An Empirical Study on the Chemical Trade between China and Germany

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Abstract—Based on the 2010-2019 data, the article uses calculation models such as the Revealed Comparative Advantage Index and Trade Complementarity Index to conduct an empirical study on the competitiveness and complementarity of Sino-German chemical trade. The results show that China and Germany have comparative advantages in chemical industries that are quite different; The trade complementarity between China's chemical exports and German chemical imports is relatively weak, while the complementarity between German chemical exports and China's chemical imports is strong.

Keywords-Calculation model; RCA index; Sino-German Chemica Trade; Fine Chemicals.

1 INTRODUCTION

The research on Sino-German trade is relatively rich, and the existing literature mostly studies Sino-German trade from the perspective of the overall trade between China and Germany and the trade of some specific industries. Xuan Shanwen (2020) used the trade integration index, the explicit comparative advantage index, and the trade competitive advantage index to study the bilateral trade between China and Germany. The potential for trade development is huge. Zhang Junling (2016) analyzed Sino-German bilateral trade using the trade integration index and gravity model, and believed that China-Germany commodity structure is highly complementary, and Germany's trade integration with China is changing from weak to strong, and China's trade integration with Germany degree has a tendency to weaken.Luo Jiangyue's (2013) study found that the competition between the two countries in the export of agricultural products is gradually weakening, and there is more room for improvement in the trade of agricultural products between the two countries. Zhao Dawei (2012) used quantitative models and comparative methods to demonstrate that China's low-priced apple juice has limited trade potential in the German market [1]-[4].

The above literature analyzes the overall Sino-German trade, agricultural product trade, service trade, and apple juice trade. It can realize the overall understanding of Sino-German trade and the understanding of trade in some industries. Germany, as China's most important trading partner in the EU, has broad prospects for chemical trade with China, but so far there are few

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studies involving China's chemical trade with Germany. Based on this, the article will conduct an empirical study on the chemical trade between China and Germany, analyze the characteristics, development trends, competitiveness and complementarity of the Sino-German chemical trade, and propose countermeasures to provide a reference for the development of the chemical trade between the two parties.

2 MATERIALS AND METHODS

According to the two-digit standard of the harmonized commodity name and coding system (HS), the article defines the products of Chapter 28-40 as chemical products, which are: inorganic chemicals (28), organic chemicals (29), pharmaceutical products (30), fertilizers (31), tanning or dyeing extracts, etc. (32), essential oils and resins (33), soaps and organic surfactants, etc. (34), albuminoidal substances, etc. (35), explosives, etc. (36), photographic or cinematographic goods (37), miscellaneous chemicals products (38), plastics and articles thereof (39), rubber and articles thereof (40). The data used in the article comes from the International Trade Center (ITC) database.

Based on trade data from 2010 to 2019, the article analyzes the overall situation of the chemical trade between China and Germany through empirical research, and uses measurement model to study the competitiveness and complementarity of the chemical trade between China and Germany.

The article chooses the Revealed Comparative Advantage Index(RCA) to measure trade competitiveness[5].

$$RCA=(Xik/Xi)/(Xk/X) \tag{1}$$

In the formula, Xik and Xi are respectively the export value of k products and all products in country i, and Xk and X are the export value of k products and all products in the world. The larger the RCA index, the more obvious the comparative advantage of the product and the greater the export competitiveness. It is generally believed that when RCA>2.5, the product has very strong export competitiveness; when $1.25<RCA<2.5$, the product has strong export competitiveness; when $0.8<RCA<1.25$, the product has Moderate competitiveness; when RCA<0.8, the export competitiveness of the product is weak and it is not export competitiveness.

This article will use the Trade Complementarity Index to analyze the trade complementarity.

$$Cij=RCAik\times RCAjk \tag{2}$$

Cij is the trade complementarity index. RCAik represents the comparative advantage of country i in the export of k products and RCAik=(Xik/Xi)(Xk/X), while RCAjk represents the comparative advantage of country j in the import of k products and RCAjk=(Yjk/Yj)(Yk/ Y). Among them, Xik, Xi, Xk and X represent the same meanings as mentioned above. In the same way, Yjk, Yj, Yk and Y represent the import situation respectively. The larger the Cij value, the stronger the complementarity between the two countries in this type of product. It is generally

believed that when Cij>1, it means that the export advantages of country i's products are more compatible with the import advantages of country j, the two countries'trade complementarity is high, and the two countries'trade relations are close. The larger the Cij, the higher the trade complementarity between the two countries; conversely, the smaller the Cij, the lower the trade complementarity between the two countries and the closer the trade relationship between the two countries[6]-[10].

