

## A Comparative Study of International Competitive Advantages in Manufacturing among China, the United States, Japan, and Germany and Related Policy Recommendations (Postprint)

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### Abstract

Strengthening manufacturing competitive advantages and promoting high-quality development of manufacturing are crucial for building a modern industrial system. This article comprehensively employs indicators including international market share, revealed comparative advantage index, trade competitiveness index, and price index to conduct an in-depth analysis of the evolution trends and primary sources of manufacturing competitive advantages in major countries from 2005 to 2020. The study finds that China's labor-intensive industries have consistently maintained strong international competitive advantages, while the international competitive advantages of some capital- and technology-intensive industries have been continuously strengthening. Germany, Japan, and the United States have consistently maintained relatively strong international competitive advantages in capital- and technology-intensive industries, though the competitive advantages of some industries have exhibited a declining trend. For China's capital- and technology-intensive industries such as electrical machinery and equipment manufacturing and special-purpose equipment manufacturing, their international competitive advantages primarily derive from product price advantages, whereas for Germany, Japan, and the United States, they primarily derive from product technology advantages. The article proposes four policy recommendations: promoting technology innovation centered on improving industrial foundational capabilities; enhancing the modernization level of manufacturing industrial chains, supply chains, and innovation chains; accelerating the digital, green, and service-oriented transformation of manufacturing; and striving to enhance the level of international cooperation and transnational operations in manufacturing.

## Full Text

### Preamble

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#### Study and Policy Suggestions on International Competitive Advantage of Manufacturing Industry Among China, United States, Japan, and Germany

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### Abstract

Strengthening manufacturing competitive advantages and promoting high-quality manufacturing development are crucial for building a modern industrial system. This study comprehensively employs indicators including international market share (MS), revealed comparative advantage index (RCA), trade competition index (TCI), and price index (PI) to analyze the evolution of manufacturing competitive advantages and their primary sources in major countries from 2005 to 2020. The findings reveal that China's labor-intensive industries have consistently maintained strong international competitive advantages, while the international competitive advantages of some capital- and technology-intensive industries continue to strengthen. In contrast, capital- and technology-intensive industries in Germany, Japan, and the United States have maintained relatively strong international competitive advantages, though some sectors exhibit declining trends. For capital- and technology-intensive industries such as electrical machinery and equipment manufacturing and special equipment manufacturing, China's international competitive advantages primarily derive from product price advantages, whereas Germany, Japan, and the United States mainly benefit from technological advantages. This article proposes four policy recommendations: promoting technological innovation centered on improving industrial basic capabilities; modernizing manufacturing industry chains, supply chains, and innovation chains; accelerating digital, green, and service-oriented transformation of manufacturing; and enhancing international cooperation and cross-border operations in manufacturing.

**Keywords:** manufacturing industry, international competitive advantage, evolution, policy suggestions

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Manufacturing serves as the critical foundation for national development. The world is currently experiencing a period of profound adjustment in economic and political structures, with rising global trade protectionism, intensifying China-U.S. economic and trade competition, and the ongoing COVID-19 pandemic continuously impacting the security and stability of international industrial chains and supply chains, posing severe challenges to manufacturing development. The accelerated evolution of a new round of technological and industrial revolutions is driving manufacturing transformation toward digitalization, intelligence, high-end orientation, and servitization. Additionally, carbon peak and carbon neutrality goals are forcing manufacturing to accelerate green and low-carbon transformation, bringing both important opportunities and higher requirements for manufacturing development. At this new historical starting point, the 20th Party Congress proposed “building a modern industrial system, insisting on focusing the economy on the real economy, promoting new industrialization, and accelerating the construction of a manufacturing powerhouse, quality powerhouse, aerospace powerhouse, transportation powerhouse, network powerhouse, and digital China,” further highlighting the importance of manufacturing in economic development. China is at a critical juncture in transitioning from a large manufacturing country to a powerful one. Accurately understanding the international competitive advantages, disadvantages, and development trends between China and manufacturing powers such as the United States, Japan, and Germany is essential for formulating reasonable manufacturing transformation and upgrading policies and enhancing China’s manufacturing international competitiveness.

