paragraphs with reference to China were extracted. Table 2 presents examples of paragraphs extracted.

Next, the topic words are annotated manually. To complete the annotation task, we recruited five Information Science Master's students from Wuhan University, and the second author and corresponding author of this paper also participated in this work. The

Table 2

Examples of paragraphs extracted and annotated topic words.

Date	Paragraph	Topic words
2017/07/12	\<p\>At the recent G20 meetings, the Prime Minister had excellent and constructive trade discussions with the leaders of India, China, Japan and America, which collectively represent 43% of the world's population and six times the population of the European Union. Does my right hon. Friend agree with me that this demonstrates the potential for a prosperous and positive future for Britain post-Brexit, and that it really is time for the pessimists to look at the cup being half full rather than half empty? \</p\>	G20; trade discussion; Brexit.
2016/02/29	\<p\>The UK Government must work harder with their European partners to address the dumping of cheap steel in European markets, which is, as we all know, undermining UK steel production. Although 2% of UK steel demand was met by Chinese imports in 2011, that figure has been forecast to rise to 8% this year and next. We are all keen to hear from the Minister on that point. \</p\>	dumping; steel; steel production; imports.
2015/10/22	\<p\>When are the Government likely to provide time for a debate about the consequences of the agreements made with the Chinese Government this week concerning nuclear power, which are clearly very significant? Not only is the possibility of a new power station at Bradwell, overlooking my constituency, likely to have very detrimental effects on the marine ecology of the Blackwater estuary, but the ownership, construction and control of our critical national infrastructure appears not to have been fully considered by the National Security Council, and no proper assessment has been made of the consequences of these very significant decisions for our national security. \</p\>	nuclear power; power station; marine ecology; national security.

five students and two authors worked for a total of 60 hours each over a one-month period. The following set of annotation rules were defined: (1) only nouns and noun phrases with practical meaning were considered; (2) named entities (persons, locations, organizations) were considered; (3) irrelevant paragraphs were deleted, e.g., paragraphs containing "Chinese Wall" but that were irrelevant to China; and (4) all of the topic words were from paragraphs without manual editing. Manual annotation was then carried out on the corpus (6,311 paragraphs) in two rounds: (1) each paragraph was annotated by two annotators, respectively, and identical topic words were retained; and (2) different topic words were discussed by the the second author and corresponding author of this paper to decide whether or not they would be retained. Moreover, the annotation results were approved by two professors in the foreign relations field from Wuhan University. Finally, 5,687 unique topic words were determined. Examples of annotation results are shown in Table 2. We believe that these annotation guidelines can be easily applied to parliaments of other countries. To the best of our knowledge, no applicable topic lexicon yet exists in the study of foreign relations or parliamentary debates. Consequently, this work should also have profound implications for the construction of domain lexicons.

Fig. 2 presents the basic data statistics of the dataset. It can be found that the change in the number of debates related to China accorded with that of topic words. It is worth noting that they both fluctuated extensively, while the number of average words in each debate paragraph increased slightly. This indicates that the topics involved grew increasingly diverse when speakers mentioned China. International affairs concerns in the UK are increasingly related to China, which may illustrate the importance of China.

In this paper, not all topics and their corresponding words were selected to conduct the subsequent analysis. Topic words with a frequency greater than 20 were chosen as the sample for co-word analysis, and those with a frequency lower than 20 were merged with their broad terms. Finally, 179 topic words were determined to represent the main affairs in UK-China relations. Table 3 shows the top-100 words in terms of frequency. It is worth noting that the sum of the frequencies for the top-100 words accounts for nearly 60% of the total, and even the top-10 words account for 16.1%. These statistics indicate that the distribution of topic words in British parliamentary texts is sharply unbalanced. In other words, the affairs debated in the British parliament were very focused or a minority of topics in UK-China relations were of significant importance. It could even be concluded that China highly impacts the UK in these relative affairs. For example, Trade, Economy, Exports, Steel, Investment, Human Rights, Nuclear, Market, Dumping, and Energy have been afforded the most attention by the British parliament in recent years. Indeed, they constitute the most important
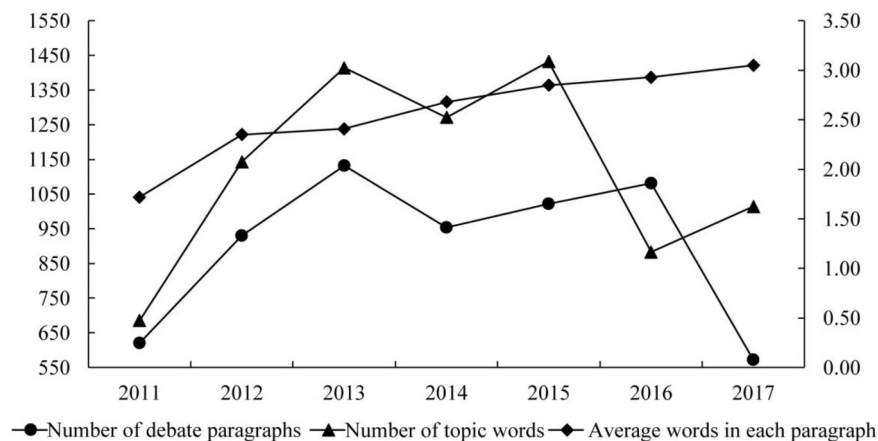

Fig. 2. Yearly number of debates and words related to China (2011–2017).

