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The structure and evolution of trade relations between countries along the Belt and Road

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Abstract: Trade facilitation is one of the five main agendas of the Belt and Road Initiative (BRI). Social network analysis has helped understand the complexity of trade networks, but existing studies tend to overlook the fact that not all bilateral trade relations are equally important to a country. To fill this gap in the literature, this paper focuses on the top 2 trade relations networks to illuminate the structure and evolution of B&R trade relations, the relative positions of different countries, and changes in the composition of trade communities (e.g., the community leaders) and the changing patterns of trade between them. We find rich dynamics over time both inter- and intra-communities. The overall international trade networks of B&R countries experienced a leadership change from Russia to China on one hand, some temporary communities experienced emergence, disappearance (e.g. the Kuwait- and Thailand-led communities) or reemergence (e.g. Poland-led community), and a community membership was generally consistent on the other hand. Since the future impacts of China's BRI will depend on the degree of integration of the connected regions, some countries with stable and high centrality indices (e.g. Russia, Singapore, Serbia, Greece, Turkey, Iran, Poland, Hungary and Romania) could be selected by China as strategic regional partners, and countries with a strategically important geographical position but weak trade links (e.g. Myanmar, Pakistan, and Belarus) should be prioritized.

Keywords: The Belt and Road Initiative; international trade; community core detection; top trade partner

1 Introduction

The Belt and Road Initiative ('BRI', hereafter) proposed by Chinese President Xi Jinping in 2013 found its way into the new revised Charter of the Chinese Communist Party in October 2017, giving the BRI a firm constitutional status as part of China's new thinking about open

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development. The BRI refers to the overland Silk Road Economic Belt (the Belt) and the 21st-Century Maritime Silk Road (the Road) that were announced in September and October 2013 respectively. Since then, particularly after March 2015 when the "Vision and Actions on Jointly Building the Silk Road Economic Belt and the 21st Century Maritime Silk Road" (NDRC, MFA and MC, 2015, "Vision and Actions" hereafter) were announced, the BRI has received widespread international attention (Toops, 2016; Bennett, 2016; Vinokurov and Tsukarev, 2017). Not only journalists but also academics were quick to take part in the debate. Academic journals published special issues (e.g., East Asia, 2015; China & World Economy, 2017; Geopolitics, 2017), as well as individual papers on the BRI from various perspectives (e.g., Cinar *et al*., 2016; Huang 2016; Liu and Dunford, 2016; Summers, 2016; Ravi, 2016; James and Chih, 2017).

Considering the increasing influence of China as a global power in a turbulent world and the positive and widespread worldwide responses to China's BRI, the initiative is considered to be a platform for an increasing number of countries to explore new international economic governance mechanisms (Liu et al., 2018). According to the Vision and Actions and President Xi's speeches at the Belt and Road Forum for International Cooperation, the intention of this initiative was not to re-establish the ancient networks of silk trade routes between Asia and Europe, but to use the metaphor of the ancient Silk Roads as a soft basis to create a promising platform for international cooperation (Liu, 2015; 2017a; 2017b). The ancient Silk Road is a transcontinental network of routes, connecting China to other parts of the Eurasian continent and facilitating economic, scientific, technological, religious, and cultural exchanges (Liu, 2010). Consequently, the Silk Road is an important, if not the only, symbol of a common historical and cultural heritage of most countries in Asia, Europe, and northern and eastern Africa. China's BRI uses this historical metaphor to denote "peace and cooperation, openness and inclusiveness, mutual learning and mutual benefit," which are referred to as the "Silk Road Spirit" in the Vision and Actions, and as a way to promote inclusive globalization (Liu and Dunford, 2016).

According to the Vision and Actions, the new initiative focuses not only on physical and economic but also on spiritual and cultural connectivity between countries along the ancient Silk Roads and beyond. Among these types of connectivity, trade facilitation and development is a priority area. President Xi's speech at the opening of the Belt and Road Forum suggests that the BRI is committed to promoting a "system of fair, equitable and transparent rules for international trade and investment" (Xinhua, 2017). Against this background, an increasing number of publications have contributed to our understanding of China's trade with countries along the Belt and Road. Some studies analyzed geographical patterns of trade between China and Belt and Road countries, either examining trade as a whole (Zou *et al*., 2015; Gong *et al*., 2015; Song *et al*., 2017b), or focusing on particular sectors such as agricultural products (He *et al*., 2016), energy (Liu and Liang, 2015), and natural gas (Ma and Xu, 2017). Other studies have discussed the current situation, commodity structure and prospects of trade between China and particular Belt and Road areas: examples are West Asia (Han and Zou, 2014), Central Asia (Yang *et al*., 2015a) and Indo-China Peninsula countries (Yang *et al*., 2015b). Moreover, some studies used spatial econometric methods to estimate the economic effects of China's trade with BRI countries on China's provinces (Zou *et al*., 2015) or the Chinese economy as a whole (Wang and Xu, 2016; Cinar *et al*., 2016).

