

Research on the Impact of "Dual Carbon Goals" on New Energy Vehicle Industry Has Financing Efficiency based on DEA-Malmquist's Analysis

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Abstract

Driven by the goal of carbon peaking and carbon neutrality, the low carbonization of China's transportation sector has become an inevitable trend. As the largest carbon emission tool in the field of transportation, the automobile is naturally closely related to the realization of the double carbon target, and the implementation of the double carbon target will obviously have a certain impact on the new energy automobile industry. This project aims to study the extent to which the double carbon target affects the financing efficiency of the new energy automobile industry, and analyze the degree to which the financing efficiency of the new energy automobile industry in different regions is affected by the changes in the internal and external financing environment variables. Through the research, it is hoped to enlighten the government's formulation of macro-control policies and improve the energy consumption structure of the new energy automobile industry, and provide targeted policy suggestions for the country's macro-control of the new energy automobile industry from the level of economic leverage.

Keywords

Double Carbon Target; Green Upgrade; DEA-Malmquist Index Model; Financing Efficiency; Opportunities and Challenges.

1. Introduction

While humans consume fossil energy to meet the needs of production and living, they also emit a large amount of carbon dioxide, leading to rising global temperatures. And global warming induces extreme weather events, threatening human survival and development. As shown in Figure 1, per capita carbon emissions from China, the United Kingdom, the United States and the world from 1930 to 2020. The negative externalities of carbon emissions make it difficult to solve them effectively by the market mechanism alone. Therefore, the government must play its role, rely on relevant policies, to make up for the defect of "market failure", and reduce carbon emissions. Against this background, the Paris Agreement climate agreement, adopted by the international community in 2015, corresponds to arrangements for climate change action, aiming to keep the global average climate rise within 1.5°C. As early as 2009, the Chinese government specified in the long-term plan for national economic and social development that 40 ~ 45% of carbon dioxide emissions per unit of GDP by 200; the 13th Five-Year Plan formulated in 2016 stipulates that carbon dioxide emissions per unit of GDP in 2020 will decrease by 18% compared with 2015. In 2020, the Chinese government announced at the UN General Assembly that "China's carbon dioxide emissions will peak and become carbon neutral

by 2030 and 2060, respectively". With the drive of carbon peak and carbon neutral task targets, the continuous strengthening of carbon emission regulation, and low carbon in China's transportation sector has become an inevitable trend. As the largest carbon emission tool in the field of transportation, the automobile is naturally closely related to the realization of dual-carbon targets. The implementation of dual-carbon targets is bound to have a certain impact on the new energy vehicle industry. core of the dual-carbon goal is "carbon reduction". At present, new energy vehicles have been included in China's strategic emerging industries, and the development of its industrial ecological chain is inseparable from the construction of carbon financial market. The diffusion of carbon emission policy is of great significance to the sustainable development of carbon financial market. So, to what extent will the dual-carbon target affect the financing efficiency of the new energy vehicle industry in the process of promoting the construction of the carbon financial market? How much does the financing efficiency of the new energy vehicle industry in different regions respond to the changes of internal and external financing environment variables? Therefore, the research on the impact of dual-carbon target on the financing efficiency of the new energy vehicle industry has important theoretical and practical significance.