3 Results & Discussion

3.1 The chemical trade scale and the trade deficit of China-Germany

As shown in Figure 1, from 2010 to 2019, the scale of China-Germany chemical trade has gradually expanded, from USD 13.4 billion in 2010 to USD 25.4 billion in 2019, an increase of nearly twice. China's chemical imports from Germany are also increasing year by year, from USD 8.9 billion in 2010 to USD 18.8 billion in 2019. China's chemical exports to Germany have remained stable, at around US$5 billion. The chemical trade of China -Germany has always been in deficit, and the deficit has been expanding year by year. The deficit has increased from USD 4.3 billion in 2010 to USD 12.2 billion in 2019. The share of China-Germany chemical trade in China's chemical trade has been stable at 4.2%-5.3%, indicating that China-Germany chemical trade still has room for further expansion.

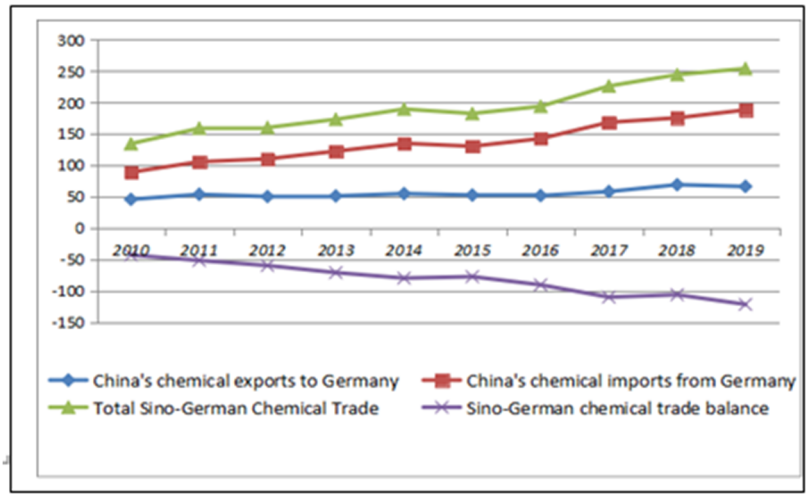

Figure 1. Chemical trade scale of China-Germany (100 million US dollars)

3.2 The structure of chemical exports between China and Germany

As shown in Figure 2, China's chemical exports to Germany are highly concentrated. In 2019, the top two chemical export products were Chapter 29 and Chapter 39 products, totaling USD4.66 billion, with a share of 70.66%.The shares of products in Chapter 40, 30, and 38 are all between 3% and 9%. Export value of Chapter 31 product is the lowest, with very small proportion. Germany's chemical export structure is relatively balanced. In 2019, the top three

export shares of products in Chapter 30, 39, and 29 ,the total export value is USD8.27 billion, the total share is 64.84%. The Chapter 36 product has the lowest export value with a share of only 0.02%. There are big differences in the chemical export structure of China-Germany .

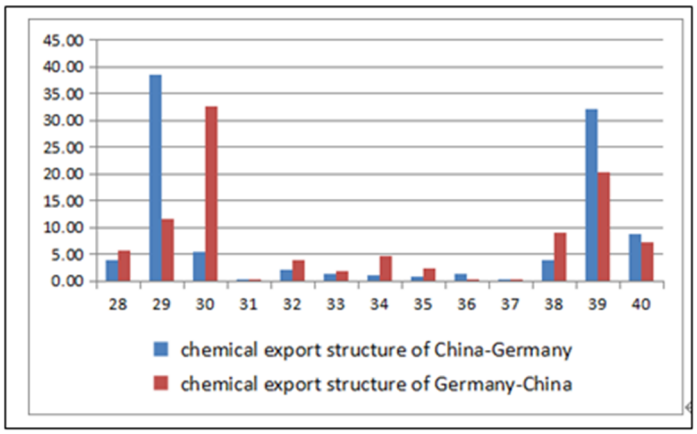

Figure 2. Chemical export structure of China-Germany in 2019 (%)

3.3 Empirical study on the competitiveness of China-Germany chemical trade

According to formula (1), the revealed comparative advantage index of chemical trade of China and Germany are obtained respectively, see Table 1 and Table 2.

