

The Influence of Low Carbon Economy on the International Competitiveness of the Chinese Automobile Industry

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Abstract: With the burgeoning global concern over climate change, nations around the world are vigorously embracing the low-carbon economy. As the primary exporter of automobiles, China faces significant carbon emissions, a factor that substantially diminishes its product competitiveness in the international market and hampers efforts towards sustainable environmental development. This research paper focuses on discussing the impact of a low-carbon economy on the international competitiveness of China's automobile export. Through qualitative analysis, the study primarily reviews existing literature, highlighting the crucial roles played by technology factors, demand structure, and capital in shaping the industry's international competitiveness. This paper finds an inverse correlation between the average fuel consumption and China's automobile industry's revealed comparative advantage. This suggests that fostering a low-carbon economy could potentially enhance international competitiveness in global trade. The findings of this research hold significant implications for policy makers that they can utilize this knowledge to formulate strategies aimed at reducing carbon emissions. Hence, it propels the progression of a low-carbon economy and elevates the worldwide prestige of China's automobile industry.

Keywords: low carbon economy, international competitiveness, Chinese automobile industry

1. Introduction

The notion of a low-carbon economy was initially introduced by the British government. It emphasizes the importance of conserving energy consumption and mitigating pollution emissions by making full use of new technology and system. Transportation is the main cause of global warming [1]. Over the past ten years, global CO₂ emissions have increased by 13 percent, which carbon emissions stemming from the transport sector have increased by 25 percent [2]. China has taken the lead as the world's largest automobile producer. It is causing great pressure on its oil resources. At present, China has a quite high consumption of vehicle fuel and the total consumption reached 133 million tons, accounting for 25 percent of oil consumption in 2021¹. Based on the above background, countries have adjusted government policies and introduced relevant laws and regulations to lessen the emissions of carbon and save energy in the automotive industry.

Many scholars studied the correlation between carbon emission levels and economic expansion. However, they did not study the influence of low-carbon economic development on specific

¹Source of data: <https://oec.world/en/profile/bilateral-product/carp/reporter/chn>

industries' competitiveness in the international market. Besides, many studies also focused on qualitative analysis to study the correlation between the low carbon economy and export trade. Therefore, this paper will develop an in-depth analysis of the impact of carbon emission reduction on the competitiveness of car products in the international market. This can help facilitate the international trade of China's automobile products and help the pursuit of sustainable progress of global environment.

This paper primarily conducts qualitative and quantitative analyses on how a low-carbon economy affects the international competitiveness of China's automobile industry. It uses the diamond theory model to examine the impact of reducing carbon emissions on China's automobile industry's global competitiveness. Based on this, it uses measurement tools and selects relevant variables to verify that a low-carbon economy will have a direct relationship with the product's market competitiveness in the world. The second session reviews relevant concepts and the impact of a low-carbon economy based on the theory model. The third session develops an empirical analysis and discussion with the regression analysis method.

The core focus of this research is to elucidate how reducing carbon emissions impacts the global export volume of China's automobile industry so as to adopt strategies to improve the international competitiveness of car exports.

2. Literature Review

2.1. Low Carbon Economy and International Competitiveness of Industry

The initial proposition of a low-carbon economy was posited by a scholar from the United Kingdom, advocating for increased economic output while minimizing the consumption of natural resources and alleviating environmental pollution [2]. Energy saving economy can create a better quality of life and a higher standard of living, creating more opportunities for the export of advanced technologies [3]. A low-carbon economy embodies a green ecological approach, focusing on optimizing energy utilization and implementing clean development mechanisms on regional levels. Its core objectives include promoting low-carbon product development and fostering a balanced enhancement of global well-being [4]. The key to reducing carbon emissions is to innovate energy technology and system to mitigate climate change, thereby fostering sustainable development [4]. The common aspects mentioned above revolve around achieving energy savings through energy innovation and efficient utilization, and ultimately obtain more economic output and maintain ecological balance.

The international competitiveness of an industry is characterized by the capacity of a nation's specific industry to provide more products that meet the needs of consumers in the international market with its higher productivity compared to other countries under the conditions of international free trade [5]. Industrial competitiveness is the overall competitiveness of enterprises in an industry and in a country [6]. From the perspective of the industry itself, it reflects the industrial organization structure, the market competitive structure, and the overall quality of the industry [6]. From a comparative point of view, it is the reflection of the differences in the capacity of enterprises and the resource conditions required for industrial development [6]. The common denominator of the above definitions is that comparing the international competitiveness of the product is comparing the competitive advantage of the same industry belonging to different countries [6]. The research on industrial international competitiveness is to objectively describe the actual results of the international competition of an industry so as to find out the reasons leading to the outcomes of industrial international competitiveness and anticipate future development trends.