These studies have proved fruitful and shed new light on China's trade with countries along the Belt and Road. However, they ignored explicitly or implicitly the fact that trade relationships are trilateral as well as bilateral. To better understand China's trade with countries along the Belt and Road, a social network approach is therefore needed. From a social network analysis point of view, the trade relations between countries along the Belt and Road constitute a complex and interdependent network. International trade networks have been studied through the lens of network analysis for a long time by sociologists, economists, mathematicians, and even physicists (Breiger, 1981; Kim and Shin, 2002; Fagiolo *et al*., 2008; Beckfield, 2009; Kali and Reyes, 2010), and have also been used to investigate the trade relations of the BRI countries (Zou and Liu, 2016; Song *et al*., 2017a). These studies revealed that the BRI area trade relations possesses typical properties of complex networks, including a three-tiered structure (core, semi-periphery, and periphery), and a high clustering coefficient. However, these studies have paid insufficient attention to the varying importance of a country's trade relations. Not all bilateral trade relations are of equal importance to a country because, in a country's trade value, a few top partners account for a dominant share.

To fill this gap and understand the structure and evolution of the B&R trade, this research identifies the relational international trade network of the Belt and Road countries. Instead of the top 1 trade network, the top 2 trade network was used, capturing important trade relations without a great increase in complexity. The top 2 trade network refers to the network of relations for all countries' top 2 trade partners: country i is linked to country j if j is one of the i's top 2 trade partners. The top 2 network should capture most important international trade relations.

Using the top 2 network, the structure and evolution of the B&R trade network is examined, and the relative positions of different countries in different periods is quantified, enabling the identification of temporal changes in the composition of trade communities (e.g., the community leaders), and in the patterns of trade between different communities. This analysis of the structure and evolution of the B&R top 2 trade relations network in turn has implications for the formulation of the BRI trade facilitation and development policy.

Although the Chinese government announced that the initiative is open to all countries, 65 BRI countries including China have been identified (hereafter, the B&R countries). These nations account for more than 60% of the world's population and about one-third of the world's GDP. To examine the structure and evolution of the B&R trade network (Zou and Liu, 2016; Song *et al*., 2017a) trade data for the period from 2000 to 2016 was used. To examine the influences of the global financial crisis and the BRI on trade networks, changes in the B&R trade networks in 2000, 2004, 2008, 2013 and 2016 were identified.

2 Methodology

2.1 Data and complete international trade network of the Belt and Road countries

From a social network analysis point of view, international trade comprises a network in which the nodes are countries and connections between nodes or edges are the trade relations between those countries. Data from 2000 to 2016 from the IMF Direction of Trade Statistics (DOTS) was used. As one of the most frequently used trade databases, it provides data on the international distribution of each country's exports and imports. Because most states

report imports in CIF values (i.e. including cost, insurance and freight) and exports in FOB values (i.e. free on board), the recorded total global imports exceeds that of exports. In this study, import data was used, as states tend to monitor imports more closely than exports (Barbieri *et al*., 2009) so that import data is considered to be more accurate than export data (Smith and White, 1992; Kim and Shin, 2002). Matlab was used to create an undirected weighted matrix A^t based on bilateral import trade among the Belt and Road countries. In the matrix, node i stands for country i and A_{ij}^t stands for the total trade values between country i and country j at year t.

Ucinet 6 software was used to describe some basic characteristics and the evolution of the B&R trade network from 2000 to 2010. Table 1 shows the results. First, the B&R trade network grew rapidly from 2000 to 2008, as the number of ties between countries increased from 1782 to 2168, indicating that on average the B&R countries together developed 43 new trade partners each year. The growth of trade ties resulted not only in a constant increase in network density from 0.428 to 0.521, but also in an increase in degree of centralization from 0.032 to 0.117 during the same period, suggesting that despite the increase in number of ties, international trade amongst the B&R countries tended to be increasingly concentrated between a few dominant countries.

Despite being affected by the 2008 global economic crisis, the complete trade network of the B&R countries from 2009 to 2016 developed very slowly, even becoming unstable. Fifty-eight new trade ties emerged in this seven-year period, but there was also a noticeable fluctuation in the number of ties and the density and degree of centralization during the crisis and post-crisis periods. The number of trade ties stayed relatively steady between 2164 and 2188 in the period from 2009 to 2012, suddenly increasing to 2216 in 2014, decreasing to 2192 one year later, and then increasing to 2222 in 2016, with an overall increase of 58 new trade relations. This may indicate that the B&R countries were still able to find new trade partners, despite the short period of stagnation immediately after the 2008 economic crisis. On the whole, the small increase in both the density and the degree centralization of the B&R trade network during this turbulent period implies that B&R countries might have started to recover from the economic slowdown and that some countries continued to strengthen their ties with key trade partners while shedding nonessential ties. Therefore, further focus on a country's top trade partners might be more useful in understanding the real picture of the international trade network of the B&R countries (Zhou *et al*., 2016).

Table 1 Descriptive statistics of the complete B&R trade network

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008
Number of countries	64	64	64	64	64	64	65	65	65
Number of ties	1782	1802	1840	1840	1886	1884	2102	2130	2168
Density	0.428	0.433	0.442	0.442	0.453	0.453	0.505	0.512	0.521
Degree of centralization	0.032	0.036	0.045	0.061	0.072	0.082	0.091	0.107	0.117
Year	2009	2010	2011	2012	2013	2014	2015	2016	
Number of countries	65	65	65	65	65	65	65	65	
Number of ties	2164	2168	2188	2184	2216	2192	2216	2222	
Density	0.520	0.521	0.526	0.525	0.533	0.527	0.533	0.534	
Degree of centralization	0.116	0.112	0.117	0.112	0.120	0.125	0.122	0.126	

2.2 The top networks of the complete B&R trade network

The B&R trade network in 2016 can be used to illustrate the construction of the top networks. First, the complete B&R trade network was identified using the data from matrix A^t. Then the top networks were identified by keeping each country's top trade relations. The top 1 network consists of each country's topmost trade relationships with each other, while the top 2 network comprises each country's top 2 trade relationships with all other countries and so on. Figure 1 visualizes the overall and top B&R trade networks. Evidently, the top 1 network contains fewer ties than the top 2 network. In other words, the top trade network includes the major trade ties from the complete network but does not include some other relations, which nonetheless provide some information about the trade relation structure. Hence, the higher the standard used, the greater the level of importance of the resultant trade network.