Table 3
Top-100 words in debates related to China.

Ranking	Words	Frequency	Ranking	Words	Frequency
1	Trade	409	51	Partnership	53
2	Economy	400	52	Infrastructure	53
3	Exports	322	53	Renewables	51
4	Steel	292	54	Crime	50
5	Investment	258	55	Eurozone	50
6	Human Rights	231	56	Humanitarian Aid	49
7	Nuclear	171	57	BRIC	47
8	Market	170	58	Olympic Games	46
9	Dumping	158	59	Free Trade	44
10	Energy	148	60	Visitors	42
11	Hong Kong	142	61	Funding	42
12	Business	140	62	Foreign Affairs	41
13	Steel Industry	121	63	G20	40
14	Visa	113	64	Workforce	40
15	Manufacturing	112	65	Religion	40
16	Climate Change	110	66	Sanctions	39
17	Tariff	103	67	Competition	39
18	Market Economy	97	68	Universities	39
19	Finance	96	69	Immigration	39
20	Industry	93	70	Deficit	39
21	Jobs	89	71	Oil	38
22	Imports	81	72	Carbon Emissions	38
23	Security	75	73	High-speed Rail	37
24	Democracy	75	74	Carbon	37
25	Tax	73	75	Christians	37
26	South China Sea	73	76	Anti-dumping	37
27	Diplomacy	71	77	Cooperation	37
28	Chinese Government	68	78	Terrorism	36
29	Trade Agreement	67	79	Economic Growth	36
30	Politics	66	80	Money	36
31	Technology	66	81	Culture	36
32	Law	66	82	Health	35
33	Education	65	83	Aid	35
34	Tibet	65	84	Joint Declaration	35
35	Nuclear Weapon	64	85	NATO	35
36	Defence	63	86	Free Trade Agreement	35
37	UN Security Council	63	87	Peace	35
38	War	61	88	Interests	34
39	Bank	60	89	Emerging Economies	34
40	Tourism	59	90	Steel Dumping	34
41	Security Council	58	91	Leadership	34
42	Emerging Markets	58	92	British Economy	34
43	Students	58	93	Crisis	34
44	Lesser Duty Rule	56	94	Coal	34
45	Government	56	95	Single Market	33
46	Military	55	96	GDP	33
47	Airport	55	97	Overseas Students	33
48	Emissions	55	98	Commonwealth	33
49	Brexit	54	99	Negotiation	32
50	Food	54	100	Language	32

affairs in UK-China relations.

Furthermore, the results of burst detection showed that 132 burst topic words with a weight range from 2 to 92 were identified. The threshold of burst weight is set at eight, and the top-30 burst topic words were obtained to map the bar graphs due to a balance between analysis scale and research aim. The sum of the weights of the top-30 burst topic words comprises 61% of the total, covering most of the important words. Fig. 3 shows bar graphs representing burst topic words, indicating that the relative affairs have increased markedly in recent years in UK-China relations.

It can be seen that the number of burst words sharply increased during and after 2014. In particular, there were 10 burst words in 2016, which can be considered as the most unstable year in this period. Moreover, certain topic words, such as Steel, Dumping, Market Economy, Tariff, Lesser Duty Rule, Chinese Government, Brexit, Foreign Affairs and Trade Agreement were given rapidly growing attention by the British parliament. Indeed, these topics and relevant affairs became new focal points in UK-China relations.