Table 1 shows that from 2010 to 2019, the RCA index of China's Chapter36 products is greater than 1.25, which has always been a strong export competitiveness. The RCA index of Chapter 28, 29, 31, 39 and 40 products are between 0.8 and 1.25, with moderate export competitiveness. Among them, the export competitiveness of Chapter 29 and 39 products is gradually improving. More than half of China's chemical products do not have a competitive advantage，the RCA index is below 0.8, and the export competitiveness is weak. Among them, the Chapter 30 have the weakest competitiveness, and the RCA index is only slightly higher than 0.1. In summary, China's export-competitive chemical products are mainly related to labor and capital input factors, while products with weaker export competitiveness are related to technological input factors. However, with the advancement of science and technology in China, the export of high-tech products is gradually increasing. It reflects the status quo of optimization of China's chemical export structure.

TABLE 1. REVEALED COMPARATIVE ADVANTAGE INDEX OF CHINA'S CHEMICAL EXPORT

HS	28	29	30	31	32	33	34
2010	0.98	0.81	0.1	0.94	0.59	0.27	0.41
2011	1.18	0.85	0.11	0.99	0.65	0.28	0.46
2012	0.98	0.82	0.11	0.87	0.62	0.28	0.47
2013	0.94	0.81	0.11	0.80	0.61	0.28	0.46
2014	1.01	0.85	0.10	1.11	0.65	0.29	0.46
2015	0.89	0.84	0.10	1.26	0.62	0.30	0.44

2016	0.95	0.92	0.11	1.02	0.64	0.28	0.45
2017	1.04	1.01	0.11	0.92	0.69	0.29	0.47
2018	1.18	1.04	0.12	0.92	0.70	0.30	0.50
2019	1.03	1.03	0.11	0.92	0.71	0.29	0.53
HS	**35**	**36**	**37**	**38**	**39**	**40**	
2010	0.75	1.65	0.57	0.60	0.69	0.84	
2011	0.76	1.75	0.60	0.62	0.77	0.86	
2012	0.75	1.76	0.61	0.55	0.88	0.90	
2013	0.74	1.67	0.61	0.57	0.89	0.96	
2014	0.73	1.23	0.59	0.60	0.88	0.99	
2015	0.71	1.56	0.59	0.56	0.86	0.88	
2016	0.72	1.55	0.56	0.59	0.89	0.87	
2017	0.77	1.49	0.57	0.66	0.91	0.86	
2018	0.79	1.69	0.56	0.66	0.95	0.90	
2019	0.79	1.50	0.54	0.61	1.01	0.89	

TABLE 2. REVEALED COMPARATIVE ADVANTAGE INDEX OF GERMAN CHEMICAL EXPORT

HS	**28**	**29**	**30**	**31**	**32**	**33**	**34**
2010	0.93	0.84	1.72	0.51	1.93	1.29	1.75
2011	0.93	0.82	1.83	0.50	1.98	1.28	1.79
2012	1.03	0.85	1.96	0.56	2.16	1.30	1.81
2013	0.99	0.88	2.00	0.56	2.21	1.29	1.87
2014	1.03	0.89	1.96	0.48	2.12	1.20	1.82
2015	0.91	0.81	1.90	0.20	2.00	1.08	1.74
2016	0.93	0.78	1.81	0.22	1.95	1.03	1.72
2017	0.92	0.80	1.93	0.23	1.97	0.99	1.74
2018	0.87	0.75	2.04	0.23	1.98	0.99	1.78
2019	1.01	0.79	1.84	0.23	1.99	0.98	1.72
HS	**35**	**36**	**37**	**38**	**39**	**40**	
2010	1.64	0.85	1.01	1.63	1.32	1.06	
2011	1.69	0.90	1.00	1.67	1.33	1.00	
2012	1.73	0.89	1.09	1.68	1.33	1.04	
2013	1.73	0.85	1.18	1.75	1.33	1.13	
2014	1.72	0.55	1.21	1.68	1.29	1.17	
2015	1.59	0.48	1.12	1.64	1.26	1.14	
2016	1.56	0.54	1.14	1.62	1.26	1.14	
2017	1.65	0.61	1.14	1.60	1.29	1.12	
2018	1.70	0.71	1.19	1.59	1.28	1.16	
2019	1.64	0.74	1.13	1.58	1.27	1.13	

Table 2 shows that most of Germany's chemical products have an export competitive advantage. The RCA index of other commodities except for Chapter 31 product are greater than 0.8. The

RCA index of Chapter 30, 32, 34, 35, 38 and 39 products are located between 1.25- 2.5, it has always been shown as strong export competitiveness. The products of chapter 28, 29, 36, 37 and 40 have moderate export competitiveness, and the export competitiveness of products of Chapter 29 and 36 have a tendency to weaken. Chapter 31 product has always been weaker export competitiveness. In summary, Germany's highly competitive export of chemical products is related to capital and technological inputs. In general, there are differences between the more competitive products of China and Germany, and they will not pose a threat to exports in the international market.