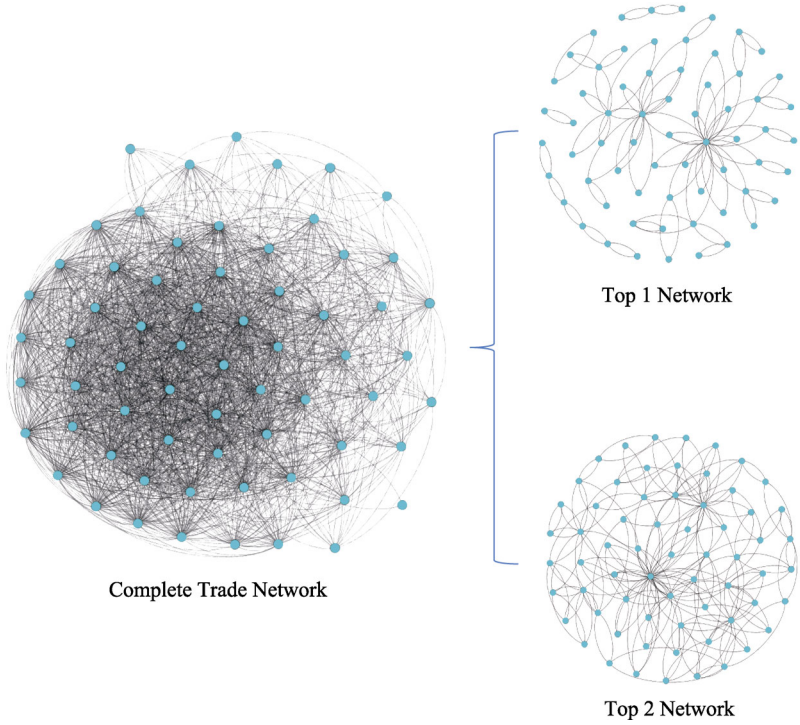

Figure 1 Complete and top B&R trade networks in 2016

Table 2 Top networks as a share of the complete B&R trade network in 2016

Networks	Top 1	Top 2	Top 3	Top 4	Top 5	Top 10	Top 20	All
Percentages of edges (%)	5.40	10.53	15.48	19.98	24.48	45.09	74.08	100.00
Percentages of trade values (%)	56.61	74.03	82.20	88.01	90.84	97.64	99.73	100.00

Table 2 shows the trade ties and trade values of the top networks as shares of the overall B&R trade network in 2016. As Table 2 shows, the ties in the top 1 and top 2 networks accounted for only 5.4% and 10.53% of the total trade ties, respectively, but the trade values made up 56.61% and 74.03% of the total trade values, respectively. As the threshold is low-

ered, more trade ties and trade values are included in the corresponding networks. The shares of the top 3, top 4, and top 5 networks were approximately 15%, 20% and 25% of the total trade ties, and were about 82%, 88% and 90% of the total trade values.

Figure 2 further visualizes the relationship between top trade networks and their shares of total B&R trade for every two years from 2000 to 2016. On the whole, the top 1 network alone was less than 6% of the total ties but above 50% of the trade values, except in 2008 when trade was hit due to the global economic crisis. The top 2 network alone was approximately 10% of the trade ties but above 70% of the trade values, indicating the top networks indeed constituted the backbone of the B&R trade network.

Although the top 1 network is the foundation of all types of top networks, it does not contain much information about the trade structure. In Figure 1, the top 1 network can mislead one to believe that there are some communities of countries that actively trade with each other but are relatively disconnected from the remaining countries. Conversely, the top 2 network shows a similar structure to that of the whole network. Consequently, in the remainder of this paper, the top 2 trade network is used to investigate the network structure in 2000, 2004, 2008, 2013 and 2016.

