ISSN 2616-5902 Vol. 7, Issue 4: 209-216, DOI: 10.25236/AJBM.2025.070426

Research on the Trade Competitiveness of China's New Energy Vehicle Industry

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Abstract: *With the intensification of the global energy crisis and environmental issues, the new energy vehicle industry, as a strategic emerging industry, has received high attention from various countries. Although China's new energy vehicle industry started relatively late, it has rapidly developed due to its resource advantages and market potential. This article objectively evaluates the trade competitiveness of China's new energy vehicle industry by calculating and comparing the trade competitiveness index of China, the United States, Japan, and Germany's new energy vehicle industry. Research has found that there is a gap between China's new energy vehicle industry and developed countries in terms of core technology mastery, image building, infrastructure, standard system construction, and collaborative capabilities. This article aims to identify the competitive disadvantages of China's new energy vehicle industry in the international market, and propose corresponding countermeasures and suggestions to promote the high-quality development of the industry and enhance its international competitiveness.*

Keywords: *New energy vehicle industry; trade competitiveness; Competitiveness measurement*

1. Introduction

The Development Plan for the New Energy Vehicle Industry (2021-2035) states: “Strengthen international cooperation, actively participate in international competition, cultivate new advantages in the new energy vehicle industry, and deeply integrate into the global industrial chain and value chain system.” According to data from the China Association of Automobile Manufacturers, the sales of new energy vehicles in China have increased from 331000 units in 2015 to 9.495 million units in 2023, with a significant increase in market share and rapid development[0].But in the international market, the competition in the new energy vehicle industry is increasingly fierce. China's current task is to promote the high-quality development of new energy vehicles, enhance industrial trade competitiveness, and firmly establish itself in the international market.

Currently, the development of China's new energy vehicles in the international market is showing strong growth momentum, with good performance in market size and demand, cost and price, and industry chain integrity[0]. However, due to the complexity of the automotive market itself, China's new energy vehicle industry faces challenges in the development process of the international market. Firstly, trade protectionism and tariff barriers have led some countries and regions to impose tariffs or implement trade restrictions on China's new energy vehicles; Secondly, in overseas markets, the influence of Chinese brands is weak, and there is still room for improvement in international market share; Furthermore, although China's production and sales of new energy vehicles rank first in the world, the number of patent applications ranks third in the world, and the development of markets such as Africa and South America is still insufficient; Finally, the Chinese new energy vehicle industry still has difficulties adapting to different technical standards and regulatory requirements in overseas markets.

Based on the shortcomings of China's new energy vehicle industry in the international market, this article first measures the trade competitiveness of China's new energy vehicle industry, compares its competitiveness index with the well-developed countries of the United States, Japan, and Germany, obtains data, analyzes the problems of China's new energy vehicle industry in the international market, and proposes solutions.

An important part of the existing research on new energy vehicles is the analysis and evaluation of relevant policies for new energy vehicles: Easwaran Narassimhan（2024）[0]Analyze how the governments of China, Germany, Japan, South Korea, and the United States adjust their industrial