2.2. Impact of Low Carbon Economy on the International Competitiveness of the Chinese Automobile Industry

Porter's "Diamond model" puts forward six factors affecting the car product's competitiveness in the international market, which are respectively capital conditions, labor conditions, technical conditions, environmental resource conditions, and infrastructure [6].

In terms of the impact of technical conditions, in a low-carbon economy, the automobile industry cannot achieve significant emission reduction requirements of products through existing technology, so it must carry out major changes in technology [7]. The way of change includes two aspects, which are respectively upgrading the traditional energy vehicle-related technologies, and researching and developing new alternative fuels. Table 1 shows Hossin, Anusara, Chanthamith and Kumar's study on the impact of upgrading technologies and innovation of technologies on amount of carbon reduction [8]. This article presented that the upgrade of conventional engine technology could help reduce the amount of carbon by 20 g/km, and advanced automatic transmission and electric power steering could reduce carbon emission by 10 g/km. The amount of carbon reduction achieved by upgrading the technology related to conventional energy vehicles [8].

Table 1: Carbon reduction amount of traditional energy vehicle technology.

Upgrade technologies and innovation technologies of traditional energy vehicles	Amount of carbon reduction (g/km)
Upgrade of conventional engine technology	20
Advanced automatic transmission and electric power steering	10
New material technology to reduce body weight by 100 kg	5

In terms of the impact of the capital factor, the development of the automobile industry in reducing carbon emissions requires huge capital injection for low-carbon vehicle technology research and development [9]. The capital sources of China's car industry mainly include the enterprise's funds, government funds, loans, foreign investment and so on [9]. The arrival of a low-carbon economy provides a new source of capital for this industry. In addition to the government's financial financing to support the new energy automobile industry, the introduction of the Clean Development Mechanism and new projects have been provided for foreign direct investment. In addition, the strong support of the national financial system is very important for the automotive industry to reduce emissions of carbons [10].

From the perspective of the demand structure factor, with the arrival of a low-carbon economy, governments of all countries vigorously promote energy conservation and regulate by laws and regulations, consumers have long realized the importance of energy conservation, and manufacturers have correspondingly improved the energy efficiency of products [11]. In the automobile consumer market, consumers are more inclined to choose energy-saving small vehicles.

All these factors demonstrate that adopting a low-carbon economy will enhance the international competitiveness in China's automobile export trade.

3. Empirical Analysis and Discussion

3.1. Research Model

To establish the interrelation between carbon emissions reduction and car export competitiveness, a regression model may be utilized for comprehensive analysis. This model involves three types of

variables, which are respectively independent variable, dependent variable, and control variable. The average fuel consumption of passenger vehicles in China (CAFC) could be used as the independent variable [9]. It is a significant indicator to measure the low carbon economy's development degree. The dependent variable in this regression model is the international competitiveness of China, s automobile export, which can be measured by the revealed comparative advantage index (RCA). In the regression model, control variables will be used to estimate the causal effects of a treatment on an outcome [6]. In this research, control variables include China's GDP, exchange rate and added value of the secondary industry. These variables may have an impact on the outcome of the regression.

Regression model when using the control variables are shown below in the equation,

$$RCA_i = \alpha CAFC_i + \beta_1 GDP_i + \beta_2 Exrate_i + \beta_3 Addindustry_i + \varepsilon_i \quad (1)$$

where RCA_i revealed comparative advantage index of China's car export in the year i. $CAFC_i$ shows China's average fuel consumption in the year i. GDP_i refers to China's GDP in the year i. $Exrate_i$ refers to the exchange rate in the year i. $Addindustry_i$ refers to the added value of the secondary industry.

RCA's value range is between 0 and infinity. When RCA is larger than 2.5, the country's product will be extremely competitive [6]. If RCA is smaller than 0.8, it indicates that the country's product competitiveness is weak [6]. Concerning the RCA in China's automobile industry, it entails the ratio between China's total car exports and its total exports, as well as the ratio between world car exports and total global exports [6].

3.2. Data Analysis

Table 2 shows a descriptive statistics analysis result. The sample data from 2006 to 2021 is chosen for analysis². The mean value of RCA is 0.07, which is far smaller than 0.8. This means that the global competitiveness of China's automotive sector very weak. The mean value of CAFC is 6.95. This shows that the average fuel consumption in the last 16 years is 6.95L / 100 KM. Three control variables are introduced, which are respectively GDP in China, exchange rate and Added value of the secondary industry.