3.4 Empirical study on the complementarity of China-Germany chemical trade

According to formula (2), the complementarity index of chemical trade between China and Germany is obtained, see Table 3 and Table 4.

TABLE 3. COMPLEMENTARITY OF CHINA-GERMANY CHEMICAL TRADE

HS	28	29	30	31	32	33	34
2010	1.00	0.85	0.14	0.34	0.70	0.26	0.46
2011	1.10	0.90	0.17	0.35	0.82	0.27	0.52
2012	1.04	0.91	0.16	0.33	0.85	0.28	0.55
2013	0.93	0.9	0.16	0.32	0.91	0.29	0.55
2014	1.00	0.97	0.15	0.45	0.94	0.29	0.54
2015	0.81	1.03	0.14	0.44	0.83	0.31	0.51
2016	0.86	1.12	0.15	0.35	0.84	0.27	0.52
2017	0.93	1.28	0.16	0.29	0.89	0.28	0.54
2018	1.05	1.52	0.16	0.22	0.88	0.27	0.59
2019	0.90	1.46	0.15	0.24	0.86	0.25	0.62
HS	**35**	**36**	**37**	**38**	**39**	**40**	
2010	1.00	1.81	0.50	0.74	0.72	1.02	
2011	1.02	1.88	0.53	0.77	0.83	1.08	
2012	1.04	1.93	0.59	0.69	0.99	1.14	
2013	1.03	1.63	0.64	0.71	1.01	1.26	
2014	1.01	1.29	0.60	0.74	0.98	1.31	
2015	0.91	1.65	0.53	0.66	0.95	1.14	
2016	0.85	1.56	0.51	0.69	0.97	1.16	
2017	0.94	1.44	0.58	0.76	1.02	1.09	
2018	0.94	1.57	0.60	0.76	1.05	1.16	
2019	0.95	1.26	0.55	0.71	1.09	1.09	

It can be seen from Table 3 that from the perspective of China's exports and German imports, the overall chemical trade complementarity between the two parties is not strong. Chapter 36 and 40 products' trade complementarity index are greater than 1, and their trade complementarity are strong, they are both products with medium competitiveness in China and Germany, indicating that is largely intra-industry trade. The complementarity index of Chapter 29 and 39 products are gradually increasing, indicating that the matching degree is gradually

strengthening. See Table 4,from the perspective of German exports and China's imports, the trade complementarity index of products in Chapter 29, 32, 34, 35, 37, 38, 39, and 40 are greater than 1, with a higher degree of product matching and trade closeness. Among them, the complementarity index of products in Chapter 37 is gradually increasing, and the complementarity of trade is constantly strengthening. The complementarity index of products in Chapters 38 and 39 are gradually decreasing, and the trade complementarity is weakening. It is mentioned that the complementarity of Chapter 30 products is growing at a relatively rapid rate. In summary, The products of China and Germany that are highly complementary are exactly the products that each have export competitiveness. It has also been found that Chapter 40 products are both competitive and complementary.

TABLE 4. COMPLEMENTARITY OF GERMANY-CHINA CHEMICAL TRADE

HS	**28**	**29**	**30**	**31**	**32**	**33**	**34**
2010	0.84	1.12	0.3	0.24	1.34	0.25	1.13
2011	0.72	1.13	0.42	0.21	1.16	0.27	1.13
2012	0.73	1.12	0.53	0.28	1.16	0.28	1.14
2013	0.69	1.18	0.58	0.24	1.14	0.27	1.16
2014	0.79	1.11	0.63	0.21	1.10	0.34	1.16
2015	0.75	0.96	0.7	0.11	1.09	0.44	1.19
2016	0.79	0.93	0.72	0.10	1.13	0.49	1.24
2017	0.78	1.03	0.83	0.08	1.09	0.57	1.25
2018	0.62	0.96	0.84	0.08	1.05	0.78	1.25
2019	0.74	0.94	0.87	0.11	1.10	0.98	1.18
HS	**35**	**36**	**37**	**38**	**39**	**40**	
2010	1.70	0.18	1.20	1.40	1.85	1.14	
2011	1.72	0.20	1.22	1.42	1.70	1.05	
2012	1.87	0.21	1.43	1.40	1.65	1.00	
2013	1.76	0.20	1.57	1.40	1.55	1.02	
2014	1.75	0.16	1.63	1.38	1.51	0.97	
2015	1.71	0.15	1.67	1.31	1.46	0.90	
2016	1.76	0.23	1.79	1.33	1.41	0.93	
2017	1.80	0.21	1.74	1.24	1.40	1.06	
2018	1.79	0.19	1.81	1.21	1.32	0.90	
2019	1.75	0.17	1.82	1.18	1.31	0.83	