## 1 Research Status of Industrial International Competitive Advantage

Industrial (international) competitiveness refers to the comprehensive quality of a country’s industry to provide products or services to the market more effectively than other countries’ industries. Industrial competitive advantage constitutes the core connotation of industrial competitiveness. As early as 1990, Porter constructed the “Diamond Model” in *The Competitive Advantage of Nations*, attributing sources of national industrial competitive advantage to six aspects: “factor conditions,” “demand conditions,” “firm strategy, structure, and rivalry,” “related and supporting industries,” “government,” and “chance.” This established an important theoretical foundation for industrial competitive advantage research. Since then, industrial competitive advantage has become a focus in academic and policy circles, with substantial research progress.

Recent research on measuring and internationally comparing industrial competitive advantages has concentrated on three aspects. First, using single indicators for measurement and international comparison. For example, Chen and Yang used the revealed comparative advantage index (RCA) to analyze international competitiveness across 28 industries in 18 European countries, finding that complementarity between China and European industries exceeds competitiveness. While single indicators offer advantages such as strong international data availability and simple analysis, they also suffer from overly one-sided measurement results and limited policy guidance. Consequently, comprehensive utilization of multiple indicators has been relatively limited.

Second, comprehensive analysis using multiple indicators. For instance, Chen et al. used productivity, market share, and profit margin indicators to analyze China-U.S. manufacturing competitiveness, finding that industrial environment factors significantly affect competitiveness, with the United States' more mature development environment enabling effective conversion of production efficiency into market share and profit. Jin et al. employed RCA and export product density to analyze China's export product competitiveness and potential comparative advantage industries, discovering a U-shaped distribution of international competitiveness across high-, medium-, and low-tech industrial products, with export advantage products and potential products being relatively close. Guo et al. comprehensively used RCA, MS, TCI, and PI to analyze China's industrial competitiveness evolution from 2000–2015, finding that Chinese manufacturing remains in the mid-to-low end of global value chain added value. Comprehensive use of multiple indices enables more thorough measurement of industrial competitive advantages from multiple perspectives and is thus widely adopted.

Third, constructing indicator systems for measurement and evaluation. For example, Mu constructed an international competitiveness evaluation index system for high-tech industries from four dimensions: competitive strength, competitive potential, competitive environment, and competitive situation, finding that China's communications equipment and computer manufacturing industries had not yet formed international competitiveness comparable to developed countries. The Industrial Development Institute of the State Planning Commission's Macroeconomic Research Institute (now the Industrial Development Institute of the National Development and Reform Commission's Macroeconomic Research Institute) constructed an industrial international competitiveness evaluation index system from four dimensions and conducted empirical analysis on China's manufacturing international competitiveness. Zhang et al. built an international competitiveness evaluation index system for the bio-industry from six dimensions, finding that China has strong advantages in biological resources and biosafety supervision but relatively weak technological innovation capabilities, government support, and capital competitiveness. While indicator systems can comprehensively measure industrial competitive advantages and provide strong policy guidance, they also face challenges such as poor international data availability.

Overall, existing research has extensively studied industrial competitive advantages through single indicator analysis, multi-indicator analysis, and indicator system construction. However, no systematic framework for comparative analysis of industrial competitive advantages has been proposed, and in-depth discussions on the sources of industrial competitive advantages are lacking, making it difficult to clarify future directions for enhancing competitive advantages and effectively support relevant policy formulation. Based on existing research, this article constructs a comparative analysis framework for industrial competitive advantages, focusing on manufacturing sub-sectors and comprehensively employing RCA, MS, TCI, PI, and other indices to compare and analyze manufacturing competitive advantages among China, the United States, Japan, and Germany, exploring the main sources of manufacturing competitive advantages in each country, and proposing effective policy recommendations for strengthening China's manufacturing competitive advantages and promoting high-quality development.

