“Measurement and spatiotemporal evolution of geo-economic relationships in China’s sporting goods manufacturing industry”

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MEASUREMENT AND SPATIOTEMPORAL EVOLUTION OF GEO-ECONOMIC RELATIONSHIPS IN CHINA'S SPORTING GOODS MANUFACTURING INDUSTRY

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Abstract

In recent years, continuous changes in geo-economics and environment, especially the rise in global trade protectionism, have severely impacted China's sporting goods manufacturing industry, which is dominant in international trade. Therefore, this paper attempts to examine the geo-economic environment and influence factors of China's sporting goods manufacturing industry, and puts forward strategies to improve the competitiveness of China's sporting goods manufacturing industry and promote its high-quality development.

This paper selects indicators that can reflect the geo-economic relationships of competition and complementarity, including household final consumption expenditure (% of GDP), sporting goods import and export trade volumes (% of GDP), FDI (% of GDP) and R&D (% of GDP) from 2013 to 2018. Using the standardized Euclidean distance method, the geo-economic relationship of sporting goods manufacturing industry between China and each One Belt and One Road Initiative (BRI) country is obtained. Statistic results show that the geo-economic relationship of the sporting goods manufacturing industry between China and other BRI countries is more competitive than complementary. Meanwhile, a map generated by the ARCGIS10.0 platform shows that competition between China and the BRI countries increased from 2013 to 2018. According to the analysis of statistical data regarding the aspects of the industrial structure of China's sporting goods manufacturing industry, geo-economics and geopolitics, respectively, several proposals are put forward for the high-quality development of the sporting goods manufacturing industry in China.

Keywords One Belt and One Road Initiative, Euclidean distance, competition and cooperation relationship, influence factors, development strategy

JEL Classification C02, F62, L67, Z21

INTRODUCTION

On January 20, 2020, the latest statistics from the General Administration of Sport and the National Bureau of Statistics showed that the output value of China's sports industry was 2.7 billion yuan, and the added value of the sports industry accounted for 1.1% of the GDP in 2018. The sports goods manufacturing industry plays a pillar role. China's General Administration of Sport statistics show that, in 2018, sports goods and related products manufacturing accounted for as high as 49.7% which sales, rental and trade agents of sports goods and related products accounted for 15.5%. However, the international geo-economic situation is increasingly severe and complicated, especially the strengthening of global trade protectionism, and the tide of "anti-globalization" is sweeping the world; China's international trade, including the manufacturing industry of sporting goods, has been severely affected. To make mat-

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ters worse, the ultimate goal of most China's sporting goods companies is exports, the sporting goods manufacturing industry in China is heavily dependent on the global trade market (Li, 2020).

Different from purely economic activities, geo-economics refers to economic activities that have state support or guidance, such as investment, market research and product development and market expansion (Luttwak, 1990). In other words, geo-economics is the use of economic means to serve national interests (Brzezinski, 1997). Specifically, powerful countries seek to consolidate their political, military and economic dominance through their economic advantages and economic means, such as human resources, science and technology, capital, investment, trade, markets, and information technology. As China's most representative geo-economic strategy, the BRI provides economic dominance to their groups, which has become the main theme of international relations, and economic factors such as technology, finance, capital and markets have become an important geo-economic platform for the world through the unique historical, cultural, political and economic origins of the relationships between the countries along the routes and China. Therefore, geo-economic relationships under the BRI framework are bound to have an impact on China's sporting goods manufacturing industry.

Given this situation, this paper measures the geo-economic relationship between the Chinese sporting goods industry and that of other BRI countries from 2013 to 2018 by using the Euclidean distance method and studying the characteristics of its spatiotemporal evolution.

By analyzing the geo-economic competition and cooperation relationship, the causes and influence factors of China's sporting goods manufacturing industry, this paper seeks to help the Chinese sporting goods manufacturing industry to avoid geo-economic risks and promote its high-quality development.

1. LITERATURE REVIEW

The study of geo-economics has undergone a transformation from "geopolitics" and "geopolitical economy" to "geo-economy" (Cowen & Smith, 2009; Luttwak, 1990), and scholars have conducted a conceptual study of the geo-economic strategies of regional powers from the perspectives of neo-imperialism, neo-mercantilism, hegemonism and liberal institutionalism (Wigell, 2015). Scholars have also taken regions and powerful countries as their research objects to study issues related to, for example, European integration and the framework of bilateral relations in the EU (Smith, 2002), the geo-economic strategy of Germany after World War II (Kundnani, 2011), the geo-economic characteristics of Russia, especially against the background of economic sanctions (Aalto & Forsberg, 2015), and Japan's geo-economic strategy to pursue the maximization of its economic strength (Huntington, 1993).

In the geo-economic era, the competition between countries have replaced military factors as important means and tools of the game between countries (Luttwak, 1990). Baracuhy believes that geo-economic forces are reshaping globalization and the map of world trade has been redrawn (Baracuhy, 2014). The economic development of any two regions or countries are mutually influenced. The degree of influence depends on the close degree of geo-economic relations. It mainly reflects the competitiveness and complementarity of economic relations between countries or regions. Therefore, correct evaluation of geo-economic relations is the precondition for formulating appropriate regional economic development strategies and promoting the prosperity and development of the economy. According to the research content of this paper, relevant literature is sorted out from the following aspects.