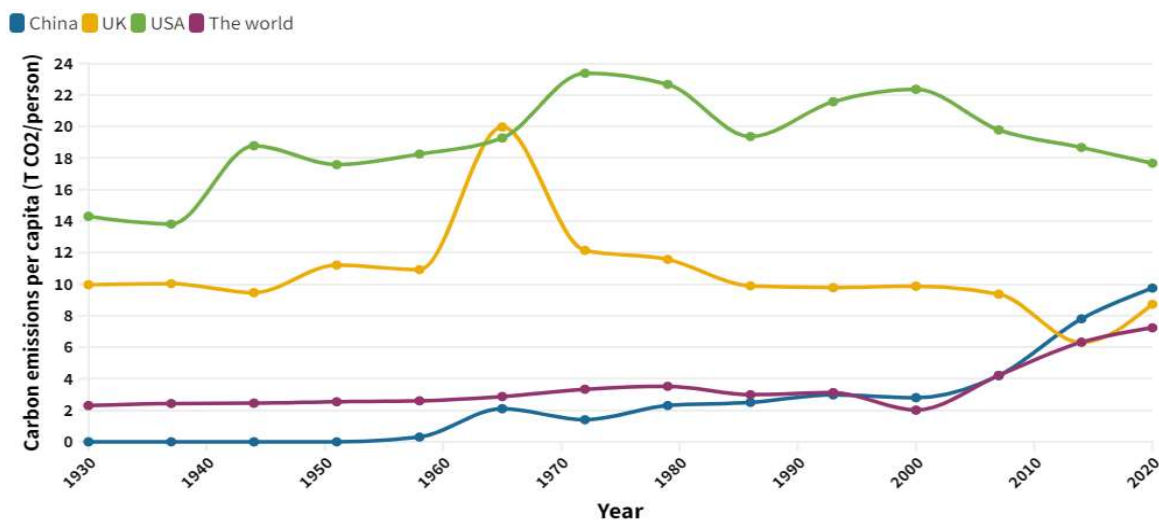


Figure 1. Per capita carbon emissions of China, the United Kingdom, the United States and the world from 1930 to 2020.

2. Literature Review

The research on the impact of low-carbon economy on the new energy vehicle industry is increasing. We focus on the impact on the financing efficiency of the new energy vehicle industry under the implementation of the dual-carbon target.

On the one hand, from the point of response to national policy, our country is actively implementing carbon emissions trading policy, by reengineering a market, in easing enterprise financing constraints, reduce the burden of enterprise policy play its positive influence, from the external efficiency of enterprise financing[1], and carbon finance is an important part of green finance, guide funds to green low carbon, ecological environment protection, energy conservation, environmental improvement project investment and financing, can promote strategic emerging industry financing, improve the green innovation ability[2]. On the other hand, from the perspective of the new energy vehicle industry itself, it is a development opportunity for it to build a low-carbon, safe and efficient energy pattern under the dual-carbon vision. H.-R. Wang [3] introduced the ecosystem theory into the research and threshold of financing efficiency, and believed that the financing efficiency of new energy industry is greatly

affected by external environmental factors of financing, while the allocation efficiency is greatly affected by internal factors of financing. H. Lei and Q.-Y. Liu [4] used the four-stage DEA model to measure the current financing efficiency of green and low-carbon listed companies, indicating that the internal and external financing environment and random factors will have a significant impact on the financing efficiency of green and low-carbon enterprises. Y. Fu [5] showed in the research that in the early stage of the development of emerging industries such as new energy automobile industries, government policies are the key factor affecting the development of the industry. According to the existing research, the improvement of financing efficiency in the new energy vehicle industry is closely related to the domestic carbon financial development environment.

3. Research Idears and Methods

3.1. Research Idears

On the basis of studying relevant literature and practical achievements at home and abroad, with "finding problems - raising problems - analyzing problems - solving problems" as the main idea, the relationship between the financing situation and efficiency of the new energy automobile industry under the background of the double carbon target, including external conditions such as government support and internal conditions such as equity, liabilities and technical level, is analyzed. Comprehensively analyze the transmission mechanism of the influence of internal and external conditions on the financing efficiency of the new energy automobile industry, and study the impact of internal and external conditions changes on the financing efficiency of the new energy automobile industry through the DEA model; finally, according to the research results, the financing efficiency of the new energy automobile industry is promoted according to local conditions and local policies, the transformation and upgrading of the upstream and downstream industries of automobiles is accelerated, and the realization of the vision of the dual carbon target is supported.

3.2. Research Methodology

(1) Model building

The development of the new energy vehicle industry involves many factors and requires a high degree of integration of internal and external resources. Based on the above analysis, the influence of heteroscedasticity has been eliminated, and the variables involved in this paper have been normalized. Effective evaluation of input and multi-output activities. Therefore, in this paper, we choose the DEA model to establish the financing efficiency evaluation system of the new energy vehicle industry to analyze.