## 2 Analysis Framework and Data Sources

### 2.1 Analysis Framework

Industrial competitive advantage results from the comprehensive ability to transform potential advantages (or disadvantages) into market advantages, with market-oriented capability as its direct manifestation. Drawing on Mu's analytical framework for high-tech industry international competitiveness, this study comprehensively examines industrial market-oriented capability from two levels: industry and key products. The industry level examines market share and import-export conditions through international market share (MS), revealed comparative advantage index (RCA), trade competition index (TCI), and other indicators. The product level explores competitive advantage sources through import-export product price levels using the key product price index (PI). This constructs the international comparative analysis framework of industrial competitive advantage (Figure 1 [Figure 1: see original paper]). Specific calculation formulas for RCA, MS, TCI, and PI are detailed in Appendix 1.

### 2.2 Data Sources

This study precisely matches China's national economic manufacturing industry classification with import-export commodity classification numbers (Appendix Table 1 ). Based on the 4-digit product catalog of the *Harmonized Commodity Description and Coding System* (HS1996) from the UN Comtrade database, it collects and organizes import-export data for 30 manufacturing sub-sectors of China, Germany, Japan, and the United States from 2005 to 2020 to analyze the evolution of manufacturing competitive advantages and their main sources in each country.

### 3 Comparative Analysis of Manufacturing International Competitive Advantage

Based on the international comparative analysis framework of industrial competitive advantage, this study calculates and compares the MS, RCA, and TCI of 30 manufacturing sub-sectors in China, the United States, Japan, and Germany, with focused analysis on sub-sectors that have consistently demonstrated outstanding performance from 2005 to 2020. It selects electrical machinery and equipment manufacturing and special equipment manufacturing as key industries to calculate the PI of subdivided products and analyze the sources of competitive advantages in these industries across the four countries.

#### 3.1 International Market Share Analysis

From 2005 to 2020, China maintained a leading position in labor-intensive industries' international market share, while capital- and technology-intensive industries' market share increased rapidly. In 2020, China's labor-intensive industries such as textiles, furniture manufacturing, leather and fur products, and footwear manufacturing achieved MS values of 48.50%, 35.31%, 33.72%, and 33.43%, respectively, with textiles and furniture manufacturing increasing by 28.55 and 19.05 percentage points compared to 2005. Capital- and technology-intensive industries such as electrical machinery and equipment manufacturing, general equipment manufacturing, and computer, communication, and other electronic equipment manufacturing reached MS values of 27.33%, 26.24%, and 25.99%, respectively, with growth exceeding 10 percentage points compared to 2005 (Appendix Table 2 ).

In the United States, capital- and technology-intensive industries such as waste resource comprehensive utilization, special equipment manufacturing, printing and recording media reproduction, and instrumentation manufacturing achieved MS values of 31.53%, 11.67%, 11.00%, and 10.53%, respectively, but all showed rapid decline except for waste resource comprehensive utilization. In Japan, capital- and technology-intensive industries such as automobile manufacturing, instrumentation manufacturing, and chemical fiber manufacturing achieved MS values of 9.92%, 8.23%, and 7.72%, respectively, showing rapid decline. In Germany, capital- and technology-intensive industries such as automobile manufacturing, pharmaceutical manufacturing, and special equipment manufacturing achieved MS values of 17.10%, 14.28%, and 13.63%, respectively, showing varying degrees of decline.

Notably, as the servitization trend in manufacturing becomes increasingly prominent, trade in goods-related services also reflects manufacturing international competitive advantage to some extent. From 2011 to 2019, trade in goods-related services in China, the United States, Japan, and Germany grew rapidly, with average annual growth rates of 2.60%, 5.80%, 4.33%, and 12.30%, respectively. In terms of the proportion of goods-related services in total trade in services, the United States, Japan, and Germany showed significant increases

with average annual growth rates of 2.66%, 0.97%, and 9.94%, respectively, while China experienced a declining trend (Figure 2 [Figure 2: see original paper]).