In terms of the study of geo-economic relationship measurement, Pual Krugman's "New Economic Geography" has opened a precedent for scholars to study geo-economic relations (Krugman, 1998). From the perspective of time and space, scholars have used different methods to measure geo-economy or geo-economic relations. For example, by using the grey relational model based on the ideas of TOPSIS methods, Qin et al. (2020) measured the geo-economic connection between China and South

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American countries. Huang et al. (2019) calculated the geo-economic relationship between China, the United States and Japan based on Coulomb force model. Coccia (2007) analyzed the spatial mobility of technology transfer and knowledge spillover measuring their impact on the domestic geo-economic system by using evolutionary theory and economics of proximity. According to the space of flow theory (Castells, 1996), Hu et al. (2020) built a geo-economic flow model and measured the geo-economic relations between China and the BRI countries.

In addition to the literature from the perspective of the overall development of economy of the country or region mentioned above, some scholars have also measured geo-economy from perspectives of international trade and OFDI. Referring to empirical evidence of the BRI, Qiao (2019) analyzed the impact of geo-economic relations on China's OFDI. Du and Liu (2016) studied the geo-economic relationship of service industry between Beijing and 30 provinces in China. This is also one of the few papers that measure the geo-economic relationship of certain industries.

In terms of the research on sports goods manufacturing industry, scholars used the gravity model of trade and multiple linear regression and other methods to study the international trade of sports goods and the competitiveness of sports goods industry. Andreff M. and Andreff W. (2009) analyzed comparative advantages, disadvantages and competitiveness of sample countries' sports goods industry, and described the characteristics of international specialization of sports goods industry in different countries and regions. By using key data combined with case studies of global sporting goods brands positioned centrally in production networks, Wolfram (2014) carried out the quantitative analysis on the global sporting goods market and the role of Asian capital and Asian labor. Navjote and Balram (2008) studied the export barriers faced by Indian sports goods industry from the perspectives of financial, marketing, technology and input perspectives. Pinch and Henry (2010) analyzed the geographical cluster of the British motor sport industry though Paul Krugman's geographical economics. Taking football manufacturing as an example, Khalid et al. (2011) explored the relationship between the rise in Chinese and international labor standards, and analyzed how labor standards affected the geography and organization of global soccer production by comparing China, Pakistan and India as three major production areas. Using the test based on the extended trade gravity model, Ji and Ren (2020) discussed influencing factors and trade potential of China's sporting goods export to the BRI countries. Fu (2016) analyzed the current situation of Chinese sporting goods IPO enterprises and the opportunities and challenges they encounter when marching into ASEAN Trade Area.

In conclusion, previous research has provided assistance in terms of a research perspective, research ideas and methods, thus laying a solid foundation for this study. A literature review suggests that geo-economic relations, as a comprehensive indicator of the economic relations between countries or regions, can also reflect the competition and cooperation relationship of the sporting goods industry. Since there has not been a national geo-economic study of the sporting goods manufacturing industry, this paper has certain innovation.

2. RESEARCH METHODOLOGY

As one of the most popular geo-economic relationship measurement methods, the Euclidean Distance method, can help scholars' idea or needs that select different indicators to measure geo-economic relations between countries or regions. In the literature reviewed by the authors, Wen (1998) is the first author to propose the use of the "Euclidean distance measurement method" to measure geo-economic relations. After that, scholars standardized the Euclidean distance calculation based on Wen' s method and adjusted the standardized value according to the geographical location studied. For example, Du and Liu (2016) creatively incorporated the weight of the time-distance into the standardization of the distance value. By referring to the theory of regional economic competitiveness and the system analysis framework of city competitiveness, Zhang et al. (2006) further designed a theoretical framework for measuring the regional geo-economic relationship. With the continuous improvement of this research method, scholars later carried

out relevant empirical research. Chinese scholars have conducted geo-economic relationship measurement analysis on China's Yangtze River Delta (Zhang & Zhang, 2003), Pearl River Delta economic zone (Deng, 2009), Beijing-Tianjin-Hebei Region (Zhang et al. 2012) and Wuhan urban agglomerations (Zen & Luo, 2008). According to different types of geo-economic relations, scholars put forward relative economic strategies for regional development. Scholars have also used this research method to study geo-economic relations at the national level. For example, Wang measured the geo-economic relationships between China and ASEAN Countries (Wang er al., 2017). Su et al. (2013) measured and compared the geo-economic relations between six extra-regional powers (China, the United States, Russia, the EU, Japan and India) and ten Southeast Asian countries.

Following the definition of geo-economic relationships, this paper assumes that the flow of resources and products, such as capital, technology, talent and other factors, which flow from high-efficiency places to low-efficiency places, can reflect the geo-economic relationships of competition and complementarity. Therefore, this study selects the following indicators to study the geo-economic relationship of China's sporting goods manufacturing industry.

The indicator X represents household final consumption expenditure (% of GDP). It reflects the purchasing power of households and the scale of the retail market in a country, and the higher X is, the stronger the output capacity of a country's products is. The proportion of sporting goods import and export trade volumes in GDP is represented by the indicator Y. It reflects a country's ability to absorb sporting goods resources and the dependence of sporting goods on foreign trade. The indicator Z represents FDI (% of GDP), which reflects the overall economic openness of a country, that is, the degree of its connection to the international economy. W represents research and development expenditure (% of GDP), which mainly reflects the efficiency with which a country's capital and resources are processed and converted.