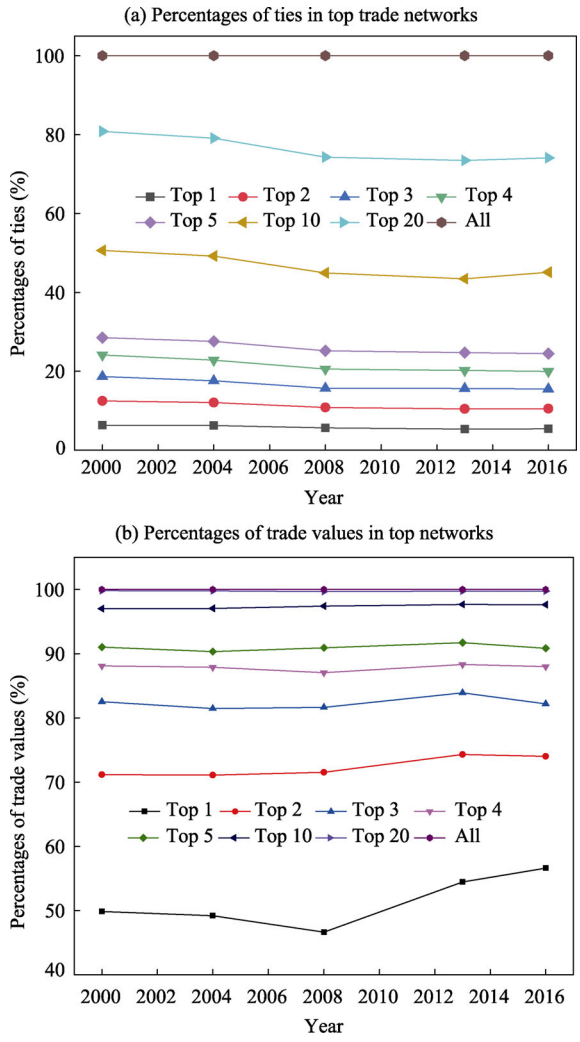

Figure 2 Visualization of the shares of the top networks in the B&R trade network in 2000, 2004, 2008, 2013 and 2016

Although the top networks were identified, some problems remain. First, it is not the exact values of the top trade relations but the top trade relations themselves that are important for each country. Another problem is that the top networks do not indicate the volume of trade which is small for small countries. However, for those small countries, the top networks still represent the most important trade links, which make those networks worth studying. Second, it is very difficult to visualize the original top networks, partly because there are tremendous differences in trade values, and partly because these trade values cannot represent the real structure. Moreover, since many trade relations are removed, comparing the values of the top relations does provide and accurate visualization of the real trade network. For this reason, binary codes were used for the top networks, i.e., 1 for all top networks and 0 for the rest. In the remainder of this paper, the Community Detection ap-

proach was used to investigate the structure and dynamics of the top trade networks, rather than the trade values of the B&R countries.

2.3 Community detection approach

Along with descriptive statistics, community detection illuminates the features of the top networks, especially their structural characteristics. There are a number of publicly available tools for exploring complex networks. Gephi, for example, is an open source platform with analytical and data visualization functions. The software runs on Windows. Gephi provides many common metrics for social network analysis (SNA) and scale-free networks, measuring the centrality, density, clustering coefficients, path lengths, community detection, etc. of graphs. Many social network analysts choose Gephi because it is extremely powerful in visualization and community detection. It allows users to interact with the representation and to manipulate the structures, shapes, and colours to reveal hidden patterns. And users can customize the colour, size and labels for readability and overall aesthetics. Moreover, Gephi uses a modularity optimization method—the fast unfolding algorithm for community detection—to decompose a gigantic network into several relatively independent modules (also called groups, clusters, or communities), which are sets of highly connected nodes (Blondel *et al*., 2008). For these reasons, Gephi was used to detect and visualize the community structure in the top trade networks of the B&R countries from 2000 and 2016. This study split the overall top 2 trade network into several relatively independent trade communities. Each country is densely connected internally within the communities, but there are sparser connections between communities.

There are many different methods for community identification. A widely used measure for the evaluation of community decomposition is modularity. Modularity is designed to measure the density of links inside communities as compared to the links between communities. The value of the modularity coefficient lies in the range [−1, 1]. The closer the value of the modularity coefficient is to 1, the better is the quality of the partitions. The modularity coefficient is defined as

$$Q = \frac{1}{2m}\sum_{ij}\left[A_{ij} - \frac{k_i k_j}{2m}\right]\delta(c_i, c_j), \tag{1}$$

where c_i presents the community to which node i belongs. The δ function equals 1 if $c_i = c_j$ and 0 otherwise. A_{ij} is the edge weight between i and j. $k_i = \sum_j A_{ij}$ are the sums of the weights of the edges of node i and $m = \frac{1}{2}\sum_{ij} A_{ij}$ is the total edge weight of the network.

In order to maximize the modularity value efficiently, a fast unfolding algorithm is used. This algorithm, also known as Louvain Method for community detection, is a method used to extract communities from large networks and was developed by Vincent Blondel and his colleagues from the University of Louvain. It is a simple, efficient, and easy to implement method for identifying communities in large networks and outperforms many similar greedy modularity optimization methods in both the modularity and the time categories. It is today widely used for detecting communities in large networks (Blondel *et al*., 2008).

This algorithm is performed in two phases, each of which is iterated. First, each node in

the network is assigned to a community. So, there is only one node in each community. In this study node i was put into its neighboring community designated by node j is giving rise to a variation in modularity, ΔQ. For each node i and the neighboring community C, the variation in modularity is defined as:

$$\Delta Q = \left[\frac{\sum_{in} + 2k_{i,in}}{2m} - \left(\frac{\sum_{tot} + k_i}{2m} \right)^2 \right] - \left[\frac{\sum_{in}}{2m} - \left(\frac{\sum_{tot}}{2m} \right)^2 - \left(\frac{k_i}{2m} \right)^2 \right], \quad (2)$$

where $\sum_{in}$ is the sum of the weights of the edges inside the neighbouring community C. $\sum_{tot}$ is the sum of the weights of the edges incident to all nodes in C, k_i represents the sums of the weights of the edges of node i, $k_{i,in}$ is the sum of the weights of edges from node i to nodes in community C and m is the total edge weight of the network. If the variation is positive, i joins the neighboring community with maximum ΔQ. Otherwise i stays in its original community. This process is applied repeatedly and sequentially for every node until no further improvement can be achieved.