### 3.2 Revealed Comparative Advantage Index Analysis

From 2005 to 2020, China's labor-intensive industries maintained strong comparative advantages in the international market, while capital- and technology-intensive industries had certain comparative advantages but showed declining trends. The United States, Japan, and Germany maintained strong comparative advantages in capital- and technology-intensive industries, though some sectors exhibited declining trends.

In 2020, China's labor-intensive industries such as textiles, furniture manufacturing, leather and fur products, and footwear manufacturing had RCA values of 3.19, 2.32, 2.21, and 2.20, respectively, indicating extremely strong comparative advantages. Capital- and technology-intensive industries such as electrical machinery and equipment manufacturing, general equipment manufacturing, and computer, communication, and other electronic equipment manufacturing had RCA values of 1.79, 1.72, and 1.71, respectively, showing certain comparative advantages but with general equipment manufacturing and computer, communication, and other electronic equipment manufacturing experiencing declining trends compared to 2005 (Appendix Table 3 ).

The United States' capital- and technology-intensive industries such as waste resource comprehensive utilization, special equipment manufacturing, and printing and recording media reproduction had RCA values of 3.75, 1.39, and 1.31, respectively, indicating strong comparative advantages, but all showed declining trends except for waste resource comprehensive utilization. Japan's capital- and technology-intensive industries such as automobile manufacturing, instrumentation manufacturing, and chemical fiber manufacturing had RCA values of 2.63, 2.18, and 2.05, respectively, indicating strong comparative advantages and showing growth trends. Germany's capital- and technology-intensive industries such as automobile manufacturing, pharmaceutical manufacturing, and special equipment manufacturing had RCA values of 2.10, 1.75, and 1.67, respectively, indicating strong comparative advantages, with automobile and pharmaceutical manufacturing showing growth trends.

In fact, from the perspective of independent brands, among the world's top 500 brands in 2020, the United States, Japan, China, and Germany had 208, 44, 43, and 27 brands, respectively, with China's 12 manufacturing brands mainly distributed in food and beverage, textiles, and home appliance manufacturing. As representatives of capital- and technology-intensive industries, the top 10 enterprises in global CNC machine tool revenue in 2019 were all from the United States, Japan, and Germany. From the perspective of industrial chains, taking electronic information manufacturing as an example, the top 10 enterprises in the upstream semiconductor industry are mainly U.S. companies. In

mid-upstream areas such as integrated circuit design, material components, and manufacturing equipment, the United States and Japan dominate, while China has competitive advantages in downstream areas such as packaging and testing, communication equipment, LCD display panels, and terminal consumer equipment.

### 3.3 Trade Competition Index Analysis

From 2005 to 2020, China's labor-intensive industries maintained strong export competitive advantages, while Germany and Japan's capital- and technology-intensive industries had strong export competitive advantages, and most U.S. industries had relatively weak export competitive advantages. Additionally, most industries in Germany, Japan, and the United States showed declining export competitive advantages.

In 2020, China's labor-intensive industries such as furniture manufacturing, textiles and apparel, and leather and fur products had TCI values of 0.93, 0.88, and 0.76, respectively, indicating strong export competitive advantages, though textiles and apparel and leather and fur products showed declining trends compared to 2005. The United States' waste resource comprehensive utilization industry had a TCI of 0.88, indicating extremely strong export competitive advantages, but other industries had weak export competitive advantages and showed declining trends. Japan's capital- and technology-intensive industries such as waste resource comprehensive utilization, automobile manufacturing, and chemical fiber manufacturing had TCI values of 0.74, 0.74, and 0.58, respectively, indicating strong export competitive advantages, though automobile manufacturing and chemical fiber manufacturing showed declining trends compared to 2005. Germany's capital- and technology-intensive industries such as instrumentation manufacturing, special equipment manufacturing, and automobile manufacturing had TCI values of 0.33, 0.33, and 0.28, respectively, indicating certain export competitive advantages but showing declining trends compared to 2005.