4.2. Correlation structure of topic words in UK-China relations
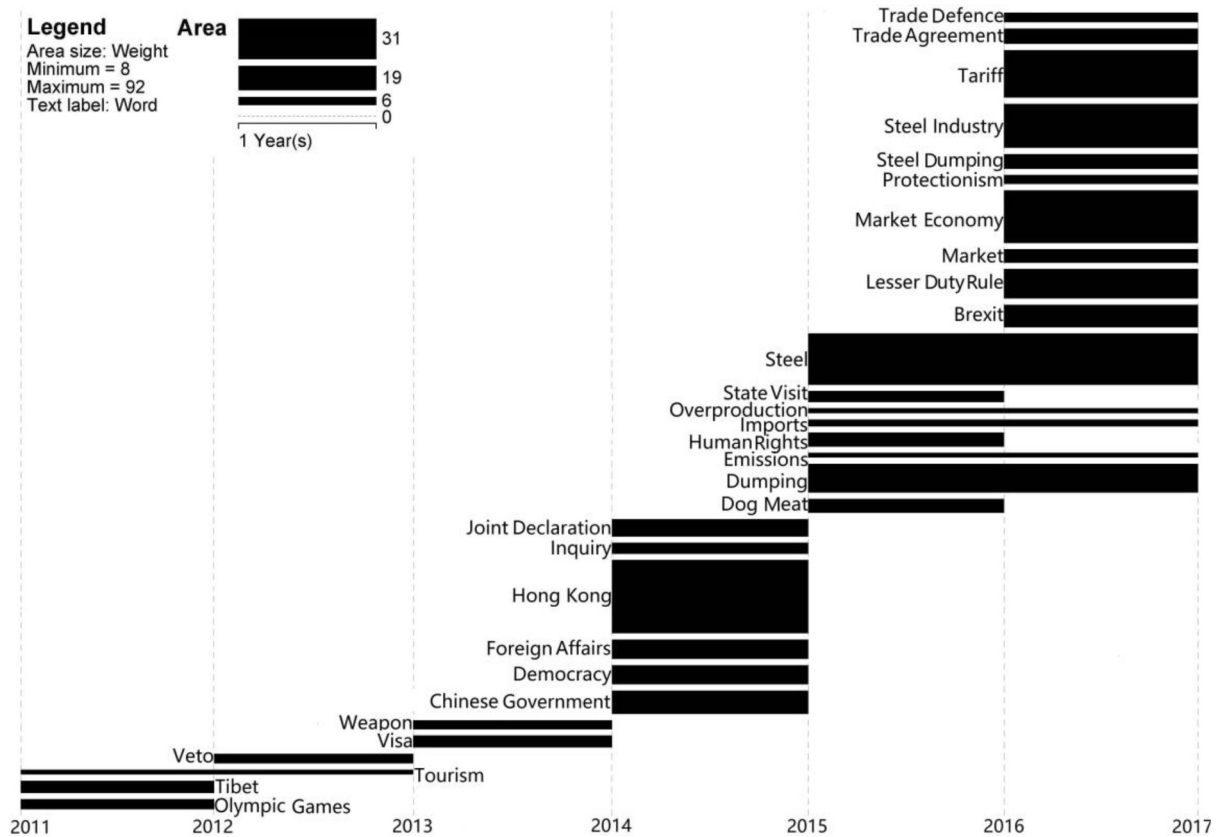
(1) Network indicators analysis

Fig. 3. Burst topic words in UK-China relations (2011–2017, weight ≥ 8).

The co-word network generated by the 179 main topic words is the largest connected component. Its characteristics can be shown with the network indicators in Table 4. The average degree, i.e., the average number of words directly correlated with each word, is 31.98. The network only accounts for 17.86% of all words, indicating that the scope of word correlation is not broad overall, and that the aggregation of topics in debates is quite obvious.

Both degree centralization and closeness centralization are high. This indicates that topic words are highly aggregated in terms of directions of foreign relations, and the probability of direct correlation between any two topic words is great. These topic words aggregate into a cluster or community with a high and direct correlation, in accordance with the relatively high clustering coefficient. Specifically, topics words are divided into distinct communities due to coherence in connotation for foreign relations. Inversely, both betweenness centralization and density are at a very low level. Correlation of any two topic words is more likely to be direct rather than indirect through a third one. This also reveals that the path between any two topic words is quite short, with a high probability. In addition, the overall correlation among all topic words is not high. Although topic words are highly correlated when they belong to one community or are involved in the same affair categories, correlation between communities is markedly low, indicating that UK-China relations are in a state of dynamic change, and affairs related to China are not consistent in terms of speakers' debates.

Individual network indicators for topic words equal their position in the network structure, and ability to influence and control others. As shown in Table 5, Economy, Trade, Investment, Exports, Market, Business, Human Rights, Nuclear, Finance, and Energy are listed in both degree centrality and closeness centrality. These words are most central to the structure and have the most powerful

Table 4
Whole network indicators.

Indicators	Value
Number of nodes	179
Number of lines	2862
Average degree	31.98
Network all degree centralization	0.5967
Network all closeness centralization	0.5466
Network betweenness centralization	0.0973
Network clustering coefficient	0.3649
Density	0.1796

Table 5
Top-10 keywords in terms of degree, betweenness, and closeness centrality.