The data standardization process for X, Y, Z and W generates X', Y', Z', and W'. For example, the formula of X' is as follows:

$$X' = \frac{X - \overline{X}}{S_x}, \quad S_x = \sqrt{\frac{\sum\left(x - \overline{x}\right)^2}{n}}, \quad (n = 36). \quad (1)$$

In the formula, $\overline{X}$ is the average value of household final consumption expenditure (% of GDP); S_x is the standard deviation of household final consumption expenditure (% of GDP). The calculation method for Y', Z', and W' is the same as that for X'. The standardized values of the four indicators for country i are X_i', Y_i', Z_i', and W_i'. Setting X_0', Y_0', Z_0', and W_0' as the standard value of four indicators of China, the calculation formula for the actual distance between China and the country i indicators is as follows:

$$D = \left(\left(X_i' - X_0\right)^2 + \left(Y_i' - Y_0\right)^2 + \right. \\ \left. + \left(Z_i' - Z_0\right)^2 + \left(W_i' - W_0\right)^2\right)^{\frac{1}{2}}, \quad (2)$$

$$D_{xi} = \left|X_i' - X_0'\right|, \quad D_{yi} = \left|Y_i' - Y_0'\right|, \\ D_{zi} = \left|Z_i' - Z_0'\right|, \quad D_{wi} = \left|W_i' - W_0'\right|. \quad (3)$$

In the formula, i stands for the index number for the countries.

Similarly, to improve the usefulness of the data, this paper standardizes D_i and obtains the normalized value of the comprehensive distance D_i'. Therefore, the standardized distance between China and country i, which includes D_{xi}, D_{yi}, D_{zi}, and D_{wi}, generates the standardized values D_{xi}', D_{yi}', D_{zi}', and D_{wi}'. The formula is as follows:

$$D_i' = \frac{D_i - \overline{D_i}}{S_{di}}, \quad S_{di} = \sqrt{\frac{\sum (D_i - \overline{D_i})^2}{n}}, \quad (4)$$

$$\left(n = 35\right).$$

If the value of D_i' is positive, it indicates a complementary relationship between the two countries. The greater the positive value, the stronger the complementarity is. In contrast, if D_i' is negative, there is a competitive relationship between the two countries. The greater the absolute value of the negative, the stronger the competition. D_{xi}', D_{yi}', D_{zi}', D_{wi}' allow D_i' to be analyz-

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ed in detail. Taking D_{xi}' as an example, if D_{xi}' is positive, it indicates that the contribution of household final consumption expenditure (% of GDP) to sporting goods trade is complementary. The larger the value is, the greater the contribution is. In contrast, if D_{xi}' is negative, the relationship is competitive; the lower the value, the stronger the competitive relationship.

In general, D_i' can be used to distinguish between competitive and complementary relationships between countries. However, the above calculation does not consider the impact of transportation, culture, geography, etc., on the relationships between countries or regions. In particular, geographical location greatly affects capital flow, production and product circulation. As shown in Table 1, according to the spatial distance between the capitals of various countries and Beijing, this paper gives each country a corresponding weight and then multiplies the standardized Euclidean distance by that weight. In this way, the adjusted distance reflects the differences between countries more accurately. The standardized D_i' is adjusted according to the geographical distance between each country and China, and the geographical weight is denoted by k. Finally, D_{ik}' represents the adjusted distance. The formula is as follows:

$$D_{ik}' = k \cdot D_i'. \quad (5)$$

Table 1. Weighting of geographical distances between China and other countries

Dstance	< 3000	3000-5000	5000-7000	> 7000
k	2.0	1.5	1.0	0.8

Note: The distance between the two countries is the distance between Beijing and the BRI country's capital (or major city).

Due to a lack of data, this paper ultimately selected 36 BRI countries, including China, as observations. In terms of geographical distribution, these observations cover most major regions, including Northeast Asia, Southeast Asia, South Asia, the Middle East, and Central and Eastern Europe. The time span is from 2013 to 2018, that is, from the year the One Belt and One Road Initiative was proposed to the latest year in which the World Bank database was updated.

In this paper, GDP, household final consumption expenditure, FDI and R&D come from the World Bank Open Datab. The volume of sporting goods imports and exports is from the United Nations Comtrade Database (https://comtrade.un.org/). Sporting goods generally include clothing accessories designed for use in sports; sports footwear, including ski boots and snowboard boots; yachts and other vessels for pleasure or sports; gymnastic, athletic, or outdoor game equipment, as well as equipment for other sports (including table tennis). The commodity codes are as follows: 420321, 640211, 640212, 640219, 640311, 640312, 640319, 640411, 890310, 890391, 890392, 890399, and 9506.

3. RESULTS

According to the relevant data covering 2013 to 2018 from the World Bank and the United Nations trade database for 36 countries participating in the One Belt and One Road Initiative, the study standardizes the indicators X, Y, Z, and W, and obtains X', Y', Z' and W' (the specific indicators and results are shown in Appendix A).

Next, the standardized values of China's indicators are set to X_0', Y_0', Z_0' and W_0', and the columns D_{xi}, D_{yi}, D_{zi}, and D_{wi} in Appendix B show the Euclidean distance between China and other countries. To conduct the analysis more accurately, this paper needs to calculate the standardized values of D_{xi}, D_{yi}, D_{zi}, D_{wi}. The results are shown as D_{xi}', D_{yi}', D_{zi}', and D_{wi}' in Appendix B. Finally, to facilitate clustering, one needs to further adjust the standardized distance D_i' according to the assignment principle k in Table 1. The weights of the countries according to the geographical distance between the capitals of the countries and China are as follows: Mongolia is 2.0; India, Kazakhstan, Singapore, and Thailand are 1.5; Armenia, Azerbaijan, Belarus, Estonia, Georgia, Indonesia, Kuwait, Latvia, Lithuania, Moldova, Oman, Poland, Russia, Turkey, Ukraine, and the United Arab Emirates are 1.0; and Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, the Czech Republic, Egypt, Greece, Hungary, Israel, Montenegro, Romania, Serbia, Slovakia, and Slovenia are 0.8.