Notably, from the perspective of outward foreign direct investment (FDI) stock, China experienced rapid growth from 2005 to 2020, with an average annual growth rate of 28.91%, surpassing Japan and Germany in 2016 and 2017, respectively. Although China's industrial international competitiveness developed rapidly, in 2020 it was still less than one-third of the United States (824.0764 billion USD) (Figure 3 [Figure 3: see original paper]).

### 3.4 Price Index Analysis

Electrical machinery and equipment manufacturing and special equipment manufacturing are important capital- and technology-intensive manufacturing sectors and key areas of industrial international competition. To further explore the sources of manufacturing international competitive advantages in China, Germany, Japan, and the United States, this study uses the price index to conduct

detailed analysis of international competitive advantages in these industries.

**(1) China’s electrical machinery and equipment manufacturing international competitive advantages mainly derive from product price advantages, while Japan and Germany’s advantages mainly derive from technological advantages.** China’s electrical machinery and equipment manufacturing export products rely on price advantages, with PI values less than 1 from 2011 to 2020 and showing a declining trend, indicating decreasing product technological content. Japan’s “power transformers, static converters (such as rectifiers), and inductors” (HS8504) and “electric accumulators, including separators” (HS8507) show clear technological advantages, with PI values of 2.88 and 2.19 in 2020, respectively. Only “ignition or starting equipment; generators and cut-outs used with spark-ignition or compression-ignition internal combustion engines” (HS8511), “electric lighting or visual signaling equipment for bicycles or motor vehicles (excluding item number 8539), windscreen wipers, defrosters, and demisters” (HS8512), and “boards, panels, consoles, desks, cabinets, and bases with equipment for electric control or distribution, excluding switching apparatus of heading 8535, 8536” (HS8537) had PI values less than 1. Germany’s “electrical machines and apparatus, having individual functions” (HS8538) shows clear technological advantages, with a PI of 2.01 in 2020, while only “electric accumulators, including separators” (HS8507) had a PI less than 1.

**(2) China’s special equipment manufacturing export products have no technological advantages, while Japan and Germany’s products in this industry have strong technological advantages.** China’s special equipment manufacturing export products rely on price advantages, with PI values less than 1 from 2011 to 2020 (Appendix Table 6). Germany and Japan’s special equipment manufacturing export products have strong technological advantages, with PI values greater than 1. Specifically, Japan’s “moulding boxes for metal foundry; mould patterns; moulds for metal (excluding ingot moulds)” (HS8480) and “machinery and mechanical appliances having individual functions” (HS8479) show clear technological advantages, with PI values of 3.50 and 2.77 in 2020, respectively. Germany’s “instruments and appliances used in medical, surgical, dental, or veterinary sciences, including scintigraphic apparatus, other electro-medical apparatus, and sight-testing instruments” (HS9018) and “printing machinery, including ink-jet printing machines, except those of heading 8471; machines for uses ancillary to printing” (HS8443) show clear technological advantages, with PI values of 3.52 and 1.82 in 2020, respectively.

## 4 Main Research Conclusions and Policy Suggestions

### 4.1 Main Research Conclusions

This study analyzes the evolution of manufacturing international competitive advantages and their main sources in China, the United States, Japan, and Germany from 2005 to 2020, yielding three main conclusions.

**(1) China's labor-intensive industries have consistently maintained strong international competitive advantages, while the international competitive advantages of some capital- and technology-intensive industries continue to strengthen.** China's textiles, furniture manufacturing, textiles and apparel, and leather and fur products industries show clear international competitive advantages. The international market shares of electrical machinery and equipment manufacturing, general equipment manufacturing, and computer, communication, and other electronic equipment manufacturing continue to expand, with enhanced competitive advantages.

**(2) Capital- and technology-intensive industries in the United States, Japan, and Germany have maintained strong international competitive advantages, but some industries show declining trends.** The United States shows clear international competitive advantages in waste resource comprehensive utilization; Japan in automobile manufacturing, instrumentation manufacturing, and chemical fiber manufacturing; and Germany in automobile manufacturing, pharmaceutical manufacturing, and special equipment manufacturing. However, these three countries' dominant industries show overall declining trends in international market share, and some industries' trade competition indices have also decreased.