Ranking	Words	Degree	Words	Closeness	Words	Betweenness
1	Economy	137	Economy	0.8128	Economy	0.1016
2	Trade	130	Trade	0.7876	Trade	0.0855
3	Investment	112	Investment	0.7295	Investment	0.0538
4	Exports	93	Exports	0.6768	Human Rights	0.0341
5	Market	81	Market	0.6473	Exports	0.0251
6	Business	79	Business	0.6426	Market	0.0241
7	Human Rights	77	Human Rights	0.6380	Nuclear	0.0201
8	Nuclear	73	Nuclear	0.6290	Security	0.0193
9	Finance	72	Finance	0.6268	Business	0.0182
10	Energy	71	Energy	0.6224	Finance	0.0174

influence on others. Specifically, other topic words are inclined to directly connect with them. All of the words also have a low betweenness centrality, which means that the correlation among words does not require a "bridge". The distance between any two topic words is short overall. It is worth noting that, in addition to the above words, "Security" in the list of betweenness centrality served as a bridge to some extent. This indicated that members of Parliament (MPs) often refer to Security, such as Energy Security and Cyber Security, when discussing affairs related to China.

(2) Topic community analysis

The co-word network of parliamentary debates is divided into five communities, representing five directions related to China, as shown in Table 6. The modularity is 0.3692, indicating good performance in community detection (Newman, 2004). In terms of scale, the five communities are quite distinct. The larger topic communities are C1-Trade and C2-Human Rights. C1-Trade mainly involves affairs, such as Economy, Exports, Investment, Market, Business, Manufacturing, Finance, Industry, and Jobs. C2-Human Rights primarily focuses on Hong Kong, Security, Democracy, South China Sea, Diplomacy, Chinese Government, Politics, and Law. The smaller topic communities are C3-Nuclear, C4-Steel, and C5-Visa. C3-Nuclear discusses Energy, Climate Change, Emissions and Renewables, as well as the impact on the international community and the UK. C4-Steel debates involve the Steel Industry, Dumping, Tariff, Market Economy, and Imports. For the C5-Visa, MPs are also concerned about Tourism, Students, Airport, Partnership, and Visitors related to China.

Topic words related to UK-China relations in British parliamentary texts are categorized into five affair directions. In addition to the fact that topic words are highly correlated within each community, correlation between communities also exists due to the interplay of international affairs. Thus, correlation structures within and between communities are shown in Figs. 4 and 5, respectively.

Fig. 4 presents the internal correlation network structure of each topic community. Each node representing a topic word is located in the community with different color and size, as well as different links of width, which indicate the word's status and function in the network. Topic words in a central position possess a potent ability to influence others, and even dominate whole affairs categories. For example, C1-Trade mainly involves affairs related to the Economy, Exports, Investment, Market, and Business. These words are the most focused topics when discussing UK-China trade. Others in this community are discussed following these central topics in

Table 6
Topic communities of debates related to China.