ISSN 2616-5902 Vol. 7, Issue 4: 209-216, DOI: 10.25236/AJBM.2025.070426

policies, and point out that policy adjustments in industries will affect their development speed. However, the article does not specifically compare the industrial competitiveness of new energy vehicles in different countries, so it cannot further explain the degree of impact of policies on the new energy vehicle industry. Na Zhou （2020）[0]Detailed analysis of every policy since the development of China's new energy vehicle industry, pointing out that technology is the core of China's new energy vehicle industry. But the article only analyzes the domestic situation and does not explore the role of China's new energy vehicle industry policies in international trade; Some studies analyze the export targets of China's new energy vehicle industry to explore its competitiveness in the international market: Hu X（2020）[0]analyzes the trend of China's export of new energy vehicles to countries along the "the Belt and Road", and points out that China's export is growing and the two sides still have great trade potential to tap. However, the research object of this article is the "the Belt and Road" countries, which cannot fully reflect the current situation of China's trade in the international market. Xu Pei（2024）[0]used complex network theory to deeply compare the changes in competitive relationships between core exporting countries. However, as the essence of competition is a technological game between core countries, the paper does not cover all the influencing factors of China's new energy vehicle industry trade. Some literature has analyzed the competitiveness of China's new energy vehicle trade and concluded its current competitive status in the international market: Song Yongcheng（2024）[0]reflected China's shortcomings in core technology by analyzing the trade competitiveness of lithium-ion batteries, an important component of new energy vehicles. However, this literature considers lithium-ion batteries as the main influencing factor and does not provide a comprehensive summary of other influencing factors in China's industry. White Rose（2020）[0]focuses on comparing the competitiveness of new energy vehicle trade between China and the United States, conducting detailed analysis from a more comprehensive perspective and drawing conclusions, but does not conduct index calculation and comparison. Gao Yunsheng（2021）[0]measured the trade competitiveness of China's new energy vehicle industry and analyzed it using the diamond model. But the relevant data is only updated up to 2020, and the latest data is not included. The article summarizes the above literature and selects data from China, the United States, Japan, and Germany from 2017 to 2023 to calculate the trade competitiveness index. From an industry perspective, it provides a more detailed analysis of the competitiveness of China's new energy vehicle industry in the international market.

2. Measurement of Trade Competitiveness of China's New Energy Vehicle Industry

To study the trade competitiveness of China's new energy vehicle industry in the international market, the MS index, TC index, and RCA index were calculated separately to analyze the competitiveness of China's new energy vehicle industry in the international market, and to identify the advantages and disadvantages of China's new energy vehicle industry in the international market.

2.1. Current Status of Trade Development in China's New Energy Vehicle Industry

To unify the criteria, export data of pure electric vehicles and plug-in hybrid electric vehicles are selected as the export data for new energy vehicles in foreign trade. The Chinese customs system has been coding and classifying new energy vehicles since 2017, and currently available trade data has been available since 2017[0].

Table 1 Import and export volume of new energy vehicles in China (in billions of US dollars).

year	Export value	import value	total trade value	trade balance
2017	2.99	19.09	22.08	-16.10
2018	4.95	16.64	21.59	-11.69
2019	13.22	34.99	48.21	-21.77
2020	31.74	19.18	50.92	12.56
2021	106.76	29.11	135.87	77.65
2022	237.31	35.60	272.91	201.71
2023	401.34	39.89	441.23	361.45

According to Table1, from 2017 to 2019, due to the immature development of China's new energy vehicle industry and insufficient research and development technology, China continued to import a large amount, resulting in a negative trade balance; The economic changes after the epidemic have brought about changes in many industries, and new energy vehicles have developed rapidly in this stage: in 2020, China's new energy vehicle exports increased, while imports decreased, and rapidly developed in the following years. In 2023, China's new energy exports reached 40.134 billion US

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dollars. From 2020 to 2023, China's new energy vehicle trade balance will be positive, and the total trade volume will grow rapidly. Overall, China's new energy vehicles have developed rapidly from 2017 to 2023, and the current state of trade development is good.

2.2. Competitiveness Calculation - Selecting China, the United States, Japan, and Germany for Comparison

The new energy vehicle industry in the United States has developed earlier and its technology research and development is relatively more mature; Japan has been laying out in the field of new energy vehicles for a long time due to the lack of traditional energy sources; Germany's exports of new energy vehicles rank first in the world. Therefore, this article calculates the trade competitiveness index of China, the United States, Japan, and Germany respectively, and compares and analyzes the competitiveness of the four countries in this industry.

2.2.1. International market share

International market share (MS) refers to the proportion of a country's total export trade of a certain industry to the world's total export trade of that industry.