After standardizing the distance between each country and China and multiplying by their cor-

Table 2. The value of the geo-economic relationship between China and the BRI countries from 2013 to 2018

Country	2013	2014	2015	2016	2017	2018	MEAN
Armenia	1.7883	1.2595	1.0661	1.1277	0.901	1.3961	1.2564
Azerbaijan	−0.2167	−0.7081	0.0384	0.1277	−0.5214	−0.0616	−0.2236
Belarus	−0.3843	−0.4316	−0.2977	−0.3133	−0.8358	−0.3341	−0.4328
Bosnia and Herzegovina	1.4511	1.0674	1.1741	1.071	0.7107	0.8528	1.0545
Bulgaria	0.1637	0.0742	−0.0262	−0.0923	−0.2981	−0.0649	−0.0406
Croatia	0.4826	0.075	0.2581	−0.1828	−0.2214	−0.1472	0.044
Cyprus	3.8034	4.7072	4.4426	3.9101	3.938	3.6864	4.0813
Czech Republic	−0.3211	−0.343	−0.5489	−0.835	−0.323	−0.8583	−0.5382
Egypt	1.0271	0.9044	0.9467	1.0911	1.146	1.1851	1.0501
Estonia	−0.2864	−0.4965	−0.7419	−0.8252	−0.8593	−0.9035	−0.6855
Georgia	1.1925	0.8159	0.9448	0.655	0.243	0.6383	0.7482
Greece	0.4033	0.3533	0.2742	0.279	0.1275	0.2114	0.2748
Hungary	−0.662	−0.4476	−0.6901	1.3547	−0.5507	1.8686	0.1455
India	−0.1408	−0.2329	−0.1669	−0.2226	−0.7834	−0.1029	−0.2749
Indonesia	0.2822	−0.1766	0.1418	0.024	−0.5171	0.0378	−0.0346
Israel	0.2318	−0.2381	0.1093	0.1535	1.0497	0.3405	0.2744
Kazakhstan	−0.1101	−0.9335	−0.1014	−0.0764	−1.3087	−0.1416	−0.4453
Kuwait	−0.3208	−0.817	−0.3361	−0.3491	−1.3534	−0.3281	−0.5841
Latvia	0.0636	0.0185	0.0036	0.0847	−0.4028	−0.0591	−0.0486
Lithuania	−0.0576	0.0301	−0.058	0.0097	−0.2462	−0.0402	−0.0604
Moldova	1.9943	1.4989	1.5739	1.6905	1.2746	1.56	1.5987
Mongolia	0.2821	−0.4578	0.3006	0.6917	−1.5121	0.1458	−0.0916
Montenegro	1.078	0.779	0.9349	0.8582	0.4767	0.6948	0.8036
Oman	−0.2942	−0.857	−0.442	−0.543	−1.4827	−0.4159	−0.6724
Poland	−0.1347	−0.0897	−0.2699	−0.3089	−0.4602	−0.3358	−0.2665
Romania	0.174	0.015	0.0995	0.1047	−0.1832	0.1785	0.0648
Russia	−0.4651	−0.3694	−0.5963	−0.6965	−0.8807	−0.72	−0.6213
Serbia	0.5601	0.4941	0.4272	0.4069	0.2182	0.3429	0.4083
Singapore	−1.4461	−1.221	−1.8397	−1.3909	−0.3446	−0.6422	−1.1474
Slovakia	−0.0968	−0.2123	−0.3296	−0.3041	−0.4572	−0.2291	−0.2715
Slovenia	0.8694	−0.0258	−0.2669	−0.6042	−0.0893	−0.6445	−0.1269
Thailand	−0.3853	−0.6785	−0.6328	−1.0289	−1.7076	−1.3334	−0.9611
Turkey	0.0253	−0.0246	−0.1195	−0.2398	−0.4612	−0.4027	−0.2038
Ukraine	0.6087	0.5077	0.3572	0.3627	0.0167	0.563	0.4027
United Arab Emirates	−0.8432	−1.0696	−0.9032	−1.0725	−1.0875	−1.18	−1.026

responding weights, D_{ik}', is obtained, which is shown in the last column of Appendix B. By calculating formulas and steps above, this paper measures the geo-economic relationship between China and 35 other sample countries from 2013 to 2018. The average value from 2013 to 2018 is calculated, and the results are shown in Table 2.

According to the values of 2013 and 2018 generated with the help of ARCGIS10.0, Figure 1 shows the pattern in the geo-economic relationships of China's sporting goods manufacturing industry with those of the BRI countries in 2013 and 2018. By comparing the patterns in the geo-economic relationships in 2013 and 2018, the dynamic evolution of the geo-economic relationships in different regions can also be identified, which shows a trend of increasing competition.

4. DISCUSSION

Theoretically, there are two types of geo-economic relationships, namely, competitive and complementary relationships. However, in the actual analysis, according to the average value from 2013 to 2018, this paper further divides the geo-economic relationship into the following four types according to the threshold value of D_{ik}': strong competitive relationship, generally competitive relationship, generally complementary relationship and strong complementary relationship (Table 3).