| Community	Words
C1	Trade; Economy; Exports; Investment; Market; Business; Manufacturing; Finance; Industry; Jobs; Tax; Trade Agreement; Technology; Education; Bank; Emerging Markets; Brexit; Food; Infrastructure; Eurozone; BRIC; Free Trade; Funding; Workforce; Competition; Deficit; Cooperation; Economic Growth; Money; Culture; Free Trade Agreement; Interests; Emerging Economies; British Economy; GDP; Commonwealth; Single Market; Trading Relationship; Global Economy; WTO; Innovation; Inward Investment; UKTI; World Trade; Growing Markets; Pork; State Visit; Employment; Unemployment; Research; Dog Meat; Budget; Global Market; Export Market; Trading Partner; Supply Chain; Productivity; Agriculture; OECD; Trade Deficit.
C2	Human Rights; Hong Kong; Security; Democracy; South China Sea; Diplomacy; Chinese Government; Politics; Law; Tibet; Nuclear Weapon; Defence; UN Security Council; War; Security Council; Government; Military; Crime; Humanitarian Aid; Olympic Games; Foreign s; Religion; Sanctions; Christians; Terrorism; NATO; Aid; Peace; Joint Declaration; Leadership; Negotiation; Language; Freedom; Refugee; Weapon; Arms; Dalai Lama; Communism; Women; Veto; Regime; Sovereignty; Referendum; Election; Poverty; Military Action; Assad; FCO; Taiwan; BBC; Intervention; Conflict; Intellectual Property; Corruption; Freedom of Speech; One Country Two Systems; Sanction; Protest; Children; Population; Missile; Medicine; Threat; Foreign Policy; Death Penalty.
C3	Nuclear; Energy; Climate Change; Emissions; Renewables; G20; Oil; Carbon Emissions; Carbon; High-speed Rail; Coal; Gas; Nuclear Power; Low-carbon; EDF; Water; Nuclear Power Station; Climate; Electricity; Pollution; Nuclear Programme; Power Station.
C4	Steel; Dumping; Steel Industry; Tariff; Market Economy; Imports; Lesser Duty Rule; Anti-dumping; Crisis; Steel Dumping; Reform; Overproduction; Price; Procurement; Protectionism; Solar Energy; Energy Costs; Trade Defence.
C5	Visa; Tourism; Students; Airport; Partnership; Visitors; Immigration; Universities; Health; Overseas Students; Flights; Aviation; British Universities; Higher Education.
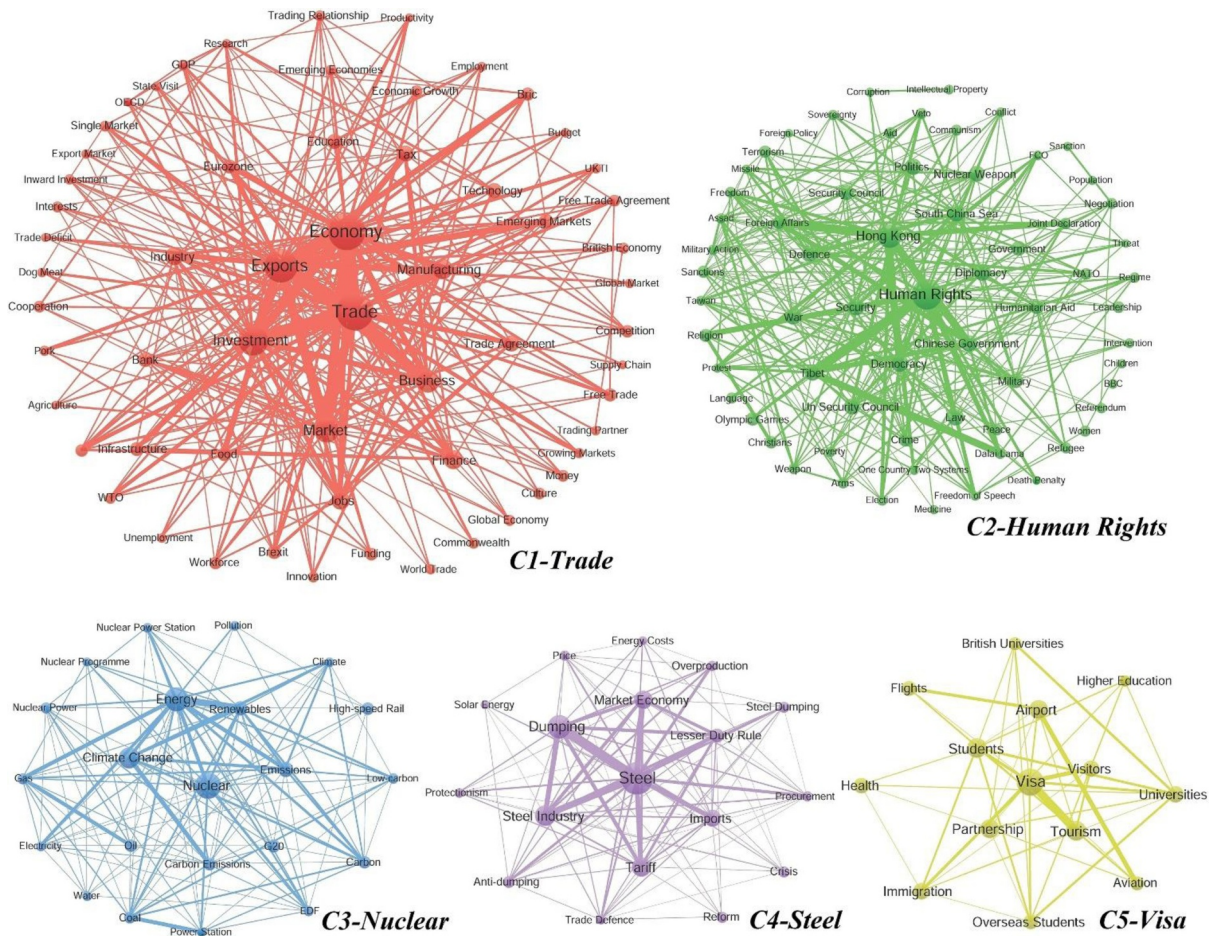
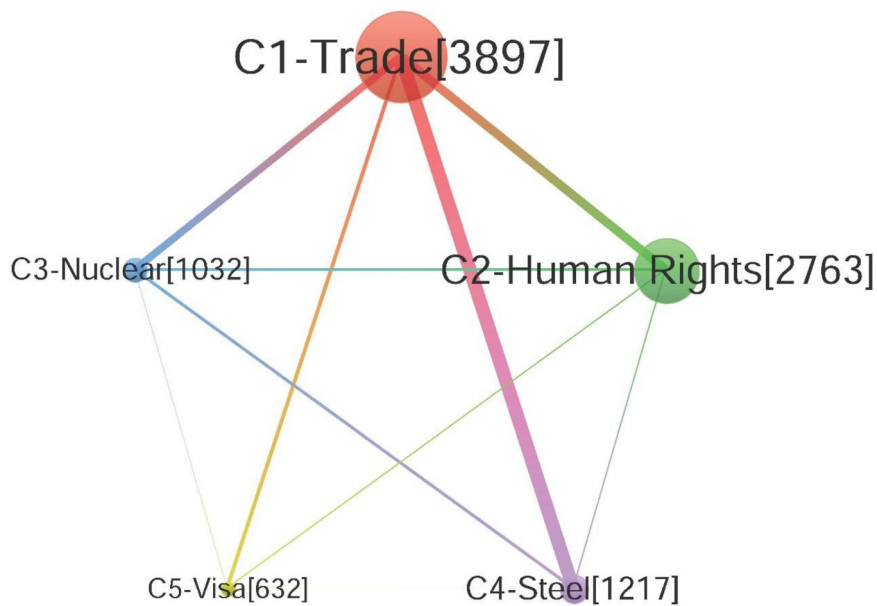**Fig. 4.** Internal correlation network structure of each debate community.

