The import competition relationship and intensity in the international iron ore trade: From network perspective

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ABSTRACT

As a critical raw material, iron ore plays an important role in the development of the national economy, which results in intense competition between iron ore importers. Using the international iron ore trade data of the UN Comtrade from 2000 to 2015, this paper calculates the competition intensity between iron ore importers importing iron ore from the same exporters. The paper then constructs iron ore import competition networks with the importers as nodes, the import competitive relations as edges, and the competition intensity as weights of edges. Applying complex network theory, the paper analyzes the overall characteristics of the iron ore importing competition pattern, the import competition region and the main importing countries. The results reveal that the global iron ore import competition is tight, unbalanced and expanding and that the global iron ore import competitive pattern is moving from a core-periphery structure to a reticular structure. Although Australia and Brazil are both the main competition regions, the demand for Australian iron ore is more intense. The import competitive relations for iron ore exist primarily between Europe and Asia as well as intra-European and intra-Asian markets. The total import competition intensities between China and Japan and between China and South Korea are much larger than other competitive relationships with increasing trends from 2000 to 2015. We propose three policy recommendations for the importers: (1) diversifying the import channels; (2) enhancing the cooperation between importers; (3) investing in overseas equity mines to improve competitiveness.

1. Introduction

Iron ore is a strategic resource for national development. In addition to domestic production, countries, especially those lacking iron ore, compete against each other for the overseas resources to ensure the supply security of the resources. Thus, it is meaningful for scholars to investigate the international iron ore trade and related policy issues. Previous studies are categorized into two threads. The first one focuses on the demand side of iron ore. Tcha and Wright (1999) research the determinants of China's import demand for Australia's iron ore. Wu et al. (2016) systematically analyze the Chinese development strategy of iron ore. Chen et al. (2016a) identifies the influencing factors of China's iron import price. The second thread involves research on the supply aspect of iron ore. Hurst (2015) assesses the competitiveness of the supply side response to China's iron ore demand shock. Lawrence and Nehring (2015) study the impact of market structure differences on

the Australian iron ore industry. In addition to the research on the demand and supply of iron ore, scholars also focus on the international iron ore trade (Labson, 1997; Nakajima et al., 2011; Toweh and Newcomb, 1991).

However, there is little research on the competition among the importers of iron ore. The distribution of iron ore reserves across the world is uneven, and the productions are controlled by Australia, Brazil, and India. The World Steel Association reports in its Steel Statistical Yearbook 2016 that in 2015, with Australian iron ore production accounting for 40% of the global output, Australia is the largest producer of iron ore, followed by Brazil with 21%, and India with only 7%. Thus, there is intense competition among major consumers for the importation of iron ore. However, as each country generally imports iron ore from several suppliers, the competition is more complex, creating a complex competitive iron ore import system. Accordingly, other than analyzing the traditional international iron ore trade, the global

competition pattern is also worthy of research to understand more deeply the international iron ore market. Through understanding their positions in the global iron ore trade system, importers can develop strategies for importing to improve their global competitiveness and status and secure the supply.

The analysis of the global competition pattern and study of the positions of numerous importers in the international iron ore trade call for a complex network analysis. The basic idea of a network analysis is to abstract the importers as nodes and the competition relations as linkages between the nodes. In this way, the topological characteristics of the system can be ascertained, and the major players and vital relationships can be identified. Because of its effectiveness, there is rich literature on applying network theory to international trade issues, some of which analyze the topological features of international trade (Fagiolo et al., 2010; Garlaschelli and Loffredo, 2005; Li et al., 2003; Zhong et al., 2016). There is also literature using complex network theory to study the relationships of competition. Teller et al. (2016) study the impact of competition and cooperation on the performance of a retail agglomeration. Li et al. (2014a) and Li et al. (2014b) construct the holding-based network to study business competition. Zhang et al. (2014) analyze the competition and transmission pattern of global oil trade based on complex network theory and provides a 5 C, i.e., changeability, contestability, cooperation, commitment, and circumstances, policy framework to improve the energy security of oil importers. Chen et al. (2016b) also uses complex network theory to analyze the competition pattern of global liquefied natural gas. An et al. (2014) analyze the international crude oil trade relationships using a trading-based network. To fill the research gap in the mineral resource network at the global level, this study attempts to use complex network theory to investigate the import competition in the international iron ore trade.