In the second phase of the algorithm, a new network was identified based on the communities (i.e. nodes) during the phase. The weights of the edges between the new nodes are given by the sum of the edges between nodes in the corresponding two communities. Edges between nodes of the same community lead to self-loops in the new network. Then the first phase of the algorithm was re-applied and iterated. When the number of the communities stopped changing, the maximum modularity of the community partition was attained.

3 Results and analysis

3.1 Countries' positions in the top 2 network

Identifying influential nodes in dynamic processes is crucial to understanding network structure and evolution. Centrality concepts were developed in social network analysis to quantify the importance of nodes in a network. Various centrality measures have been proposed to identify the hierarchical structures of a network. In order to identify countries' positions in the top 2 trade network of the B&R region, three classic quantitative indicators of centrality were used: degree centrality (DC), closeness centrality (CC), and betweenness centrality (BC). Each centrality measure has particular structural properties (De Benedictis, 2014).

Degree centrality records the number of connections of a node. In international trade, because degree centrality is the number of countries a particular country exports to or imports from, it can be used as the measure of a country's influence on the entire international trade network. Closeness centrality is a measure of the geodesic distance from a node to other nodes (i.e. a measure of how topologically close a node is with respect to others) and is related to the ability to reach other nodes. In trade network, degree centrality captures how much a country is influenced by and how much it influences other countries. Betweenness centrality is a measure of the share of all of the shortest paths between each pair of nodes going through a particular node and quantifies the ability of a node to act as a bridge among other nodes (Benedictis and Tajoli, 2011). Betweenness centrality measures how much a

country acts as an intermediary or gatekeeper in the trade network. Both degree centrality and closeness centrality are based on the idea that the centrality of a node in a network is related to its distance to the other nodes, while betweenness centrality is based on the idea that central nodes stand between others. Ucinet 6 software was used again to measure these centralities.

Table 3 lists the top 10 countries in terms of centralities in 2000, 2004, 2008, 2013 and 2016. According to the connectivity analysis, the following conclusions can be drawn. First, China and Russia were consistently the top 2 countries in terms of all centralities, suggesting that these two large countries are not only the biggest trading countries but also absolutely dominated the trade network of the B&R region. China grew fast and became the center of the B&R trade network in 2016, overtaking Russia. Second, Serbia and Hungary are the two key countries in the B&R trade network. Their centrality indices are high and stable, particularly after 2004. Greece also played an important role in the years 2004, 2008 and 2013, although it experienced a decline after 2013. Third, there are three pivotal countries in the Middle East: Turkey, Iran, and Saudi Arabia. Turkey has been ranked high on all centrality indices in all years. Iran, following Turkey, is the second most important country in the Middle East. The degree centrality of Saudi Arabia was also high but the country's low closeness centrality is indicative of a weak influence on the overall trade network. Last but not least, in Southeast Asia, Singapore occupied a similar position to Saudi Arabia: high in degree centrality but low in closeness centrality and betweenness centrality.

As Table 3 shows, there are some changes in the positions of some countries in the top 2 trade network over time. The European countries became more important after 2004. Besides Hungary and Serbia, countries as Romania, Greece, and Poland played increasingly important roles, which is connected with the shift of industry in Europe and the improvements in strategic infrastructures in these countries (such as Piraeus). The Middle Eastern countries always have a strong influence in the B&R trade. Besides Turkey, Iran, and Saudi Arabia, some countries with rich oil and natural gas resources like Qatar and Oman, also rank high in some years. While European countries are gaining importance, Central Asian and Southeast Asian countries might be losing importance. In 2000, some countries in Central Asia and Southeast Asia had high centralities, but their centralities index declined in 2004 and 2016, implying that their positions in the B&R trade remained unstable.

3.2 Structural evolution of the top 2 network

Gephi and the ForceAtlas2 algorithm was used to detect communities and visualize the structures and communities of the B&R trade network (Jacomy *et al*., 2014). In the visualization, the nodes indicate countries, the links represent trade relationships between two countries, countries with the same colour belong to the same community, and the size of a node is proportional to the number of trade relations of the country.

Table 4 shows the size of identified communities in the top 2 trade network of the B&R countries. While the number of communities remained stable at six or seven, the patterns and commodity composition of trade across different communities did not. First, the overall international trade networks of the B&R countries experienced a leadership change from Russia to China, owing to the economic rise of the latter. Second, some communities experienced substantial membership reorganization, especially in the cases of the Russia- and

Table 3 Top 10 countries by centrality indicators in 2000, 2004, 2008, 2013 and 2016