Fig. 5. Correlation network structure among debate communities.
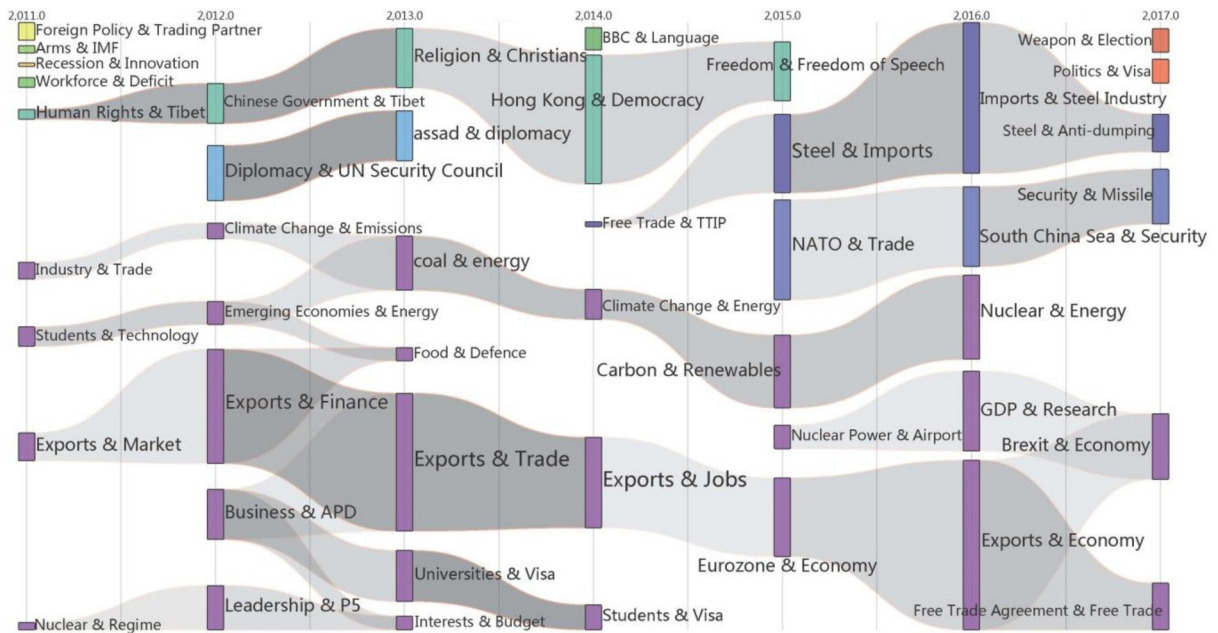
Fig. 6. Topic evolution of debates related to China (2011–2017).

most cases. They constitute one direction of international affairs in UK-China relations.

Fig. 5 shows the correlation structure of five distinct communities. It also demonstrates the interrelation among international affairs categories related to the UK and China. The width of the link indicates the strength of interplay between two affairs categories. C1-Trade highly correlates with the other four communities, indicating that Trade and its correlated topics are the most important focus in UK-China relations. It can be even asserted that all affairs in UK-China relations are influenced by trade to some extent. Most remarkably, the correlation between C1-Trade and C4-Steel is the greatest, showing that affairs related to Steel and Dumping constitute the most important debate topics in UK-China trade. Inversely, other directions are relatively isolated, with lower correlations.