Table 2 MS Index of China, the United States, Japan, and Germany from 2017 to 2023.

year	China	United States	Japan	Germany
2017	0.01	0.11	0.06	0.13
2018	0.01	0.08	0.06	0.12
2019	0.02	0.11	0.04	0.11
2020	0.03	0.08	0.02	0.14
2021	0.06	0.05	0.02	0.15
2022	0.10	0.05	0.03	0.17
2023	0.21	0.07	0.08	0.30

As shown in the table 2, from 2017 to 2019, China's MS index was the lowest. At this time, China was in the exploration stage of new energy vehicle industry policies, technologies, etc., and the industry chain still needed to be improved. The other three countries developed the industry earlier than China and had a significant advantage in the international market share. From 2020 to 2023, China has successively surpassed the United States and Japan to come in second place, indicating that China's new energy vehicles are becoming increasingly important in the international arena, with advantages in technological innovation, industrial upgrading, cost, and strong policy support. But Germany's international market share still leads, and China still has a certain distance to go.

2.2.2. Trade Competitiveness TC Index

The Trade Competitiveness TC Index refers to the proportion of a country's import and export trade balance of a certain industry to the total import and export trade of that industry.

Table 3 TC Index of China, the United States, Japan, and Germany from 2017 to 2023.

year	China	United States	Japan	Germany
2017	-0.73	0.25	0.80	0.65
2018	-0.54	0.21	0.82	0.66
2019	-0.45	0.37	0.83	0.41
2020	0.25	0.38	0.55	0.22
2021	0.57	0.05	0.54	0.23
2022	0.74	-0.13	0.66	0.31
2023	0.82	-0.34	0.72	0.40

According to Table 3, the TC index of China's new energy vehicle industry shows a growing trend from 2017 to 2023. But from 2017 to 2019, China's TC index was negative, while the United States, Japan, and Germany were at a normal level. Among them, Japan's TC index reached 0.8 in 2017, indicating greater competitiveness. From 2019 to 2020, the United States and Germany were affected by the COVID-19, which led to the export of commodities being blocked to a certain extent and the decline of trade competitiveness. From 2020 to 2023, the TC index of China's new energy vehicle industry will be greater than 0, and its trade competitiveness will improve. By 2022-2023, China's new energy vehicles will show strong export competitiveness, surpassing Germany, which has been leading before. It can be seen that due to the strengthening of technology, increased research and development efforts, large market size and demand, and increased opportunities for international cooperation, China's position in the international market is more stable.

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2.2.3. Display comparative advantage RCA index

The Revealed Comparative Advantage (RCA) index refers to the ratio of a country's export value of a certain industry to its total export value, and the share of the world's export value of a certain industry to the global total export value.

Table 4 RCA Index of China, the United States, Japan, and Germany from 2017 to 2023.

year	China	United States	Japan	Germany
2017	0.06	1.19	1.41	1.57
2018	0.07	0.97	1.53	1.42
2019	0.12	1.24	0.97	1.33
2020	0.17	0.96	0.66	1.78
2021	0.36	0.65	0.69	1.99
2022	0.64	0.55	0.81	2.29
2023	0.81	0.43	1.42	2.30

According to Table 4, before 2022, the RCA index of China's new energy vehicle industry is significantly lower than the other three countries and all less than 0.8, indicating that China's international competitiveness in this field is relatively weak. Mainly because before 2017, China's core technology was still insufficient and China needed time to establish brand trust and market recognition. In 2023, the RCA index of this industry in China surpassed that of the United States by a small margin, mainly due to the limited supply of car models in the United States, which has limited the diversified development of the market in recent years. Overall, the RCA index of China's new energy vehicle industry is relatively low, still lagging behind Germany and Japan, mainly due to insufficient technological innovation capabilities, insufficient international market development efforts, and insufficient brand influence.