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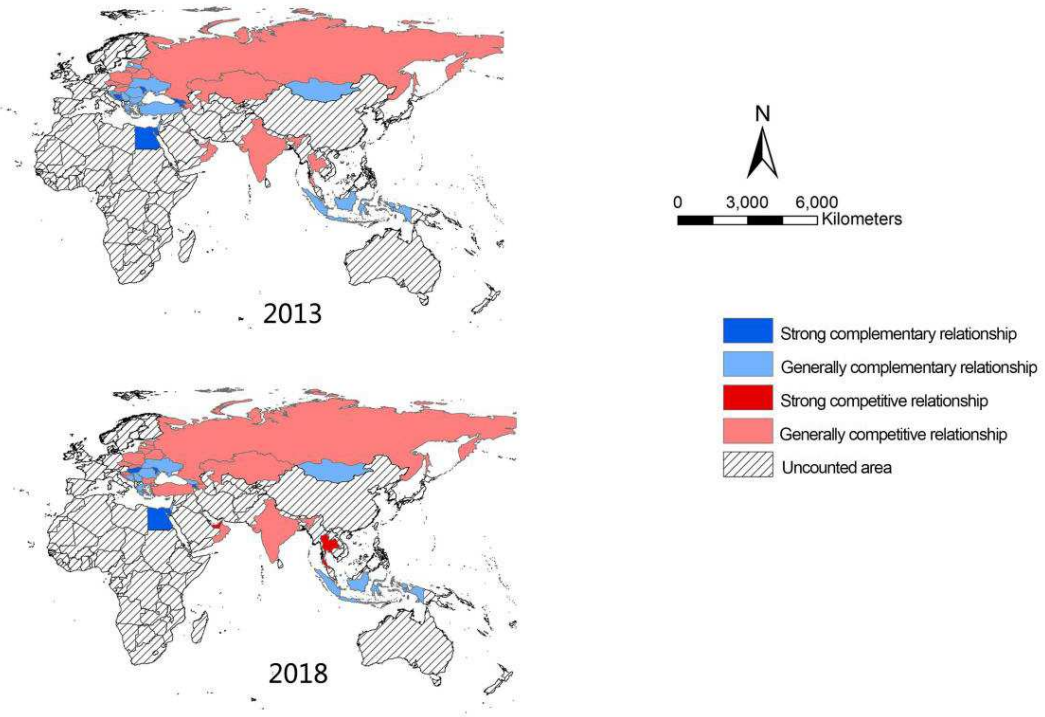

Figure 1. The evolution of geo-economic relationships of China's sporting goods industry with those of the BRI countries from 2013 to 2018

Table 3. Types of geo-economic relations between the sporting goods industry in China and those in the BRI countries

Type	Threshold value	Number	Countries
Strong competitive relationship	$D_{ik}' \leq -1.0$	2	Singapore, United Arab Emirates
Generally competitive relationship	$-1.0 < D_{ik}' \leq 0$	19	Thailand, Estonia, Oman, Russia, Kuwait, Czech Republic, Kazakhstan, Belarus, India, Slovakia, Poland, Azerbaijan, Turkey, Slovenia, Mongolia, Lithuania, Latvia, Bulgaria, Indonesia
Generally complementary relationship	$0 < D_{ik}' \leq 1.0$	9	Croatia, Romania, Hungary, Israel, Greece, Ukraine, Serbia, Georgia, Montenegro
Strong complementary relationship	$1.0 < D_{ik}'$	5	Egypt, Bosnia and Herzegovina, Armenia, Moldova, Cyprus

Note: The final result is the arithmetic mean of each country from 2013 to 2018.

Table 3 shows that the geo-economic relations of most of the sample countries are competitive with China. Of these, there are two countries that have strong competitive relationships, and 19 countries have generally competitive relationships with China. In general, China's sporting goods manufacturing industry is facing fierce geo-competition. The BRI encompasses various regions or organizations, including Central Asia, Northeast Asia, Central and Eastern Europe, ASEAN, West Asia, the Middle East and South Asia, China has to face a complicated political, economic and cultural environment. Therefore, this paper suggests that there are three aspects that lead to the geo-economic situation of China's sporting goods manufacturing industry. They are industrial structure of China's sporting goods manufacturing industry, and geo-economic and geopolitical environment.

The first cause is the industrial structure of China's sporting goods manufacturing industry. In the past period, foreign processing and low-end manufacturing dominated China's sporting goods manufacturing industry, which has fewer core technologies and intellectual property rights. There are too many sports goods enterprises with low-added value and high consumption. Under

this background, the increasing rise of the international price of raw materials, fuel, and the surging domestic prices, including circulation costs, inflation and the rise in labor costs has significantly increased the cost of production of sporting goods. These directly lead to the fact that the comparative advantage of China's sporting goods manufacturing industry is no longer obvious. Furthermore, Chinese sporting goods enterprises are mostly engaged in foreign processing and exporting, so sporting goods transactions are settled in US dollars. Therefore, unstable exchange rate, especially the appreciation of the RMB, also lead to a significant increase in the cost of enterprises and has also caused the adverse situation of downstream foreign trade enterprises in the sporting goods sector.

The second cause that leads to the geo-economic situation of China's sporting goods manufacturing industry is geo-economic environment.

On the one hand, one of the most important reasons why China launched the BRI is the BRI countries can help China to reduce inventory and overcapacity. However, China's total trade in this area accounted for only a small proportion of China's total trade volume (Han er al., 2015). In terms of China's sporting goods manufacturing industry, data from the World Trade Database shows that sporting goods trade between China and the BRI countries just accounted for 14.2 percent of China's total sports goods trade in 2017, and China's exports to the BRI countries only accounting for 13.7 percent of China's total sports goods exports. The main reasons are differences in geographical environment, sports culture, sports habits of the BRI countries, especially in regions such as the Middle East and Central and Eastern Europe, which are far from China. Additionally, the insufficient capacity of consumption of most BRI countries has caused this situation as well.