4.3. Topic evolution venation and development trend

(1) Topic evolution venation

Evolution venation of topics related to UK-China relations is depicted in Fig. 6. It can be seen that the continuity of debates in British parliament is steady overall, with the exception of a small amount of change in topic words. In addition, there are relatively fewer isolated topic communities, only accounting for 15%. A majority of topics drew continuous attention in this period. Moreover, differentiation and merging appear in different evolution venation.

The distribution of evolution venation in terms of scale is markedly unbalanced. A few affairs categories in UK-China relations receive much more attention by most of the MPs. For example, the scale of the venation (purple) related to Exports and Trade is the largest. The number of topic communities involved in this venation accounts for 54%, which is a very high level. In terms of chronological series, this venation mainly concerns the Market, Business, Job, Economy, etc. Furthermore, the venation merges with other topics, such as Coal, Carbon, Energy, Climate Change, Renewables, and Nuclear. Even Brexit, in the recent period, is included in this venation. MPs often refer to China when they discuss these topics. In 2012, "Business & APD" (Air Passenger Duty) merges with the venation above. This indicates the correlation between them, as well as including University, Student, Visa, and other related topics.

In addition, there are four smaller topic evolution venation: Human Rights, Steel & Imports, Security, and Diplomacy. The venation "Human Rights" evolves for a long time period from 2011 to 2015, mainly including the Chinese Government, Tibet, Hong Kong, Democracy, Freedom, etc. MPs do not focus on these topics, especially after 2016. The venation "Steel & Imports" reflects the affairs categories, including Steel and Steel Industry, that are related to China, as well as the positive negotiation of Free Trade and Import, and the spirited debates over Dumping and Anti-Dumping.

MPs have begun to pay close attention to Security affairs related to China since 2015. This venation involves NATO, South China Sea, Missile, etc. Notably, Trade was also often discussed by MPs, indicating its effect in related affairs. Obviously, Diplomacy and related topics were less discussed by MPs, only appearing in debates in 2012 and 2013. This venation also includes the topics UN Security and Assad, indicating that MPs were concerned about these affairs if China participated in them.

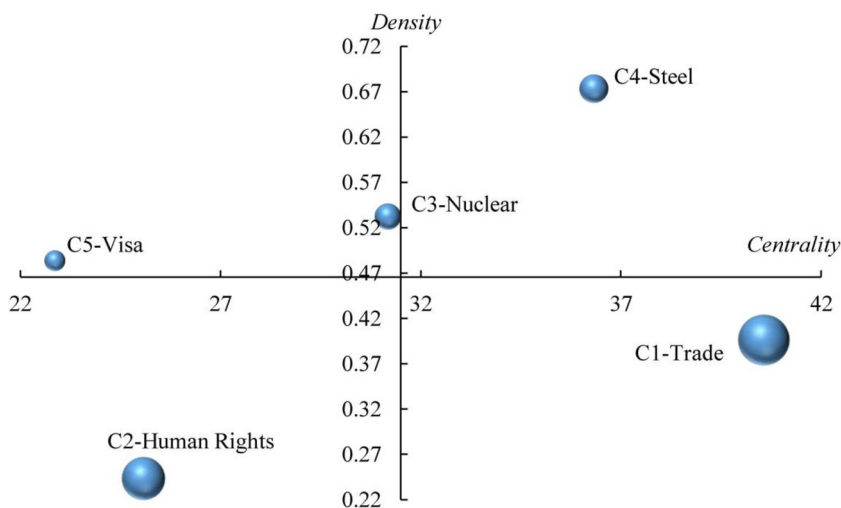#### (2) Topic development trend

Fig. 7. Strategic diagram of five topic debate communities (2011–2017).

Topic communities have different development statuses and trends due to density and centrality. As shown in Fig. 7, five communities are located in the strategic diagram. The nodes representing topic communities are scaled with the respective sum of the frequency of topic words. C4-Steel is located in Quadrant I, due to both high density and centrality. High density indicates that C4-Steel tends to be mature, with close internal correlation. Discussion on these topics is relatively consistent. High centrality indicates that C4-Steel has recently been the core of UK-China relations. C3-Nuclear and C5-Visa are located in Quadrant II, because of their high density and low centrality. These topics are not central in UK-China relations, but they have formed a considerable scale. Discussion on these topics is also relatively consistent. The topics also tend to be mature. C2-Human Rights is located in Quadrant III, because of both low density and low centrality. This direction involves relatively more topics, and its scale is larger. However, discussion on those topics is not concentrated and consistent. These topics are being marginalized in UK-China relations, and are not the foci due to changes in former views. C1-Trade, as the largest topic community, is located in Quadrant IV, with high centrality but low density. MPs are paying increasing attention to these topics which are the cores of UK-China relations. Too many topics also lead this community to be not very concentrated. Indeed, this direction is not mature in terms of development.

5. Discussion

In this paper, characteristics of UK-China relations are elucidated using topic words from British parliamentary texts, including the words' foci, correlation structure, directions of affairs, evolution venation, and development trends. These findings could assist us to understand connotations in UK-China relations in recent years.