By comparing the trade competitiveness of the four countries, Germany's industry is still at the forefront in the international market and has strong trade competitiveness; Japan's trade competitiveness is not very strong, but it has technological and market advantages; Although the trade competitiveness of the United States has shown a downward trend in recent years, the country itself holds a dominant position in the international market and has significant competitiveness; China's trade competitiveness index has improved and its exports have grown rapidly, but the RCA index is still relatively small and its export competitiveness is weak, which needs to be further strengthened.

3. Analysis of the Problems in Trade Competition of China's New Energy Vehicle Industry

With the expansion and opening up of the new energy vehicle market, international market competition is becoming increasingly fierce. The trade competitiveness of China's new energy vehicle industry has been increasing year by year, but it has also entered a new challenge period. There are shortcomings in some aspects, which have become key issues affecting the further improvement of the trade competitiveness of the new energy vehicle industry.

3.1. The ability of industrial technological innovation needs to be improved

The lack of technological innovation capability in China's new energy vehicles is mainly reflected in three aspects: range, battery technology, and degree of digital transformation.

3.1.1. Range needs to be increased

Table 5 Comparison of endurance capabilities among China, the United States, Japan, and Germany

Country	China	United States	Japan	Germany
Vehicle model	Dong Hai 001	Lucid Air	Hong Kong Company	muc002
Highest endurance mileage record	1032kilometer	830kilometer	1500kilometer	2573kilometer

As shown in the table 5, various countries are constantly improving their endurance capabilities, and consumers' expectations for endurance are also constantly increasing. China's new energy vehicles do not have an advantage in endurance capabilities, indicating that there is still significant room for improvement in endurance.

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3.1.2. Battery technology is slightly outdated

At present, the energy density of lithium-ion batteries for new energy vehicles in China is approaching its theoretical limit, and breakthrough technological innovation is needed to achieve higher energy densities. And the recycling and reuse system of new energy vehicle batteries in China has problems such as high battery recycling costs and immature recycling technologies, which limit the efficiency and effectiveness of battery recycling and reuse[0].

3.1.3. Low degree of digital transformation

The Chinese new energy vehicle industry lacks a global perspective, systematic planning, and digital talent in the process of digital transformation. Internal integration and collaboration are not in place, and in the process of global operation, new energy vehicle companies need to comply with laws, regulations, and industry standards in different countries and regions to ensure data security and compliance. This to some extent increases the difficulty of digitization, making it impossible to achieve global resource optimization and efficient collaboration.

3.2. Insufficient construction of industrial image

Chinese brand BYD has certain advantages in various aspects, to some extent leading other domestic enterprises, but there is still some gap between BYD and American brand Tesla.

Table 6 Comparison of Tesla and BYD's Industrial Images

Difference	tesla	BYD
Brand positioning	high-end brand image	low-end brand image
Profitability	stronger	Slightly weak
Factory industrial layout	Global layout	Mainly concentrated in China
Sales Strategy	Direct model	Traditional dealer channels
Product Strategy	The strategy of “large order products”	Car Sea Tactics

From Table 6, it can be seen that BYD has certain shortcomings compared to Tesla in terms of profitability, market layout, sales strategy, etc. It is inferred that Chinese new energy vehicle companies have overall shortcomings in the international market, with significant room for improvement in quality, foreign market layout, development process, technological innovation, and a relatively small number of patents and intellectual property rights[0]. The construction of industrial image needs to be improved.

3.3. The infrastructure required for industrial development is relatively lagging behind

Charging infrastructure is an important support for the development of the new energy vehicle industry. With the rapid growth of the new energy vehicle market, the demand for charging infrastructure is also constantly increasing. There are two shortcomings in the charging facilities of China's new energy vehicles in the international market: firstly, the global layout is unbalanced. Although the sales and market share of new energy vehicles in China continue to increase globally, the international layout of charging facilities is relatively lagging behind, especially in some countries and regions where the new energy vehicle market is just starting or developing slowly; Secondly, cross-border cooperation and construction are limited. Chinese new energy vehicle companies have relatively limited cooperation in the construction of charging facilities in the international market, lacking deep cooperation with local governments, power companies, and international charging facility operators, resulting in limited construction progress and coverage of charging facilities.