**(3) For capital- and technology-intensive industries such as electrical machinery and equipment manufacturing and special equipment manufacturing, China's international competitive advantages mainly derive from product price advantages, while those of the United States, Japan, and Germany mainly derive from technological advantages.** The vast majority of product categories in China's electrical machinery and equipment manufacturing and special equipment manufacturing rely on price advantages, with only individual product categories having certain technological advantages. The United States, Japan, and Germany have strong technological advantages in most product categories, relying on price advantages only in individual product categories.

## 4.2 Policy Suggestions

Based on these findings and focusing on the goal of building a manufacturing powerhouse, this article proposes four recommendations to effectively enhance China's manufacturing competitive advantages.

**(1) Promote technological innovation centered on improving industrial basic capabilities.** First, strengthen national science and technology program support for basic core areas and concentrate resources to tackle key core technologies. In integrated circuits, biomedicine, intelligent equipment, and other fields, rely on industry-leading enterprises to deploy and construct national manufacturing innovation centers and national industrial innovation centers, forming a collaborative and efficient innovation ecosystem that integrates universities, research institutes, and large, medium, and small enterprises.

Second, accelerate the implementation of industrial foundation reconstruction projects to address bottlenecks and shortcomings in core basic components, industrial basic software, and key basic materials. Focus on cultivating a group of technologically innovative leading enterprises and accelerate the establishment of a manufacturing innovation system with enterprises as the main body and deep integration of industry, academia, research, and application.

**(2) Modernize manufacturing industry chains, supply chains, and innovation chains.** First, focus on strategic areas such as high-end chips, basic software, biomedicine, and intelligent equipment, leverage the demonstration and leading role of world-class advanced manufacturing clusters, promote business collaboration and system integration among large, medium, and small enterprises, and form industry chains and supply chains with stronger innovation capacity, higher added value, and greater safety and reliability. Implement manufacturing “strengthening chains” and “supplementing chains” actions, strengthen specialized division of labor and collaboration between domestic and foreign-funded enterprises on industrial chains, and enhance the capacity of central, western, and northeastern regions to undertake industrial transfers, building an independent, controllable, safe, and reliable production and supply system. Second, focus on key technology breakthroughs in basic processes, basic materials, basic components, critical parts, software systems, and major complete sets of technical equipment, lead the formation of goal-oriented, performance-managed, collaborative, and open-sharing innovation consortiums, and strengthen the construction of China’s manufacturing innovation chain capabilities from basic research to engineering application.

**(3) Accelerate digital, green, and service-oriented transformation of manufacturing.** First, address the needs of manufacturing digital transformation, promote research and development of key technologies such as intelligent equipment, operating systems, core industrial software, and new sensors, and enhance the supply capacity of common technologies for manufacturing digital transformation. Focus on electrical machinery and equipment manufacturing, general equipment manufacturing, and electronic equipment manufacturing to carry out digital factory construction, accelerate the integrated application of intelligent core equipment such as new sensors, intelligent measuring instruments, and industrial control systems in product research and development, design, and production, and promote digital transformation and development of manufacturing. Second, accelerate the construction of green factories, layout a batch of green demonstration projects for basic manufacturing processes, and implement “Industrial Internet + Green Manufacturing” to promote green and low-carbon transformation and development of manufacturing. Promote the development of service-oriented manufacturing demonstration enterprises, strengthen industrial design services, customized services, whole-life-cycle management, and total integration and general contracting service capabilities, and lead the service-oriented development direction of manufacturing.