On the other hand, most countries in Asia and Eastern Europe are specialized in trite sports goods and some less equipment-intensive sports goods (Andreff & Andreff, 2009). Statistics show that the similarity indicator for exports between China and ASEAN to Europe and the USA in the last 15 years has increased year by year (Wang & Liu, 2015). However, the ASEAN and South Asian countries have more advantages in terms of natural resources, including rubber and cotton, and in terms of labor costs than China. Therefore, some countries in ASEAN and South Asia have seized a large part of China's market share. This has even caused production lines for international sporting goods manufacturers such as Nike and Adidas to constantly transfer from China to Southeast Asia and South Asia.

Finally and unfortunately, the BRI experiences frequent crises, strong conservatism and the most intensive trade protection measures all over the world in recent years. In the international context of rising trade protectionism, countries have generally adopted protectionist trade policies. China's sporting goods have had to face more trade barriers, such as anti-dumping and "green" barriers. Take India for example. Due to the fear that cheap Chinese products, especially consumer lifestyle products, including sporting goods, will strike at India' s domestically similar product and industrial chains, India took many unprecedented protectionist measures (Vandenbussche & Viegelahn, 2012) that are even harsher than those of the United States. Statistics showed that India launched 193 anti-dumping investigations against China from 2005 to 2016. As a form of trade protectionism, India even introduced tariffs on 19 products simultaneously in 2018.

The third cause for the geo-economic situation of the Chinese sporting goods manufacturing industry is geopolitics.

With the intensified rivalry between China and the United States in recent years, the US government spares no effort to advocate the Chinese threat theory. Some academics and politicians even claim that China is creating a "debt trap" in Central and Eastern Europe and Africa. They even advocate that the BRI is China's Marshall Plan. The result is obvious that these geopolitical effects have led to tension between China and part of the BRI countries and have even disrupted their policies towards China.

In general, there is a lot of political and economic instability in the BRI zone, frequent regional conflicts and even wars, such as the Ukrainian crisis, the European migrant crisis, the Israeli-Palestinian conflict, the war between Armenia

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and Azerbaijan. For example, the political conflict between Turkey and the United States directly led to the sharp devaluation of the Turkish lira, which has led to a sharp decline in economic growth of Turkey. Statistics from the Turkey Statistics Bureau show that the bilateral trade volume between China and Turkey has a significant downward trend from 2013–2018. In 2018, Turkey was affected by a domestic economic crisis. The import and export volume between China and Turkey even plunged by 10.4% to USD 23.62 billion (Wu, 2019).

Based on the causes above, this paper argues that the Chinese government, sporting goods manufacturing industry and enterprises should take the following steps to adapt to the changing geo-economic situation. Details are provided below.

Firstly, according to Kojima's marginal industry expansion theory, as an obvious industry about to lose its comparative advantage, the Chinese sporting goods manufacturing industry should accelerate the upgrading of industrial structure, actively cultivate and develop new technology-intensive sports products, and enhance export competitiveness. Increasing the export capacity of sporting goods can promote inter-industry trade between the two sides to transform competitive relations into cooperative ones.

Secondly, given that ASEAN has rich natural resources and cheap labor, and geographical location and cultural background are relatively close to China, especially the super national treatment of foreign investors, China's sports goods manufacturing industry should speed up the transfer of over-supplied enterprises to the region (Zhou et al., 2010).

Thirdly, according to the theory of product differentiation (Beath & Katsoulacos, 1991), China's sports goods manufacturing industry should fully consider geographical differences of each BRI country, including geographical location, sports culture, sports habits, economic level, consumption capacity, wealth gap, etc., to meet the needs of different consumers by integrating differences and emerging technologies into Chinese sports goods.

Fourthly, if China wants to maintain and even expand the advantage of sporting goods export scale, it should continue to explore emerging markets and strengthen its cooperation with other countries that are experiencing large and rapidly growing imports of sporting goods.

Fifthly, Chinese government should increase efforts to promote the internationalization of the RMB, and strive to improve the utilization rate and influence of the RMB. Because if RMB is the settlement currency for international trade of sporting goods, it is also beneficial to reduce the exchange rate risk and operating costs. Furthermore, by importing more raw materials, sporting goods companies can also hedge the increased cost of exports caused appreciation of the RMB.

Sixthly, as most important of all, China should resist unilateralism and protectionism, continue to support the multilateral trading system and actively advocate and firmly promote free trade. Under the WTO's cooperation framework, China should actively build or join more multilateral cooperation platforms, such as the newly signed RECP and EU-China Comprehensive Investment Agreement.

CONCLUSION

Since geo-economic competition and complementarity among countries are manifested in many industries and influence factors, different indicators should be selected to reflect different purposes of the actual analysis. Therefore, according to the characteristics of sporting goods manufacturing industry and the research purpose, this paper innovatively chooses four indicators to reflect geo-economic relations of China's sporting goods manufacturing industry, including household final consumption expenditure (% of GDP), the proportion of sporting goods import and export trade volumes in GDP, FDI (% of GDP), and R&D (% of GDP), and calculates the standardized Euclidean distance by using the model of geo-economic relationship. Statistics show that the geo-economic relationship in the sporting goods manufacturing industry between China and the 35 sample countries is more competitive

than complementary overall, and the competition has increased significantly in recent years. According to the research results, this paper finds that the geo-economic relationship of China's sporting goods manufacturing industry is influenced by many aspects, which can be roughly divided into the industry itself, the geo-economic and geo-political environment of BRI. Finally, this paper puts forward several suggestions on how to improve the competitiveness and high-quality development of China's sporting goods industry. Under the background of the "Made in China 2025" strategy, this study will help China master the power of discourse of the sporting goods manufacturing industry worldwide and provide an important basis for government decision-making.