3.4. The industry standard system is incompatible with international standards

The differences in charging standards between countries have become a key factor limiting the convenience of charging new energy vehicles. At present, there are five main charging station standards internationally, namely: Chinese national standard GB/T, CCS1 American standard (combo/Type1), CCS2 European standard (combo/Type2), and Japanese standard CHAdeMO. Tesla also has its own independent set of charging interface standards. These standard charging gun sockets are listed in the table below.

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Table 7 National standards for charging gun sockets

	United States	Europe	China	Japan	Tesla
AC alternating current	J1772 (Type1)	Mennekes (Type2)	GB/T	J1772 (Type1)	all masks except EU
DC alternating current	CCS1	CCS2	GB/T	CHAdeMO	

According to Table 7, For the sales of new energy vehicles in the international market, it is necessary to consider the issue of inconsistent charging interfaces, which require specialized charging station equipment or the use of conversion joints. The conversion joints need to consider voltage and power, and the differences in charging facilities have a certain impact on foreign consumers' purchase of Chinese new energy vehicles.

3.5. Industrial synergy capability needs to be strengthened

3.5.1. Unbalanced collaborative division of labor among regions

The new energy vehicle industry cluster has already formed in some regions, such as the Yangtze River Delta, Pearl River Delta, Beijing Tianjin Hebei, etc. However, in some non-traditional automobile manufacturing hubs and inland cities, the development of the new energy vehicle industry is still in its infancy.

Table 8 Top 10 provinces and cities in China for exporting new energy vehicles

province	2020		2021		2022		2023		Overall ranking
	Export volume	ranking	Export volume	ranking	Export volume	ranking	Export volume	ranking	
Shanghai	24953	2	211278	1	415143	1	581083	1	1
Zhejiang	48466	1	98716	2	192354	2	249433	2	2
Hebei	23559	3	37172	4	34193	7	74447	4	3
Guangdong	2026	8	15112	7	76409	3	168840	3	4
Beijing	22201	4	34703	6	39755	6	58387	6	5
Tianjin	2616	7	35075	5	72294	5	62895	5	6
Jiangsu	17479	6	56580	3	75221	4	12448	10	7
Sichuan	17513	5	14743	8	24632	8	42664	7	8
Anhui	737	9	3285	9	16338	9	27872	9	9
Shanxi	157	10	908	10	2437	10	32497	8	10

According to Table 8, Shanghai and Zhejiang have occupied the top two export positions over the past four years, stabilizing in the first tier of new energy vehicle industry exports. Especially in Shanghai, there is a significant gap compared to other provinces, mainly due to its more complete industrial structure, more diversified export markets, and the establishment of research and development centers overseas, which can better meet the needs of the international market. Hebei and Guangdong have fluctuated in their rankings in the past four years, with Guangdong's export volume experiencing a sudden increase from 2022 to 2023, rising to the third place. This is mainly due to Guangdong's geographical advantage, which makes export trade more convenient and the construction of free trade zones more complete. However, Hebei is more inland and does not have much advantage in trade; In other regions, especially in the northeast and northwest, the industrial structure is not yet perfect, and it is still in the early stages of construction or has not yet formed large-scale production capacity, resulting in a regional distribution of new energy vehicle industry exports and uneven development.

3.5.2. Uneven division of labor in collaboration between government, industry, academia, and research

At present, the forms of cooperation between government, industry, academia, and research departments are still relatively single, lacking flexible and diverse collaborative mechanisms, and mostly relying on project cooperation. The degree of policy measures coordination is uneven, with differences between different departments and measures, resulting in the overall synergy effect not being fully utilized. In the development of the new energy vehicle industry, some departments or institutions dominate in decision-making and resource allocation, leading to excessive concentration of collaborative departments, limited decision-making perspectives, and insufficient resource integration.