The DEA model is a nonparametric method used to analyze the efficiency (or performance) evaluation of individuals or units. The basic principle is to keep the input or output of the decision unit unchanged with the help of our linear planning and statistical data to determine the relatively efficient production frontier, and to judge the relative effectiveness by comparing the degree of deviation of the decision unit from the front.

Each DMUs has a corresponding efficiency evaluation index:

$$h_j = \frac{u^T y_j}{v^T x_j} = \frac{\sum_{r=1}^n u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}}, j = 1, 2, \dots, t. \quad (1)$$

where $x_j = (x_{1j}, \dots, x_{mj})^T$, $y_i = (y_{1j}, \dots, y_{mj})^T$, $j = 1, 2, \dots, t$.

The weight factor sum can be selected appropriately to satisfy it, $h_i \leq 1$, $j = 1, 2, \dots, t$.

(2) Metric selection

Based on existing research and the characteristics of the new energy industry, this paper determines the factors affecting the financing efficiency of the new energy automobile industry from both internal and external aspects. Among them, internal factors refer to the factors that can be determined or controlled by the enterprise itself. As shown in Table 1, this paper selects indicators such as enterprise size (sca), operating capacity (OPE), market penetration rate (mar); external factors are not controlled by enterprises, mainly affected by the market environment and economic system, this paper selects government investment level (gov), per capita consumption level (cpi), energy dependence (eng) and other indicators.

Table 1. Evaluation index of financing efficiency of new energy automobile industry.

	variable	Indicator interpretation	symbol
Internal factors	Enterprise size	New energy vehicles add new enterprise registrations every year	sca
	Operational capacity status	Comparison of production and sales of enterprises	ope
	Market penetration	The new energy automobile industry accounted for the proportion of total automobile sales	mar
External factors	The level of government input	The proportion of government funds in the internal funding of the new energy industry is significant	gov
	Energy dependence	Imported crude oil and other energy sources account for the proportion of total imported and exported energy	eng
	Per capita consumption level	Changes in the price levels of goods and services purchased by households	cpi

(3) Data sources

In this paper, taking 11 provinces in China (due to the difficulty of data collection, the study area does not include the Tibet Autonomous Region, Hong Kong Special Administrative Region, Macao Special Administrative Region and Taiwan Region), the data for 2001-2021 are selected by considering the accuracy and availability of data. The original data of each indicator are derived from the "China Statistical Yearbook", "China Energy Statistical Yearbook", the website of the National Bureau of Statistics and the statistical yearbooks of various provinces, and a small number of missing data are calculated and completed according to the actual situation using the moving average method.

(4) Results and analysis

According to Table 2, the average comprehensive efficiency of the new energy vehicle industry is 0.693, the average pure technical efficiency is 0.743, and the scale efficiency is 0.936. The financing efficiency of the new energy automobile industry is generally characterized by high scale efficiency and low comprehensive efficiency, indicating that my country's new energy automobile industry already has a certain scale benefit, but the comprehensive development level is low, and the technological innovation capability is still insufficient. The innovation efficiency results of the three major regions in my country show that the financing efficiency of the provinces (cities) located in the eastern and central regions is significantly higher than that in the western regions. The results are basically consistent with the actual economic development status quo.

Table 2. Financing efficiency of the new energy vehicle industry.

firm	crste	vrste	scale	
1	0.764	1	0.764	irs
2	0.61	0.703	0.868	irs
3	0.563	0.717	0.784	irs
4	1	1	1	-
5	0.732	0.736	0.995	irs
6	0.644	0.646	0.997	drs
7	0.632	0.634	0.997	drs
8	0.641	0.642	0.998	drs
9	0.478	0.479	0.999	drs
10	0.555	0.618	0.897	irs
11	1	1	1	—
mean	0.693	0.743	0.936	—

4. Effects of Heterogeneity

China has a vast territory, and there is a big gap in the economic development level of different regions. Is there differences in the impact of the implementation of two-carbon targets in different economic development levels on the financing efficiency of the new energy vehicle industry? The answer to this question will help to improve the understanding of the impact mechanism of the dual-carbon targets on the financing efficiency of the new energy vehicle industry.