4 CONCLUSIONS AND RECOMMENDATIONS

Based on the data of the International Trade Center (ITC), this paper uses the Revealed Comparative Advantage Index and Trade Complementarity Index to analyze the competitiveness and complementarity of chemical trade in China-Germany. The research finds: First, there are big differences in chemical products with comparative advantages of China-Germany. China's chemical products with strong trade competitiveness are mainly traditional

labor or capital-intensive products, such as explosives, inorganic chemicals, organic chemicals, fertilizers and rubber products. The vast majority of German chemical products have strong trade competitiveness, mainly concentrated in technology or capital-intensive products, such as pharmaceutical products, tanning or dyeing extracts, essential oils and resins, soap organic surfactants and plastic products.It is in line with the advantages of the resource endowments of the two countries. Second, from the perspective of Chinese exports and German imports, the two sides'trade complementarity is not strong enough, and the trade closeness is not enough. The products with strong complementarity are mainly explosives and rubber products; from the perspective of German exports and Chinese imports, the two sides'trade complementarity is strong, trade closeness is high, mainly organic chemicals, tanning or dyeing extracts, soap organic surfactants, albumin substances, photographic photosensitive materials, plastic products and rubber products. It is in line with the product characteristics of the two countries with competitive advantages in trade.

In order to promote the sustainable development of chemical trade between China and Germany, the following suggestions are put forward: First, China and Germany have different competitive advantages in chemical products, and there is no fierce trade competition. China should give full play to its own competitive advantages and actively explore international markets. Chinese and German companies should be encouraged to make full use of the dividends of bilateral trade policies, promote bilateral trade towards in-depth cooperation, actively promote the development of inter-industry trade and intra-industry trade, and realize the interconnection and mutual benefit .Second, China should increase technological innovation, develop towards fine and ecological chemical products, improve product technology content, meet the needs of the German market, and find new trade growth points, expand export varieties, and optimize export structure. While continuing to maintain its cooperative relationship with Germany, China should actively absorb the other party's advanced technology and scientific management experience, improve its own chemical industry level, and focus on industrial transformation and upgrading, and gradually realize the transition from importing to going out.

REFERENCES

[1] S.Xuan,H.Wang.Research on China-Germany Trade Competitiveness and Complementarity,Business Economics Research, vol 13,pp.155-158,2020.

[2] A.Tian ,An Empirical Study on the Intra-industry Trade of China and Germany Manufacturing,Foreign Economic Relations and Trade, vol 8,pp. 25-30,2015.

[3] J.Luo,X.Li,Analysis of the competitiveness and complementarity of China-Germany agricultural trade ,World Agriculture,vol10,pp.21-26,2013.

[4] D.Zhao,The export trade situation of China's apple juice to Germany,Beverage Industry, vol 7,pp.52-53,2012.

[5] B.BALASSA,Trade liberalization and revealed comparative advantag,.Manchester School of Economics and Social Studies,vol 2,pp.99-123,1965.

[6] J.Zhang,The current situation and potential evaluation of Sino-German bilateral trade ,World Geographical Research,vo l6,pp. 18-27,2016.

[7] X.Zhang,A Comparative Study of the Development Status and International Competitiveness of China-Germany Productive Service Trade,Monthly price,vol 11,pp.45-54,2018.

[8] J.Zhang,C.Feng,Grey Relational Analysis of Influencing Factors of Sino-German High-end Manufacturing Trade,International Business Studies.vol 40,pp.16-24,2019.
[9] J.Guo,Research on the Intra-industry Trade of Sino-German Mechanical and Electrical Products,Market Modernization,vol 3,pp.31-33,2017.
[10] Y.Xiao.Analysis on the Status Quo and Prospects of Sino-German Trade Cooperation,Foreign Economic and Trade Practices,vol 7,pp.33-35,2017.