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4. The Path to Enhancing the Trade Competitiveness of China's New Energy Vehicle Industry

The competitiveness of China's new energy vehicle industry in international trade is gradually improving, but its overall competitiveness in the global market still needs to be strengthened. Given the existing shortcomings, this article proposes the following strategies.

4.1. Intensify efforts in technological innovation

The Chinese new energy vehicle industry needs to address the issue of unstable range capability, improve range, and make range an advantage for Chinese new energy vehicles; We need to improve battery technology and increase research and development efforts for new battery technologies such as lithium-ion batteries; Further investment is needed in the research and development of intelligent networking and autonomous driving technologies, especially in the study of automotive chips, to prevent chip bottlenecks from occurring[0]. China should also increase the protection of patents and intellectual property rights for new energy vehicles, explore the feasibility of autonomous driving and intelligent traffic control through data connectivity, enhance the level of intelligent manufacturing, tap into digital talents, and achieve true digital transformation.

4.2. Building high-quality independent brands

The industry should attach great importance to brand development strategy, refer to international standards, set higher product quality standards, and continue technological innovation to ensure product stability and reliability. In terms of after-sales service, car companies should enhance their service awareness, standardize after-sales service management[0], and continuously optimize user experience. In the process of selling new energy vehicles, enterprises need to form a complete service chain. Tesla's experience of setting up online experience stores can be used as a reference, with the main purpose of guiding consumers' understanding of new energy vehicles and promoting consumption.

4.3. Improve the infrastructure required for industrial development

We should strengthen the top-level design of charging infrastructure development, adhere to the principles of building as much as possible, adapting to local conditions, and balancing and rationalizing, and scientifically plan the construction scale, network structure, layout functions, and development models of different countries. At the same time, in combination with the development trend of new energy vehicles, there is a margin in terms of total scale, structural functions, and construction space to meet the charging needs of different fields. China can also establish market alliances with trading countries, strengthen capital, technology, and research and development cooperation with European and American countries[0],establish production and processing cooperation with developing countries, and encourage overseas factory construction and promote localized production.

4.4. Establish a sound industrial standard system

China should accelerate the development of key standards, continuously improve new energy vehicle standards, and deploy standards in cutting-edge fields. Due to the lack of international standardization, the government needs to promote international standardization cooperation, actively participate in the formulation and revision of international standards, and enhance the influence and discourse power of China's new energy vehicle standards internationally. Regarding the issue of trade barriers, it is necessary for China to actively respond to international trade barriers, actively participate in the negotiation and signing of free trade agreements, strengthen communication and negotiation with target market governments, strive for favorable trade conditions, and provide a broader market space for China's new energy vehicle industry.

4.5. Improve industrial synergy capability

The government needs to increase subsidies for new energy vehicles in underdeveloped areas, reduce the gap between developed and underdeveloped regions, and eliminate the imbalance in industrial structure development. The Chinese new energy vehicle industry should optimize supply chain management, improve the stability and efficiency of the supply chain, strengthen cooperation with domestic and foreign suppliers, ensure stable supply of key components, and promote the coordinated development of upstream and downstream enterprises in the industry chain, forming an

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industrial cluster effect. In addition, in response to the uneven division of labor among government, industry, academia, and research institutions, the government, enterprises, universities, and research institutions should strengthen cooperation to jointly promote the research and industrialization of new energy vehicle technology.

5. Conclusions

In summary, this article mainly studies the measurement and improvement of the trade competitiveness of China's new energy vehicle industry. By calculating the trade competitiveness index and comparing it with the United States, Japan, and Germany, the shortcomings of China's new energy vehicle industry in the international market are identified, and the reasons for its limited development are explored from five aspects. Propose relevant suggestions to promote the high-quality development of the industry and enhance international competitiveness in response to the current problems.

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