2000						2004						2008					
Country	DC	Country	CC	Country	BC	Country	DC	Country	CC	Country	BC	Country	DC	Country	CC	Country	BC
Russia	0.35	Russia	0.50	Russia	0.47	Russia	0.35	Russia	0.52	Russia	0.45	Russia	0.38	Russia	0.57	Russia	BC
China	0.29	China	0.47	China	0.31	China	0.32	China	0.52	China	0.38	China	0.33	China	0.55	China	0.50
Singapore	0.19	Singapore	0.41	Singapore	0.12	Serbia	0.14	Turkey	0.45	Turkey	0.09	Serbia	0.16	Turkey	0.47	Serbia	0.40
Turkey	0.11	Turkey	0.41	Mongolia	0.08	Singapore	0.13	Greece	0.42	Iran	0.09	Singapore	0.14	Hungary	0.44	Iran	0.13
Iran	0.10	Mongolia	0.40	Thailand	0.07	Turkey	0.11	Hungary	0.41	Ukraine	0.07	Turkey	0.13	Greece	0.44	Turkey	0.10
Saudi Arabia	0.10	Kyrgyzstan	0.39	Croatia	0.07	Iran	0.08	Singapore	0.40	Serbia & Montenegro	0.07	Iran	0.09	Syria	0.42	Hungary	0.08
Thail&	0.10	Vietnam	0.39	Turkey	0.06	Hungary	0.08	Saudi Arabia	0.39	Hungary	0.07	Hungary	0.09	Serbia	0.41	Greece	0.07
Pol&	0.08	Iran	0.37	Hungary	0.06	Saudi Arabia	0.08	Kyrgyzstan	0.39	Greece	0.07	Saudi Arabia	0.08	Kyrgyzstan	0.41	Tajikistan	0.06
Hungary	0.08	Thailand	0.37	Belarus	0.05	Greece	0.08	Iran	0.39	Saudi Arabia	0.07	Greece	0.08	Vietnam	0.41	Singapore	0.05
Croatia	0.08	Croatia	0.37	Iran	0.05	Oman	0.08	Romania	0.39	Qatar	0.06	Oman	0.06	Tajikistan	0.41	Kuwait	0.05

2013						2016					
Country	DC	Country	CC	Country	BC	Country	DC	Country	CC	Country	BC
Russia	0.34	Russia	0.55	Russia	0.49	China	0.41	China	0.59	China	0.60
China	0.33	China	0.52	China	0.40	Russia	0.25	Russia	0.50	Russia	0.24
Serbia	0.19	Turkey	0.46	Serbia	0.22	Serbia	0.16	Serbia	0.46	Serbia	0.16
Turkey	0.13	Serbia	0.44	Turkey	0.10	Singapore	0.14	Turkey	0.44	Hungary	0.13
Singapore	0.13	Hungary	0.43	Iran	0.08	Turkey	0.13	Singapore	0.42	Poland	0.11
Hungary	0.11	Kyrgyzstan	0.42	Hungary	0.08	Hungary	0.11	Hungary	0.42	Turkey	0.08
Saudi Arabia	0.09	Vietnam	0.41	Romania	0.06	Qatar	0.09	Qatar	0.41	Qatar	0.07
Romania	0.09	Belarus	0.41	Greece	0.05	Poland	0.09	Greece	0.41	Iran	0.07
Iran	0.08	Greece	0.40	Bhutan	0.04	Iran	0.08	Poland	0.41	Singapore	0.06
Greece	0.08	Kazakhstan	0.39	Syria	0.03	Saudi Arabia	0.08	Iran	0.41	United Arab Emirates	0.04

Table 4 The evolution of the size of communities in the top 2 trade network

Community No.	Community leader	2000	2004	2008	2013	2016
	Russia	18	14	13	10	11
	China	16	13	13	17	17
	Serbia	0	0	8	10	13
	Hungary	8	5	10	14	6
	Kuwait	8	0	0	0	0
	Poland	7	0	0	0	9
	Thailand	7	0	0	0	0
	Serbia and Montenegro	0	11	0	0	0
	Iran	0	8	11	9	0
	Turkey	0	7	0	0	0
	Israel	0	6	0	0	0
	Greece	0	0	6	0	0
	Kazakhstan	0	0	4	0	0
	Czech	0	0	0	5	0
	Myanmar	0	0	0	0	9
No. of communities		6	7	7	6	6

Iran-led communities. Third, temporary communities emerged and disappeared quickly. For instance, two communities, each led by Kuwait and Thailand appeared in 2000, but did not last long. A Poland-led community disappeared in 2004 but reappeared in 2016. It is worth nothing here that a community may comprise smaller sub-communities of counties. Finally, the number of trade communities declined from seven in 2000 to five in 2016, which means that the level of concentration has increased over time.

As Figure 3 shows, seven trade communities were identified in 2000, centred on Russia, China, Kuwait, Hungary, Poland, and Thailand. The Russia-led community was the largest with 18 member countries, most of which were former Soviet Union countries (Azerbaijan, Latvia, Tajikistan, Kyrgyzstan, Georgia, Armenia, Moldova, and Estonia) and the Balkan states (Greece, Romania, Macedonia, and Albania). The second largest community was the one around China and included 16 countries, most of which were South and Southeast Asian countries (Singapore, Sri Lanka, Malaysia, Indonesia, Pakistan, Bangladesh, Brunei, and the Philippines), and the Middle East (Turkey, Saudi Arabia, Qatar, Israel, Syria, Jordan, and Egypt). In this community, Singapore was the second largest after China. The Hungary and Kuwait communities both covered eight countries, while the other two communities were oriented towards Poland and Thailand, and were smaller in terms of the number of countries as both consisted of only six countries each. The Kuwait, Poland and Thailand-led communities were geographically decentered and disappeared in 2004, 2008, and 2013.