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APPENDIX A

Table A1. Standardized values of the indicators for the BRI countries

Country	X	X'	Y	Y'	Z	Z'	W	W'
Armenia	81.7700	2.1535	0.0743	–0.3249	2.0963	0.0426	0.1891	–1.1029
Azerbaijan	54.1400	–0.1126	0.0319	–0.3805	6.7155	0.3072	0.1848	–1.1066
Belarus	53.5500	–0.1610	0.0729	–0.3267	2.4682	0.0639	0.6082	–0.7371
Bosnia and Herzegovina	76.0600	1.6852	0.3651	0.0567	2.9124	0.0893	0.1988	–1.0944
Bulgaria	59.6900	0.3426	0.3425	0.0270	3.1654	0.1038	0.7680	–0.5976
China	38.5200	–1.3936	0.0985	–0.2931	2.7233	0.0785	2.1857	0.6399
Croatia	58.1900	0.2196	0.5837	0.3434	2.5125	0.0664	0.9749	–0.4170
Cyprus	65.1800	0.7929	5.7444	7.1143	7.7062	0.3639	0.5586	–0.7804
Czech Republic	47.4500	–0.6612	0.5041	0.2390	5.8797	0.2593	1.9283	0.4152
Egypt	85.4500	2.4553	0.0286	–0.3848	3.3738	0.1158	0.7239	–0.6361
Estonia	49.6600	–0.4800	0.2853	–0.0481	3.2488	0.1086	1.4252	–0.0240
Georgia	69.3100	1.1316	0.1116	–0.2759	8.5925	0.4147	0.3046	–1.0021
Greece	68.0000	1.0241	0.1909	–0.1719	2.0835	0.0419	1.1773	–0.2403
Hungary	48.7000	–0.5587	0.2461	–0.0994	–84.4358	–4.9136	1.5548	0.0892
India	59.3200	0.3123	0.0408	–0.3688	1.9732	0.0355	0.6500	–0.7006
Indonesia	56.9800	0.1204	0.3082	–0.0179	2.4283	0.0616	0.2263	–1.0704
Israel	54.7500	–0.0625	0.0404	–0.3693	7.4479	0.3491	4.9528	3.0553
Kazakhstan	52.1000	–0.2799	0.0307	–0.3821	–2.4701	–0.2189	0.1229	–1.1607
Kuwait	39.1800	–1.3395	0.0582	–0.3460	2.0978	0.0427	0.0619	–1.2139
Latvia	61.7700	0.5132	0.2794	–0.0558	3.1447	0.1026	0.9450	–0.4431
Lithuania	59.1000	0.2942	0.2765	–0.0595	0.3275	–0.0587	0.6307	–0.7175
Moldova	84.7800	2.4003	0.0713	–0.3288	3.0907	0.0996	0.2550	–1.0454
Mongolia	54.3000	–0.0994	0.0278	–0.3858	15.1002	0.7874	0.1029	–1.1781
Montenegro	73.4400	1.4703	0.2294	–0.1214	10.7546	0.5385	0.3676	–0.9471
Oman	37.4400	–1.4822	0.0892	–0.3053	8.3979	0.4035	0.2196	–1.0763
Poland	58.1100	0.2130	0.3459	0.0315	3.1689	0.1040	1.2123	–0.2098
Romania	63.4800	0.6534	0.2426	–0.1040	3.6614	0.1322	0.5051	–0.8271
Russia	49.4600	–0.4964	0.0330	–0.3791	2.4055	0.0603	0.9899	–0.4039
Serbia	69.2900	1.1299	0.1131	–0.2739	8.7554	0.4240	0.9213	–0.4638
Singapore	34.7800	–1.7003	0.1896	–0.1736	32.3664	1.7763	2.0412	0.5138
Slovakia	56.1800	0.0547	0.3852	0.0831	3.0323	0.0962	0.8325	–0.5413
Slovenia	51.9000	–0.2963	0.5643	0.3180	3.6774	0.1332	1.9422	0.4274
Thailand	48.9000	–0.5423	0.1758	–0.1916	6.8021	0.3121	1.3071	–0.1270
Turkey	56.6900	0.0966	0.1205	–0.2642	2.1614	0.0463	1.1033	–0.3049
Ukraine	69.3600	1.1357	0.1126	–0.2746	3.5844	0.1278	0.4713	–0.8565
United Arab Emirates	38.3000	–1.4117	0.2556	–0.0870	6.0312	0.2680	1.3032	–0.1304

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APPENDIX B

Table B1. Indicators for the Euclidean distance between China and the BRI countries in 2018

