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On the Influencing Factors of the Development of New Energy Vehicles in China from the Perspective of Low-carbon Economy

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Abstract

With the transformation of global energy structure and the improvement of environmental protection awareness, new energy vehicles, as green and low-carbon modes of transportation, are gradually becoming an important development direction of the global automotive industry. Against this background, this article applies grey correlation analysis to study the influencing factors of the development of new energy vehicles in China. The research results indicate that the prices of public charging stations and new energy vehicles have the highest correlation with the development of new energy vehicles, followed by the prices of new energy batteries and new energy vehicle safety incidents. Based on the conclusions drawn, it is necessary to support the sustainable development of the new energy vehicle industry from three aspects: policy guidance, industrial empowerment, and technological foundation building.

Keywords

Low-carbon Economy; New Energy Vehicles; Influence Factor.

1. Introduction

Global climate change has become a major challenge faced by all humanity. According to reports from international authoritative institutions, the global temperature rise has led to frequent extreme weather events, causing serious impacts on human life and natural ecosystems. To address climate change, countries have proposed low-carbon economic development strategies to reduce greenhouse gas emissions and mitigate global warming trends. For China, its energy structure has long been dominated by coal, with a relatively high proportion of fossil fuels, making it the world's largest emitter of greenhouse gases. The carbon emissions generated by energy consumption have a serious impact on China's environment and global climate change. Therefore, adjusting the energy structure and reducing carbon emission intensity have become important tasks for China to achieve sustainable development. As a major consumer of oil and emitter of carbon dioxide, automobiles need to undergo revolutionary changes. The development of new energy vehicles has become a consensus among countries around the world, and China has listed them as one of the eight strategic emerging industries. Various support and cultivation policies have been introduced to create a favorable policy environment for the development of new energy vehicles. Faced with many favorable opportunities, it is urgent for China's new energy vehicle industry to accelerate its development.

With the Party Central Committee's strategic planning of "dual carbon" from a comprehensive perspective, the transformation of energy structure is accelerating, integrating electric vehicles with renewable energy, and truly achieving green development. New energy vehicles can participate in optimizing energy allocation by interacting with the power grid while reducing carbon emissions. In an ideal scenario, the combination of wind power, photovoltaics, energy storage, and electric vehicles, combined with smart grid support, will build an efficient and

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clean energy system. Since 2010, China has vigorously supported the new energy vehicle industry through subsidies, policy incentives, and other measures, promoting the rapid development of new energy vehicles in recent years, and the continuous increase in sales volume of new energy vehicles. With the increase of the user group of new energy vehicles, it also reveals a series of challenges faced by this emerging industry. The impact of new energy vehicles on society and future development trends are constantly discussed, and they have also received high attention from the energy economy and energy-saving and environmental protection industries.

With low-carbon economy becoming the mainstream trend of global development, new energy vehicles, as representatives of low-carbon transportation, are of great significance for China to achieve energy transformation, reduce carbon emissions, and promote economic transformation and upgrading. In order to promote the healthy development of the new energy vehicle industry, the Chinese government has introduced a series of supportive policies, continuously improving and adjusting them to meet the needs of industrial development.

In order to promote the healthy development of industries and promote the transformation of low-carbon economy, the government continuously improves the policy support system for the development of new energy vehicles. In the initial stage of establishment, the policies mainly included financial subsidies, exemption from purchase tax, exemption from vehicle purchase tax, and subsidies for charging facility construction. With the continuous development of the new energy vehicle industry and the change of the market environment, the government has constantly adjusted and improved the policy, gradually adjusted the subsidy policy, and tilted to products with advanced technology and superior performance; Improve charging facility construction policies and increase support for charging facility construction; Accelerate construction speed and improve service quality; Promote standardization, enhance product quality and market competitiveness. In addition, on October 20, 2020, the General Office of the State Council issued the "New Energy Vehicle Industry Plan (2021-2035)". On January 30, 2023, the Ministry of Industry and Information Technology, the Ministry of Transport and other eight departments jointly issued the "Notice on Organizing Pilot Work for Comprehensive Electrification of Public Sector Vehicles". In the future, the new energy vehicle industry will develop towards electrification, networking, and intelligence, breaking through core technologies.

This article collects monthly data on the production of new energy vehicles and related influencing factors in the past three years, and combines relevant reality to explore the influencing factors of China's new energy vehicle development from the perspective of low-carbon economy. The main factors affecting China's new energy vehicle development are revealed through the use of grey correlation analysis, aiming to provide feasible suggestions and policy references for the sustainable development of the new energy vehicle industry, and help China's low-carbon economic development and transformation, achieve sustainable development goals.

2. Research Design

2.1. Research Methods

In the 1980s, Chinese scholar Professor Deng Julong pioneered the grey relational analysis method, which is a method used to study the correlation between variables and evaluate the degree of correlation between variables. The basic idea is to determine a reference sequence as the object of comparison with other variables, then compare the data and development of different factors with the reference sequence, and finally evaluate the degree of correlation between each variable by calculating their correlation coefficients. Compared with other methods, this method can effectively overcome the requirements of traditional data analysis

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methods, such as a large amount of data, independence between various influencing factors, and the need for sample data to have certain regularity. It can be well applied to system analysis where complete initial data cannot be obtained, uncertain data with large fluctuations and no typical distribution patterns, and data distribution with large grayscale. Therefore, this article introduces the grey correlation analysis method to study this project.