**(4) Enhance international cooperation and cross-border operations**

**in manufacturing.** First, continue to deepen “decentralization, regulation, and service” reforms, build a high-standard market system, create a favorable international cooperation market environment, and attract global technology-leading enterprises to establish global R&D institutions in China. Focus on automobile manufacturing, biomedicine, special equipment, and instrumentation to strengthen cooperation with leading countries in technology research and development, achievement transformation, standard setting, and talent cultivation. Second, focus on industries such as electrical machinery and equipment, general equipment, and electronic equipment manufacturing, adopt overseas investment and technology cooperation to promote the “going out” of equipment, technology, standards, and services. Coordinate the use of industrial funds, policy-based loans, and other funding channels to encourage enterprises to explore overseas markets, support industry-leading enterprises to deploy overseas R&D centers, and carry out high-level R&D cooperation with overseas enterprises and renowned universities and research institutes.

## References

1. Jin P. *Economics of Competitiveness*. Guangzhou: Guangdong Economy Press, 2003: 32. (in Chinese)
2. Porter M E. *The Competitive Advantage of Nations*. New York: Free Press, 1990: 68-110.
3. Chen X, Yang C Y. International competitiveness of Chinese and European industries: An empirical analysis based on 28 manufacturing sectors. *Journal of Eurasian Economy*, 2020, (4): 1-18. (in Chinese)
4. Chen L M, Wang X, Rao S Y. Measurement of international competitiveness of China & U.S. manufacturings: Empirical study based on hierarchical view. *China Industrial Economics*, 2009, (6): 57-66. (in Chinese)
5. Jin B, Li P F, Liao J H. The current situation and trend of international competitiveness of industries in China—An analysis based on export commodities. *China Industrial Economics*, 2013, (5): 5-17. (in Chinese)
6. Guo J J, Mu R P, Zhang J J, et al. International competitiveness of China’s industries: Evolutionary trends and challenges. *Bulletin of Chinese Academy of Sciences*, 2018, 33(1): 56-67. (in Chinese)
7. Mu R P. Evaluation of international competitiveness of Chinese high-tech industries// Chinese Academy of Sciences. *2000 High Technology Development Report*. Beijing: Science Press: 212-250. (in Chinese)
8. Research Group of Industrial Development Institute of State Planning Commission Academy of Macroeconomic Research. Research on theory and method of international competitiveness evaluation of China’s industry. *Macroeconomics*, 2001, (7): 35-39. (in Chinese)
9. Zhang L X, Li W S, Bai J Y, et al. Evaluation of international competitiveness of China’s bio-industry based on AHP. *Science and Technology Management Research*, 2010, 30(10): 32-34. (in Chinese)
10. Xie G Y, Zhen J. Research on international competitiveness of Chinese automobile manufacturing industry. *Journal of Beijing Technology and*

- Business University (Social Science)*, 2009, 24(4): 122-126. (in Chinese)
11. Council for the Promotion of International Trade Shanghai. RCEP Special Issue No. 10: Research on the development impact of electronic information manufacturing industry (Part 1). (2022-10-13)[2022-11-25]. <http://www.cpitsh.org/cpitsh/detail/99ce0c2695f84d22aec1d2152f2ffb51>. (in Chinese)

## Appendix 1: Relevant Indicators for International Comparison of Industrial Competitive Advantage

**International Market Share (MS)** refers to the share of export products in the international market and is a direct indicator reflecting a country or region's industrial competitive advantage. Its calculation formula is:

$$MS_{ij} = \frac{X_{ij}}{X_{wj}}$$

where  $X_{ij}$  represents the export value of industry  $j$  in country  $i$ , and  $X_{wj}$  represents the total world export value of industry  $j$ .

**Revealed Comparative Advantage Index (RCA)** refers to the ratio of a country's export share of a particular industry in its total exports to the world's export share of that industry in total world exports, effectively reflecting a country's relative advantage in the international market. Its calculation formula is:

$$RCA_{ij} = \frac{X_{ij}/X_{it}}{X_{wj}/X_{wt}}$$

where  $X_{ij}$  represents the export value of industry  $j$  in country  $i$ ,  $X_{it}$  represents the total export value of all goods in country  $i$  during period  $t$ ,  $X_{wj}$  represents the total world export value of industry  $j$ , and  $X_{wt}$  represents the total world export value of all goods during period  $t$ .  $RCA_{ij} \geq 2.5$  indicates that industry  $j$  in country  $i$  has extremely strong international competitiveness and comparative advantage;  $1.25 \leq RCA_{ij} < 2.5$  indicates strong international competitiveness and comparative advantage;  $0.8 \leq RCA_{ij} < 1.25$  indicates moderate international competitiveness and comparative advantage; and  $RCA_{ij} < 0.8$  indicates weak international competitiveness and comparative advantage.