In 2004, although the two largest communities were still Russia and China, the numbers of member countries had both declined. The Russia-led community was very unstable with new countries from Central Europe (Poland, Czech Republic, Slovakia), Eastern Europe (Belarus, Estonia, Latvia), Central Asia (Kazakhstan, Kyrgyzstan), and other regions (Mongolia, Lebanon, India, Bhutan) joining, while some old members disappeared, including

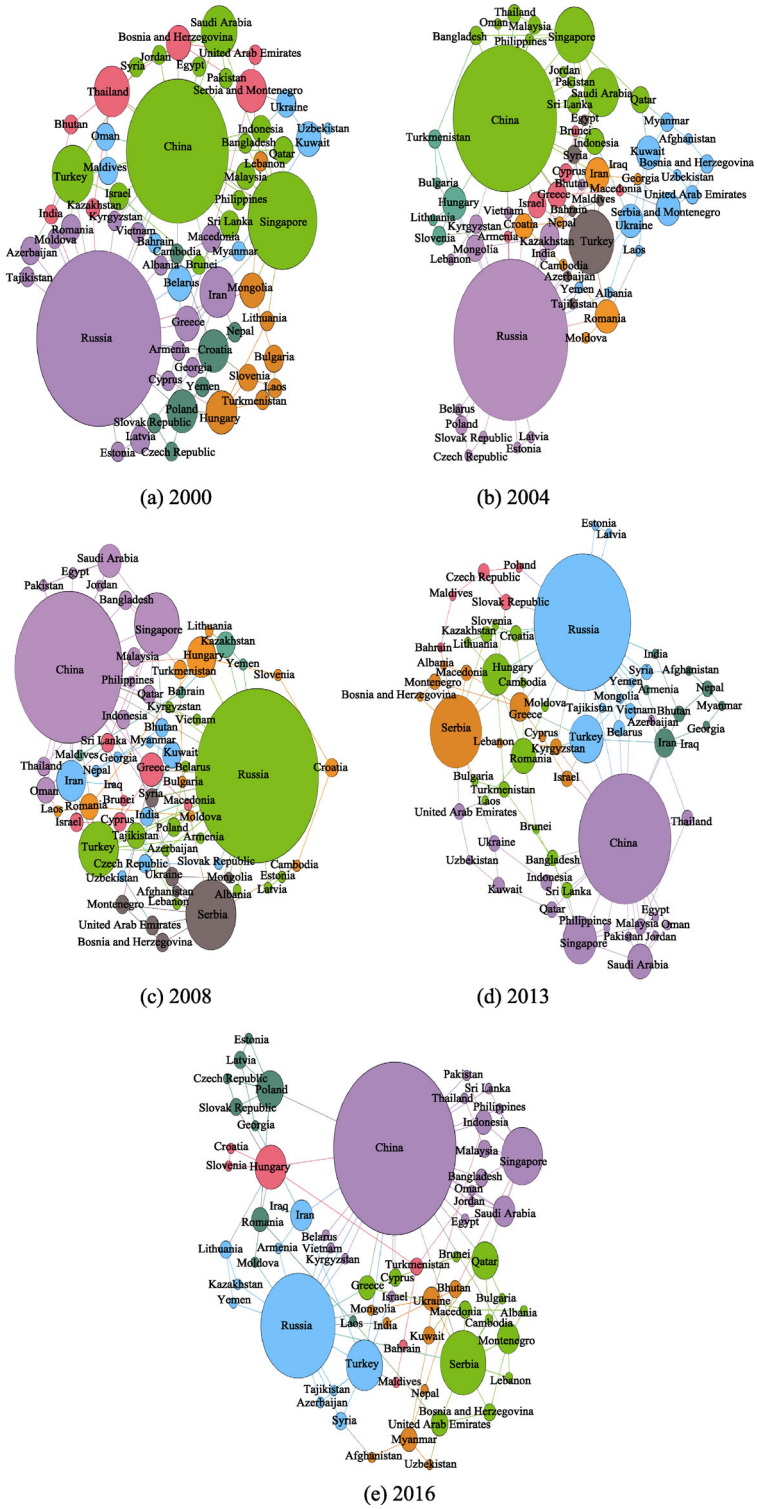

Figure 3 The visualization of the structure of the B&R trade network using Gephi in 2000, 2004, 2008, 2013 and 2016.

countries from the South Caucasus (Armenia, Azerbaijan, Georgia) and the Balkan Peninsula (Greece, Romania, Macedonia, and Albania). Compared to the Russia-led community, the China-led community remained relatively stable with only five old member countries (Turkey, Israel, Egypt, Pakistan, and Brunei) exiting and two members (Thailand and Oman) clustering. Four new community leaders (Serbia and Montenegro, Iran, Turkey, and Israel) emerged temporarily in 2004, but they did not appear in the subsequent visualizations, as shown in Table 4.

In 2008, the two largest communities were Russia- and China-led. Each had 11 member countries. Turkey, an independent community leader in 2004, joined the Russia-led community. Poland moved away from the Russia-led community and joined the China-centered community. The third and fourth largest communities were led by Iran and Hungary respectively, and their members increased to 11 and 10, respectively. Note that Serbia replaced Serbia and Montenegro as the community leader after Serbia and Montenegro was broken into two separate countries in 2006. Given that Serbia accounted for around 90% of the population and GDP of Serbia and Montenegro, this change in leadership was not surprising (United States Statistics Division, 2017). Some old member counties including Ukraine, United Arab Emirates, Bosnia and Herzegovina and Afghanistan still were in this community, while Kuwait, Uzbekistan, Laos and Albania left. Two temporary communities that were led by Greece and Kazakhstan emerged in 2008 but did not last until 2013.