Based on this, we discuss the heterogeneity of dual-carbon targets on the financing efficiency of the new energy vehicle industry from the different economic development levels in different regions. Some scholars study the impact of the implementation of dual-carbon targets in different economic development levels on the financing efficiency of the new energy vehicle industry. The study found that the eastern, central and western regions according to different economic development levels, to test the impact of low-carbon economy on the financing efficiency of the new energy vehicle industry. The results show that the average comprehensive efficiency of the new energy vehicle industry is 0.693, the average pure technical efficiency is 0.743, and the scale efficiency is 0.936. The financing efficiency of the new energy vehicle industry is generally manifested as high scale efficiency and low comprehensive efficiency, indicating that China's new energy vehicle industry has certain scale benefits, but the comprehensive development level is low, and the technological innovation ability is still insufficient.

On the whole, the innovation efficiency of the two stages of high-tech industries shows a spatial distribution pattern of step decline. From the regional level, the innovation in technology research and development and the stage of achievement transformation are efficiently concentrated, mainly distributed in the eastern and central regions. These regions have obvious location and policy advantages, which provide the "soil" for the innovation and development of high-tech industries and promote their development towards a high-quality direction. In the stage of technological research and development and achievement transformation, innovation inefficiency is mainly distributed in the western region and some central regions. These regions are limited by historical factors and natural conditions, and mainly rely on high energy consumption and high pollution industries to drive economic growth. High-tech industries have poor foundation and insufficient scientific and technological forces. At the provincial level, the innovation efficiency of high-tech industries in Beijing, Tianjin, Jiangsu, Zhejiang, Shanghai,

Guangdong, Shandong and Henan provinces remains at a high level, which is closely related to its regional economic development. Among them, Beijing has abundant technology, human resources and good economic foundation, which can promote the development of surrounding provinces and cities in Zhejiang and Jiangsu and Shanghai in Yangtze River Delta, with strong economic strength and high-tech industry; Guangdong, the largest economic province in China, with internal and external advantages of high-tech industry innovation. In addition, due to the rapid development of Sichuan and Chongqing in recent years, the high-tech industry is gradually drawing close to the direction of high-tech research and development and high-tech achievement transformation, becoming a new growth point of economic development in the central and western regions.

Finally, the results of the innovation efficiency of the three major regions in China show that the financing efficiency of the provinces (cities) located in the eastern and central regions is significantly higher than that of the western region. The main reason is that the eastern and central regions have geographical advantages, the economic foundation and financing environment are better than that of the western region, and the calculation results basically fit with the actual economic development status.

5. Conclusion and Policy Recommendations

In the context of low-carbon sustainable development that has become a global consensus, The state has issued a number of carbon emission policies, The intensity of carbon emission regulation is constantly improving, In order to investigate the impact effect of the dual-carbon target on the financing efficiency of the new energy vehicle industry, We cite 15 provinces in China (because of the difficulty in data collection, Therefore, the study area does not include Tibet Autonomous Region, Hong Kong Special Administrative Region, Macao Special Administrative Region and Taiwan region), Considering the accuracy and availability of the data comprehensively, Select the data from 2011 to 2021 (the original data of each indicator are obtained from China Statistical Yearbook and China Energy Statistical Yearbook, The Website of the National Bureau of Statistics and the statistical yearbooks of various provinces, A small number of missing data are calculated by mobile average method according to the actual situation) for empirical analysis.

The results show that: from the analysis of the time trend, in the overall financing efficiency calculation results of the new energy vehicle industry, the scale efficiency has decreased year by year, the technical efficiency has a slow upward trend after two consecutive years of decline, and the pure technical efficiency has been stable for four years, and has a slow upward trend. The following can be seen: first, with the accumulation of capacity, China's new energy vehicle industry has begun to decline the scale efficiency; second, with the decline of the industry subsidy policy must face greater pressure from technology upgrading and production and operation, the industry enters the survival of the fittest; third, excluding the impact of scale changes, using capital and profitability is generally stable, and the trend of improvement, indicating that the industry is gradually on the right track of capital absorption, reasonable application and steady development.