First, the distribution of topics related to China is extremely unbalanced and highly concentrated. UK-China relations are mainly concentrated on a minority of topics, including Trade, Economy, Exports, Steel, Investment, Human Rights, Nuclear, Market, Dumping, Energy, Business, and Finance. It can be asserted that these core topics are almost always discussed if MPs refer to China in parliamentary texts. It is also indicated that China greatly influences these affairs in Britain, especially related to the Economy, Trade, Business, Finance, and Industry. Furthermore, there are five directions of UK-China relations, which are C1-Trade, C2-Human Rights, C3-Nuclear, C4-Steel, and C5-Visa, each distinguished by a different scale, density, and centrality. C1-Trade and its related affairs constitute the most important core in UK-China relations. Indeed, most MPs have debated the interplay in trade between the UK and China. Other directions are relatively isolated and greatly impacted by C1-Trade. Notably, C4-Steel and its related affairs sharply increased in recent years and were intensely debated by MPs in UK-China relations.

Second, evolution venation of main topics differs widely in terms of continuity and development trends. The continuity of topics is good on the whole, with fewer isolated topic communities. Topics related to Trade and Economy were discussed every year from 2011 to 2017, and they merged and interplayed with others frequently. These topics have been the main foci in UK-China relations in recent years. However, topics in interrupted venations and isolated communities were not the foci in UK-China relations, a trend that might be caused by changing views of China. Furthermore, C1-Trade and C4-Steel will be the core of UK-China relations in the future, as they are the main directions of UK-China relations. This also indicates the powerful influence on the UK from China. Other directions are increasingly marginal, with many debates. For example, C2-Human Rights is no longer the focus in UK-China relations, and debates about related topics are decreasing.

Besides the findings above, this study provides several implications for researchers. Firstly, the framework for foreign relations in terms of topic analysis supplements the workflow or analysis framework of science mapping in previous studies (Alcaide–Muñoz et al., 2017; Huang, Yang, & Su, 2018; Martínez et al., 2015). Compared to the extant research, our study provides a more comprehensive and systematic framework to map and visualize topic distribution and evolution. This inspires future research to duplicate this framework in other parliamentary text analysis, such as correlation network analysis of countries and political parties

(Barnett et al., 2017). Secondly, the findings from this study contribute to the understanding of the characteristics and connotations in UK-China relations, which provides a novel quantitative perspective and complements the methodology in the research of foreign relations. To the best of our knowledge, the present study is the first to utilize co-word analysis and science mapping techniques to analyze foreign relations. Third, this study discusses foreign relations in public settings, and does not focus solely on government-to-government communications. We expand the scope of the study of foreign relations to include other venues of communication, such as trade, tourism, student exchange, etc. Furthermore, the structure and correlation of these communications are clearly depicted. This may offer important implications for theoretical research on foreign relations.

In addition to theoretical implications, this study also provides a number of practical implications and guidance for governments. Firstly, governments and policy researchers can obtain objective, reproducible, and verifiable interpretations of parliamentary text, which supplants traditional manual analysis. In this study, it can be seen that Trade, Human Rights, Nuclear, Steel, and Visa are the key issues in UK-China relations during the period of 2011-2017. Secondly, the topics of foreign relations in different periods often exhibit varied points of emphasis. In other words, foreign relations change over time, and this requires both countries to continually adjust policies to adapt to each other. By analyzing the changes and evolution of topics, we can discern national priorities toward foreign relations in all periods, which may support governments to rapidly respond to pertinent issues and contribute to forming foreign policies.

6. Conclusion

The research framework based on topic words in parliamentary texts proposed in this study is different from the traditional text analysis. Specifically, our framework is more capable to accurately identify the focus and connotations in foreign relations, including topic distribution, correlation structure, evolution venation, and development trends. We also used our analysis framework on UK-China relations during the period of 2011–2017, which has important practical significance for understanding foreign policies, especially since it is a core part of the country's diplomacy and development strategies.

However, there are several limitations in this research. First, it took much time and effort to identify the topic words in parliamentary debates due to the manual annotation. The quality of sample processing is determined by specialty knowledge and skill, as well as training and learning ability. Second, a deeper understanding and interpretation of UK-China relations is requisite. Results in this paper are insufficient to understand the status and changing of UK-China relations without support from experts in international relations.

Future studies will achieve multidimensional analysis of parliamentary texts in terms of politicians, countries, etc., potentially elucidating the deeper characteristics of foreign relations. In the meantime, interdisciplinary experts' interpretations would also augment the value of the findings. Above all, the research framework will continue to be applied in other foreign relations contexts that could indicate its effectiveness.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.ipm.2019.102191.

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