In 2013, the China-led community became the largest one, and its membership increased to 17. Most of the old members remained (with an exception of Bangladesh and Uzbekistan), and five new members (United Arab Emirates, Ukraine, Jordan, the Philippines, Azerbaijan) joined. In contrast, the size of the Russia-led community declined in 2013 to 10, because six members in 2008 (Poland, Lebanon, Kyrgyzstan, Azerbaijan, Armenia, and Albania) left, while only three new counties (Syria, Mongolia and Yemen) joined. The Hungarian community grew to become the third largest with 14 countries. It had seven new member countries, namely, two from Eastern Europe (Romania, Moldova) and five from Asia (Bangladesh, Sri Lanka, Kazakhstan, Turkmenistan, and Brunei). Although the fourth largest community was still led by Serbia and its membership increased to 10, its members changed a lot. Compared to the year 2008, just two old members, Bosnia and Herzegovina and Montenegro, which was by now a separate country, remained. Meanwhile, seven new courtiers (Greece, Israel, Kyrgyzstan, Macedonia, Lebanon, Cyprus, and Albania) joined. The number of countries in the Iran-led community was nine which was not too different from previous years. However, due to the high turnaround of membership, only five of 2008 members (India, Bhutan, Iraq, Myanmar and Georgia) remained. A small community with five members was formed around the Czech Republic but did not make it to 2016.

The most noticeable change in 2016 was the emergence of the two new communities, led by Myanmar and Poland, each with nine members. The Myanmar-led community was geographically diffused, with all of its members other than Ukraine in Asia (Kuwait, Bhutan, Mongolia, India, Afghanistan, Nepal, and Uzbekistan). However, the Poland-led community was more geographically concentrated with five out of seven members (Czech Republic, Slovak Republic, Romania, Latvia, Estonia and Moldova) within 700 kilometers in terms of border to border distance. Laos and Georgia were the two outliers in this community. The Hungary-led community shrank from 14 members in 2013 to six in 2016. Only three original

members (Turkmenistan, Slovenia, and Croatia) remained. The Serbia-led community became more visible with an increasing number of members. Only four old members (Greece, Montenegro, Cyprus, Bosnia and Herzegovina, and Albania) withdrew, while eight (Serbia, Qatar, United Arab Emirates, Macedonia, Lebanon, Cambodia, Brunei and Bulgaria) joined. The China-led and Russia-led communities continued to dominate the overall 2016 network.

4 Conclusions and policy implications

The facilitation of international trade is one of the key aims of the Belt and Road Initiative. Since the Belt and Road Initiative was proposed in 2013, an increasing number of studies have examined China's trade with countries along the Belt and Road, examining geographical patterns, commodity structures and economic effects. However, the trade relations between countries along the Belt and Road are not only bilateral but also trilateral, while trade relations comprise a complex and interdependent network of relationships. Although network analysis has been widely used to examine these network relationships, previous studies did not pay enough attention to the different weights of a country's trade relations. To fill this gap, top trade relational networks were examined to investigate the structure and evolution of B&R trade, paying particular attention to each country' top partners. More specifically, top 2 trade networks were used to identify structural changes such as changes in countries' positions, the overall patterns of trade across communities and the compositions of the communities from 2000 to 2016.

The research reached a number of conclusions that provide the basis for trade facilitation and development of policy formulation. First, not all relations in the trade network are equally important to a country, especially at a time of global economic turbulence. After the 2008 global economic crisis, although the complete trade network of B&R countries developed very slowly, both network density and the degree of centralization continued increasing. The implication is that in the post-2008 economic crisis period the trade network became more concentrated on a few dominant countries, as some countries further strengthened their ties with key trade partners, while shedding nonessential ties. In 2016 although the top 2 trade network accounted for less than 11% of the total trade ties, it was responsible for nearly 75% of the total trade values. Therefore, the identification and maintenance of the top networks is critical to overall network development. Top networks provide a useful but relatively simple tool to illuminate the network structure of international trade.

Second, a centralities-based study identified the competitive positions of countries. After 2013, China outperformed Russia in terms of the three centralities, suggesting that China had come to dominate the trade network of the B&R region. The future impacts of China's BRI will depend on the degree of integration of the connected regions. Since the top 10 countries measured by centrality indices are either community leaders (e.g. Russia) or regional sub-centers (e.g. Singapore) or "bridges" between two communities (Romania and Hungary in 2016), China should select them as strategic regional partners. Their positions can be used in various ways to realize the potential of the BRI. Despite the decline in the relative position of Russia, China should further strengthen trade relations with it, because it has strong network influence. Besides Russia, other strategic partners are other countries with stable and high centrality indices, namely Singapore, Serbia, Greece, Turkey, Iran, Po-

land, Hungary and Romania, although obviously factors other than trade network relations such as geo-political and economic competition and historical relations with China should be taken into consideration.

Third, both the trade communities and their composition were highly unstable, suggesting that the trade communities compete with each other, in terms of the community leaders and their members. Although Russia remained a community leader, its community members changed and decentralized geographically. The Poland-led community experienced disappearance and re-emergence. Community leaders such as Kuwait, Thailand, Turkey, Israel, Greece, Kazakhstan, Czech Republic and Myanmar secured leadership positions in some years while losing it in others. This fluctuation might imply that they have some influence but that it is unstable, although they might be considered as regional strategic partners for China. It is also important to note that trade networks consist of geographically separated countries reflecting the complicated politico-economic systems of the B&R countries and the obstacles that have to be overcome before the construction of a more cohesive trade network can be constructed. Countries occupying a strategically important geographical position but that have weak trade links should be prioritized. Myanmar, Pakistan, and Belarus are such countries.

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