From the perspective of space, the distribution range of listed companies in China's new energy vehicle industry is limited in interprovincial space, only in a dozen provincial administrative regions, and the distribution density of provinces and cities is different, Zhejiang and Guangdong provinces are the most dense distribution. Change trend of financing pure technology efficiency in four years of Guangdong, Shanghai, Zhejiang, Jiangsu and Chongqing five provinces and cities, financing scale efficiency in addition to the provinces and cities outside Shanghai change trend is decreasing trend, that most of the provinces and cities of new

energy automobile industry funds into and use the scale efficiency has entered the decreasing stage.

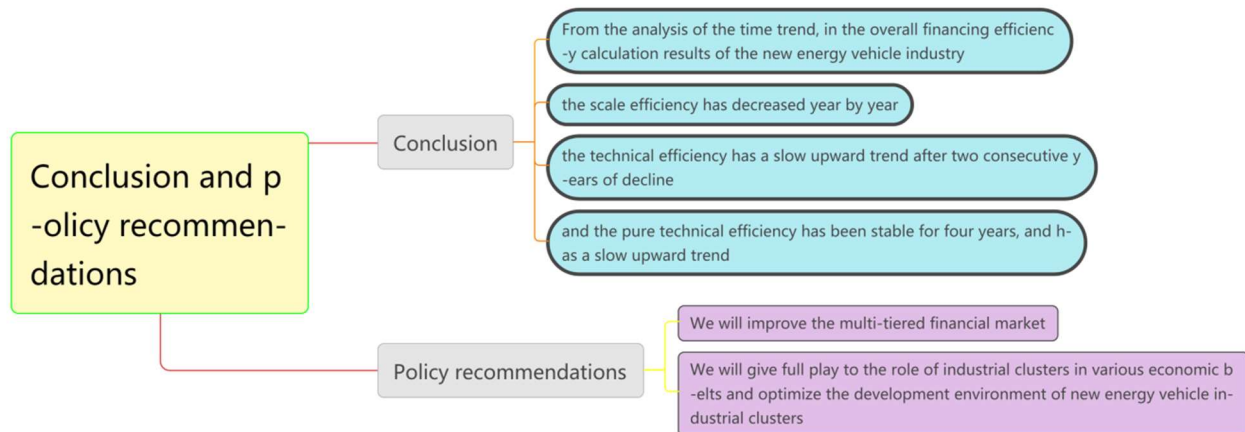


Figure 2. Synthesis recommendations.

Based on the above results, we make the following suggestions, as shown in Figure 2:

(1) Improve the construction of a multi-level financial market

Efficient financing cannot be separated from a perfect financial market. The financing of emerging high-tech industries represented by the new energy vehicle industry calls for a professional and modern multi-level financial market. It is necessary to further improve the function of the financial market in regulating the economy and making reasonable pricing, build a complete credit system, and encourage and support powerful enterprises to obtain the funds needed for production with reasonable prices and convenient channels. Specific measures include actively activating the introduction of social capital, establishing industrial support fund; enhancing the level of technology evaluation, ensuring and improving the efficiency of capital supply; accelerating the listing mechanism for the new energy vehicle industry, improving the relevant listing guidance mechanism; improving the legal and regulatory construction of venture capital, private equity and other fields, and building a good legal environment for multi-level financing.

(2) Give full play to the role of industrial clusters in various economic belts and optimize new energy.

After the calculation and spatial analysis of financing efficiency, it can be found that the scale efficiency of capital integration and use of a considerable number of individual new energy vehicles in China has entered a decreasing stage, indicating that the scale efficiency that can be obtained solely by increasing the investment of enterprises begins to decrease. In this stage of development, it is particularly important to play the role of industrial clusters in various economic belts. To realize this point, it is necessary to optimize the development environment of new energy vehicle industrial clusters. Through the analysis of the spatial distribution of new energy listed companies in China, it can be found that the distribution of large enterprises in China's new energy vehicle industry is relatively concentrated in the economically developed central and eastern provinces, so strengthening the construction of industrial clusters is in line with the development foundation of the industry. Provinces and economic belts should specifically analyze their own industrial base, superior resources and superior industries, build a more scientific professional cooperation network of new energy vehicle industry, integrate the technology, capital and other resources of each economic belt, build a more professional

regional financial service platform, and improve the financing efficiency and operation level of industrial clusters.

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