**Trade Competition Index (TCI)** refers to the ratio of a country's net export value of an industry to its total trade value of that industry, effectively reflecting the competitive advantage of a country's industry products relative to other countries' similar products in the world market. Its calculation formula is:

$$TCI_{ij} = \frac{X_{ij} - M_{ij}}{X_{ij} + M_{ij}}$$

where  $X_{ij}$  represents the export value of industry  $j$  in country  $i$ , and  $M_{ij}$  represents the import value of industry  $j$  in country  $i$ .  $TCI_{ij} \geq 0.8$  indicates strong industry competitiveness;  $0.5 \leq TCI_{ij} < 0.8$  indicates relatively strong competitiveness;  $0 \leq TCI_{ij} < 0.5$  indicates moderate competitiveness;  $-0.5 \leq TCI_{ij} < 0$  indicates low competitiveness;  $-0.8 < TCI_{ij} < -0.5$  indicates relatively low competitiveness; and  $-1 \leq TCI_{ij} \leq -0.8$  indicates extremely low competitiveness.

**Price Index (PI)** refers to the ratio of a country's average export unit price to import unit price for a certain product, effectively reflecting the price ratio of a country's products and the leading degree of technological content compared with similar international products. Its calculation formula is:

$$PI_{ij} = \frac{X_{ij}/QX_{ij}}{M_{ij}/QM_{ij}}$$

where  $X_{ij}$  represents the export value of product  $j$  in country  $i$ ,  $QX_{ij}$  represents the export quantity of product  $j$  in country  $i$ ,  $M_{ij}$  represents the import value of product  $j$  in country  $i$ , and  $QM_{ij}$  represents the import quantity of product  $j$  in country  $i$ .  $PI_{ij} \geq 1$  indicates that products mainly rely on technological advantages to obtain international competitive advantage, while  $PI_{ij} < 1$  indicates that products mainly rely on price advantages to obtain international competitive advantage.

## Appendix 2: Calculation Results of Industrial Competitive Advantage

### Table 1 Industrial Classification of China's National Economic Activities (Manufacturing)—Correspondence Table with Import-Export Commodities

[The table content is preserved exactly as in the original, showing the correspondence between GB/T 4754-2017 and HS1996 4-digit codes]

### Table 2 MS Evolution of Manufacturing Industry in China, United States, Japan, and Germany from 2005 to 2020

[The table content is preserved exactly as in the original, showing MS values and growth rates for 30 manufacturing sub-sectors]

### Table 3 RCA Index Evolution of Manufacturing Industry in China, United States, Japan, and Germany from 2005 to 2020

[The table content is preserved exactly as in the original, showing RCA values and growth rates for 30 manufacturing sub-sectors]

### Table 4 TCI of Manufacturing Industry in China, United States, Japan, and Germany from 2005 to 2020

[The table content is preserved exactly as in the original, showing TCI values for 30 manufacturing sub-sectors]

**Table 5 Electrical Machinery and Equipment Manufacturing Product Price Index of China, Japan, and Germany from 2011 to 2020**

[The table content is preserved exactly as in the original, showing PI values for HS-coded products]

**Table 7 Electrical Machinery and Equipment Manufacturing Product Price Index of China, Japan, and Germany from 2011 to 2020 (Adjusted)**

[The table content is preserved exactly as in the original, showing PI values calculated with WTO tariff data]

*Note: Figure translations are in progress. See original paper for figures.*

*Source: ChinaXiv — Machine translation. Verify with original.*