In this paper, we study the import competition intensity at three levels. We calculate the import competition intensity of each pair of competitors at the beginning, followed by the construction of the iron ore import competition network (IOICN) from 2000 to 2015. At the global level, we study the overall characteristics of the international iron ore trade competition pattern based on complex network indicators. Second, we analyze the competition with respect to the iron ore origins, namely, the competition objective level. Finally, we analyze the main competition intensity among importers, namely, the competition subject level. Then, based on the results obtained, we propose policy recommendations for the importing of iron ore.

The main contribution of this paper to the literature is the construction of an import competition network model to analyze the competition pattern and the positions of countries in the international iron ore trade. The remainder of this paper is organized as follows. Section 2 introduces the import competition model as well as the original data, and Section 3 analyzes the global import competition pattern at three levels. Section 4 then proposes policy recommendations, and Section 5 presents the conclusions.

2. Methods and data

2.1. Iron ore importing competition intensity

In this paper, we cite the indicator of competition intensity proposed by Zhang et al. (2014) to measure the level of competition between two countries importing iron ores from the same source. The specific indicator is defined as formula (1).

$$S_{ij} = \sum_c \left\{ \left(\frac{M_{ic} + M_{jc}}{M_w} \right) \times \left[1 - \frac{|(M_{ic}/M_i) - (M_{jc}/M_j)|}{(M_{ic}/M_i) + (M_{jc}/M_j)} \right] \right\} \times 100 \tag{1}$$

where S_{ij} denoted the competition intensity between iron ore importers v_i and v_j, c represents the common iron ore import source v_c, M_{ic} represents the iron ore import volume that importer v_i imports from v_c,

Table 1
The maximum, minimum, and average values of competition intensity between country i and country j, Sij.

Year	Maximum	Minimum	Average
2000	0.338	1.59E−09	0.013
2001	0.364	2.89E−09	0.013
2002	0.356	3.16E−10	0.012
2003	0.346	1.54E−09	0.011
2004	0.382	3.86E−10	0.011
2005	0.434	2.33E−09	0.010
2006	0.456	7.01E−10	0.010
2007	0.453	6.31E−10	0.010
2008	0.477	1.73E−10	0.009
2009	0.571	3.64E−09	0.007
2010	0.526	1.98E−09	0.008
2011	0.515	3.38E−10	0.009
2012	0.575	1.39E−10	0.009
2013	0.592	3.11E−10	0.009
2014	0.650	1.40E−11	0.008
2015	0.688	3.56E−10	0.009

M_{jc} represents the iron ore import volume that importer v_j imports from v_c, M_w is the world's total iron ore import volume, M_i is the total import iron ore volume of importer v_i, and M_j is the total import iron ore volume of importer v_j.

In the theory, if there are only two countries country i and country j making iron ore trading in the world, then $Mic + Mjc$ should be equal to Mw, and Mic/Mi should be equal to Mjc/Mj. As a result, the value of competition intensity indicator of country i and country j should be 1. If there are more than two countries in the international iron ore trading system, this indicator should be less than 1. And in a whole international iron ore trading system with more than two countries, as long as any two countries making iron ore trade, their competition intensity Sij should be larger than 0. From the Eq. (1) we can see that, as for the same iron ore importing source country c, the larger the difference between Mic/Mi and Mjc/Mj is, the competition intensity Sij between country i and country j will be larger. The competition intensity measures the level of import competition between two importers with same importing source. The bigger of this value, the more intense of the competition. The maximum, minimum, and average values of competition intensity values are shown in Table 1.

From the Table 1 we can see that, in the iron ore importing competition network, the average level of competition intensity between two importers declines during the research period. In the same time, the range of the competition intensity between two importers become large, with the largest value becoming larger and smallest value becoming smaller.

We also have add top 3 competition intensity values in 2013, 2014 and 2015 in Table 2. From the Table 2 we can see that, the import competition intensity between China and Japan, South Korea and Indonesia are the largest in 2013, 2014 and 2015 with increasing trend. This indicates that the China is the most important iron ore importers and its competitors are mainly Japan, South Korea and Indonesia.

Table 2
Some examples with a few nodes and links.

Year	two competition countries	import competition intensity	rank
2015	China-Japan	0.69	1
2015	China-South Korea	0.63	2
2015	China-Indonesia	0.55	3
2014	China-Japan	0.65	1
2014	China-South Korea	0.58	2
2014	China-Indonesia	0.52	3
2013	China-Japan	0.59	1
2013	China-South Korea	0.5	2
2013	China-Indonesia	0.24	3