Table 2: Descriptive statistics.

	Mean	Std. Dev.	Min	Max	Obs.
RCA	0.071	0.048	0.014	0.233	16
CAFC (L/100KM)	6.955	1.025	5.1	8.16	16
GDP in China (Trillion RMB)	63.551	28.709	21.94	114.92	16
Exchange rate (RMB/100 USD)	673.226	49.336	614.28	797.18	16
Added value of the secondary industry (Trillion RMB)	26.453	10.144	10.44	45.15	16

Since 2006, there has been a declining trend in CAFC, whereas RCA has shown a continuous increase. Figure 1 and Figure 2 illustrate these divergent growth patterns. Since 2006, the CAFC has decreased from 8.16L/100KM to 5.1L/100KM (Figure 2), indicating a reduction in China's average fuel consumption and reflecting the country's progress toward a low-carbon economy. Conversely,

² Source of data: <http://finance.people.com.cn/n1/2022/0705/c1004-32466797.html> and <https://oec.world/en/profile/bilateral-product/carp/reporter/chn>

the RCA has displayed an overall increasing trend with some fluctuations, notably experiencing rapid growth since 2020, suggesting a strengthening revealed comparative advantage in China's automobile industry (Figure 1).

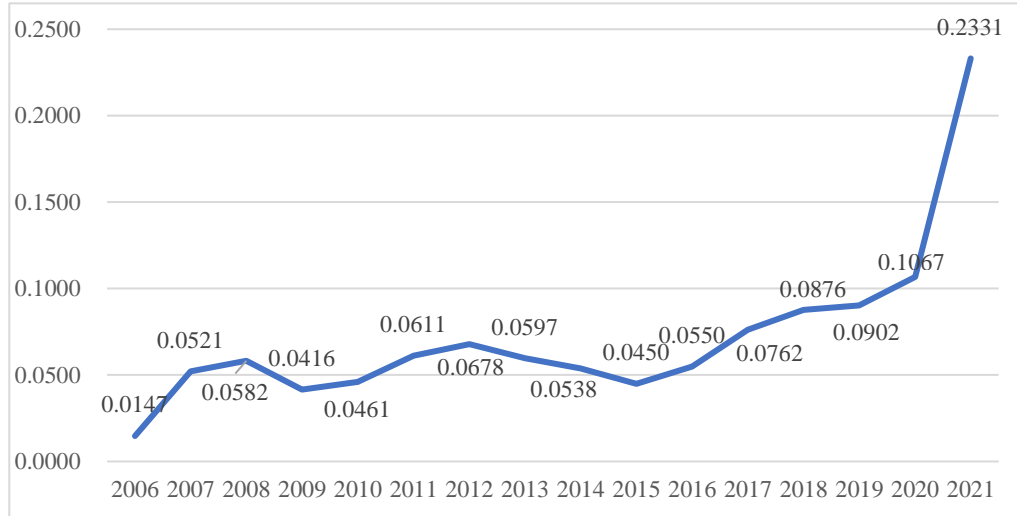


Figure 1: The trend of RCA.

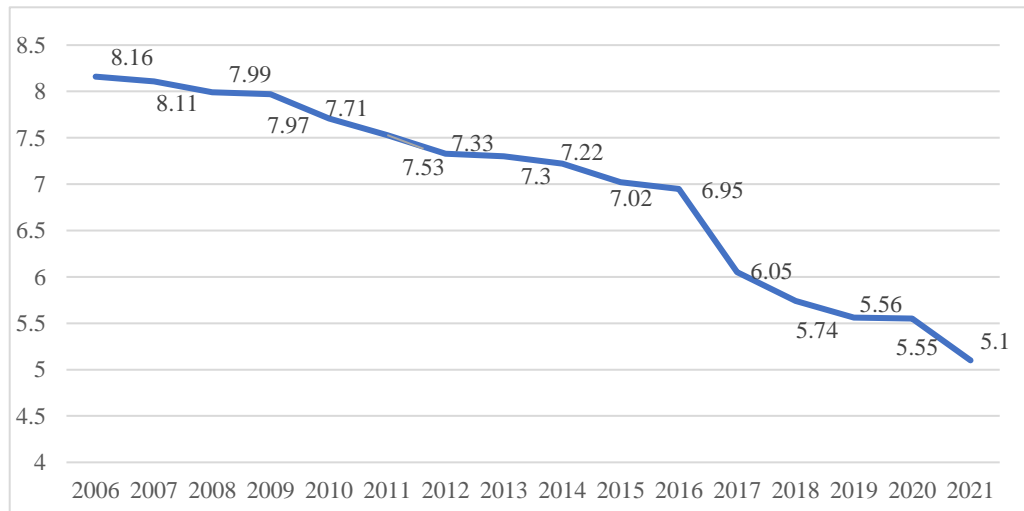


Figure 2: The trend of CAFC.