Country	D_{xi}	D_{xi}'	D_{yi}	D_{yi}'	D_{zi}	D_{zi}'	D_{wi}	D_{wi}'	D_i	D_i'	k	D_i'
Armenia	3.5471	2.3151	0.0318	−0.2994	0.0359	−0.413	1.7428	1.1985	3.9524	1.3961	1	1.3961
Azerbaijan	1.281	−0.2279	0.0874	−0.2437	0.2287	−0.204	1.7465	1.2049	2.1798	−0.0616	1	−0.0616
Belarus	1.2326	−0.2822	0.0336	−0.2976	0.0146	−0.4361	1.377	0.5666	1.8485	−0.3341	1	−0.3341
Bosnia and Herzegovina	3.0788	1.7896	0.3498	0.0191	0.0108	−0.4402	1.7343	1.1839	3.551	1.066	0.8	0.8528
Bulgaria	1.7362	0.2829	0.3201	−0.0106	0.0253	−0.4245	1.2375	0.3256	2.1561	−0.0811	0.8	−0.0649
China	0		0		0		0		0			
Croatia	1.6132	0.1449	0.6365	0.3064	0.0121	−0.4389	1.0569	0.0136	2.0309	−0.184	0.8	−0.1472
Cyprus	2.1865	0.7882	7.4074	7.0887	0.2854	−0.1425	1.4203	0.6414	7.858	4.608	0.8	3.6864
Czech Republic	0.7324	−0.8436	0.5321	0.2018	0.1808	−0.2559	0.2247	−1.424	0.9501	−1.0729	0.8	−0.8583
Egypt	3.8489	2.6538	0.0917	−0.2394	0.0373	−0.4115	1.276	0.3921	4.0561	1.4814	0.8	1.1851
Estonia	0.9136	−0.6402	0.245	−0.0858	0.0301	−0.4193	0.6639	−0.6653	1.156	−0.9035	1	−0.9035
Georgia	2.5252	1.1683	0.0172	−0.314	0.3362	−0.0875	1.642	1.0244	3.0309	0.6383	1	0.6383
Greece	2.4177	1.0477	0.1212	−0.2099	0.0366	−0.4122	0.8802	−0.2916	2.5761	0.2643	0.8	0.2114
Hungary	0.8349	−0.7286	0.1937	−0.1372	4.9921	4.9596	0.5507	−0.8608	5.095	2.3357	0.8	1.8686
India	1.7059	0.2489	0.0757	−0.2555	0.043	−0.4054	1.3405	0.5036	2.1713	−0.0686	1.5	−0.1029
Indonesia	1.514	0.0335	0.2752	−0.0556	0.0169	−0.4336	1.7103	1.1424	2.3007	0.0378	1	0.0378
Israel	1.3311	−0.1717	0.0762	−0.2549	0.2706	−0.1586	2.4154	2.3604	2.7722	0.4256	0.8	0.3405
Kazakhstan	1.1137	−0.4156	0.089	−0.2421	0.2974	−0.1295	1.8006	1.2984	2.1399	−0.0944	1.5	−0.1416
Kuwait	0.0541	−1.6047	0.0529	−0.2782	0.0358	−0.4131	1.8538	1.3903	1.8557	−0.3281	1	−0.3281
Latvia	1.6878	0.2286	0.2336	−0.0973	0.1372	−0.3032	1.3574	0.5327	2.1828	−0.0591	1	−0.0591
Lithuania	1.9068	0.4744	0.2373	−0.0936	0.0241	−0.4257	1.083	0.0588	2.2058	−0.0402	1	−0.0402
Moldova	3.7939	2.5921	0.0357	−0.2955	0.0211	−0.4291	1.6853	1.0992	4.1516	1.56	1	1.56
Mongolia	1.2942	−0.2132	0.0927	−0.2384	0.7089	0.3165	1.818	1.3284	2.3433	0.0729	2	0.1458
Montenegro	2.8639	1.5484	0.1717	−0.1593	0.46	0.0467	1.587	0.9293	3.3108	0.8685	0.8	0.6948
Oman	0.0886	−1.5661	0.0122	−0.319	0.325	−0.0996	1.7162	1.1525	1.749	−0.4159	1	−0.4159
Poland	1.6066	0.1375	0.3246	−0.0061	0.0255	−0.4242	0.8497	−0.3443	1.8464	−0.3358	1	−0.3358
Romania	2.047	0.6317	0.1891	−0.1419	0.0537	−0.3937	1.467	0.722	2.5261	0.2232	0.8	0.1785
Russia	0.8972	−0.6586	0.086	−0.2452	0.0182	−0.4322	1.0438	−0.009	1.3792	−0.72	1	−0.72
Serbia	2.5235	1.1665	0.0192	−0.312	0.3455	−0.0774	1.1037	0.0944	2.776	0.4287	0.8	0.3429
Singapore	0.3067	−1.3212	0.1195	−0.2116	1.6978	1.3886	0.1261	−1.5942	1.7341	−0.4282	1.5	−0.6422
Slovakia	1.4483	−0.0401	0.3762	0.0455	0.0177	−0.4327	1.1812	0.2283	1.9065	−0.2864	0.8	−0.2291
Slovenia	1.0973	−0.434	0.6111	0.2809	0.0547	−0.3927	0.2125	−1.445	1.2751	−0.8056	0.8	−0.6445
Thailand	0.8513	−0.7102	0.1015	−0.2296	0.2336	−0.1987	0.7669	−0.4873	1.1737	−0.8889	1.5	−1.3334
Turkey	1.4902	0.0068	0.0289	−0.3023	0.0322	−0.4171	0.9448	−0.18	1.765	−0.4027	1	−0.4027
Ukraine	2.5293	1.1729	0.0185	−0.3127	0.0493	−0.3984	1.4964	0.7729	2.9393	0.563	1	0.563
United Arab Emirates	0.0181	−1.6452	0.2061	−0.1248	0.1895	−0.2465	0.7703	−0.4813	0.8198	−1.18	1	−1.18