3.3. Results and Discussion

Using SPSS to run the regression, the output is as follows. The output shows two models' summaries in Table 3. Model 1 solely employs CAFC as the independent variable without incorporating any control variables, while Model 2 includes GDP in China, exchange rate, and the added value of the secondary industry as control variables. It can be found that the significance of the t-test for Model 2 is larger than 0.05, while that of model 1 is lower than 0.05. This means that the regression analysis of including the control variables has no statistical significance.

Table 3: Regression results.

	Model 1	Model 2
CAFC	-0.036*** (0.008)	0.022 (0.071)
GDP		-0.01 (0.005)
Exchange rate		-0.001 (0.001)
Added value of the secondary industry		0.035 (0.018)
Adj- R^2	0.593	0.702
F-stats	20.376	6.464

Notes: * $p < 0.1$ ** $p < 0.05$ *** $p < 0.01$. Standard errors in parentheses.

The results of the regression indicate a negative correlation between RCA and CAFC. Specifically, when CAFC decreases by one unit, RCA increases by 0.036 units. This implies that reducing China's average fuel consumption enhances the international competitiveness of the automobile industry. Consequently, developing a low-carbon economy will positively impact the increase in China's automobile export competitiveness.

The regression analysis reveals that the regression coefficient of CAFC is 0.022, indicating a positive relationship. Consequently, the negative association between CAFC and RCA disappears when control variables are introduced, leading to an insignificant regression model. This could be attributed to the strong correlation between the control variables and the dependent variable. In addition, the second model's lack of significance may also be attributed to the limited size of the sample data.

Higher GDP and greater added value in the secondary industry are indicative of increased international competitiveness. A higher GDP signifies greater economic progress, resulting in the creation of more valuable goods and services, which are more attractive and competitive in the international market. Additionally, a higher added value in the secondary industry reflects greater product or service creativity, contributing to heightened international competitiveness.

The exchange rate also exhibits a substantial correlation with RCA. An appreciation of the U.S. currency prompts increased purchases of products from China, thereby benefiting the export of Chinese goods. As a result, the three control variables demonstrate a high degree of correlation with the independent variable, leading to the inefficiency of this regression model. Given the limited sample size, it is important to acknowledge the potential impact of sample data scarcity on the model's statistical significance.

4. Conclusion

This research report employs a combination of qualitative and quantitative methods to demonstrate that the development of low-carbon businesses is conducive to enhancing a country's international competitiveness in the automobile export trade. The qualitative analysis underscores how reducing carbon emissions stimulates technological upgrading and innovation within the automobile industry, while also fostering consumer preference for energy-saving and emission-reduction automobile products. Key determinants impacting the degree of international competitiveness in the automobile industry include the capital factor, technology factor, and demand structure factor. China's

automobile products currently exhibit high carbon emissions and low concentrations. Nevertheless, opportunities arise from the improvement of public awareness and the implementation of the clean development mechanism, which can positively impact the international competitiveness of China's automobile industry. The regression analysis further confirms that reducing carbon emissions and developing a low-carbon economy have a positive effect on the international competitiveness of China's automobile industry.

This research holds significance for China's government in adopting appropriate policies and mechanisms to foster the development of energy-saving industries and products. Within the context of the automobile industry, this study highlights the role of key factors, such as technology and capital, in enhancing the international competitiveness of China's car exports. However, the research also possesses certain limitations. The relatively late proposal of a "low-carbon economy" makes it challenging to obtain comprehensive data concerning the domestic and foreign automobile industry in this area. Consequently, the paper relies on data consultation, sorting, and qualitative analysis for some indicators, leading to a dearth of relevant data support and persuasive evidence during the discussion process.

To address these limitations, further research will strive to obtain more comprehensive and perfect data. The future direction of this study will focus on exploring the relationship between carbon emissions in the automobile industry and its international competitiveness, aiming to derive an equation that accurately describes this connection. Additionally, the research will utilize more comprehensive data to elucidate China's automobile industry's competitiveness in the international market, considering the theories of a low-carbon economy and the current developmental status of the industry.

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