Grey correlation analysis can be divided into the following steps.

(1) Determine the analysis data columns. Reference sequence refers to a data sequence that reflects the behavioral characteristics of the system, also known as the parent data column; Comparison sequences are composed of effective factors that affect system behavior, also known as sub factor data columns. Given $X_i = \{x_i(1), x_i(2), x_i(3), \cdots, x_i(n)\}$, where m and n are sequence lengths, X_0 is defined as the reference sequence when i is 0, and $X_1, X_2, \cdots, X_n$ is defined as the correlation factor comparison matrix when $i = 1,2, \cdots n$.

The reference sequence is:

$$X_0 = \left(x_0(1), x_0(2), \cdots x_0(m)\right)^T \tag{1}$$

The comparison matrix of relevant factors is represented as follows:

$$[X_1 X_2 \cdots X_n] = \begin{bmatrix} x_1(1) & x_2(1) & \cdots & x_n(1) \\ x_1(2) & x_2(2) & \cdots & x_n(2) \\ \vdots & \vdots & \vdots & \vdots \\ x_1(m) & x_2(m) & x_2(m)\cdots & x_n(m) \end{bmatrix} \tag{2}$$

In the formula, X_0 is the reference sequence, representing the production of new energy vehicles in China from September 2019 to January 2024; X_i is a comparative sequence that represents the number of public charging stations, prices of new energy vehicles, electricity prices, prices of new energy batteries, safety incidents of new energy vehicles, and carbon emissions.

(2) Dimensionless data processing, as an important step in grey relational analysis, can effectively improve the accuracy and effectiveness of grey relational analysis. Considering that the measurement units of various influencing factors are different, in order to solve this problem, the original data is normalized through dimensionless processing, so that its values are on the same dimension. This article selects the initial value row data for dimensionless processing, and the calculation formula is:

$$X_i'(m) = \frac{x_i(m)}{\overline{x_i}} \tag{3}$$

Where, $\overline{x_i}$ is the average value of the corresponding impact factor of the original data; $X_i'(m)$ is the transformed data of the original data.

(3) Calculate the grey correlation coefficient. The grey correlation coefficient between each comparison sequence and the reference sequence is:

$$\gamma(x_0(k), x_i(k)) = \frac{\Delta min + \rho \Delta max}{\Delta_{ik} + \rho \Delta max} \tag{4}$$

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$$\Delta min = \min_{i} \min_{k} |x_0(k) - x_i(k)| \tag{5}$$

$$\Delta max = \max_{i} \max_{k} |x_0(k) - x_i(k)| \tag{6}$$

$$\Delta_{ik} = |x_0(k) - x_i(k)| \tag{7}$$

Among them, $\rho \in (0,1)$ is the resolution coefficient. If ρ is smaller, the difference between the correlation coefficients is greater, and the discrimination ability is stronger, generally taken as 0.5.

(4) Grey correlation degree calculation. Calculate the weighted average of the correlation coefficients between each indicator and the reference sequence, and obtain the correlation degree r_i with the reference sequence.

$$r_i = \frac{1}{n} \sum \gamma(x_0(k), x_i(k)) \tag{8}$$

Usually, based on the size of the correlation, the correlation is divided into different levels, ranging from 0 to 1. The larger the value is, the higher the correlation is. When the value of r_i approaches 1, it indicates a strong correlation between the reference sequence and the feature sequence.

2.2. Indicator Selection

In order to reflect the development of new energy vehicles in China more systematically, comprehensively, and scientifically, this article selects representative factors that affect the development of new energy vehicles as the indicator set based on extensive reading and reference to the research results of existing scholars. This article constructs an evaluation index system of influencing factors from five aspects: policy, technology, market, infrastructure, and environmental factors. Selecting the number of public charging stations, prices of new energy vehicles, electricity prices, prices of new energy batteries, safety incidents of new energy vehicles, and carbon emissions as influencing indicators, taking the production of new energy vehicles as the parent factor, and analyzing the correlation between new energy production and influencing indicators through grey correlation. When collecting relevant data, China was selected as the research object, and the research period was from September 2019 to July 2024.

2.3. Data Sources

Due to data availability limitations, China was selected as the research sample. The data used are from China Statistical Yearbook, China Labor Statistical Yearbook, China Investment Field Statistical Yearbook and other statistical yearbooks from 2011 to 2021. After data preprocessing and screening, 378 panel data were finally obtained with China's new energy vehicle production as the reference sequence, 6 variables as influencing factors, and a time limit from September 2019 to January 2024.

3. Grey Correlation Analysis

By collecting raw data and using the grey correlation analysis method to study the degree of correlation between the development of new energy vehicles and impact indicators, the production of new energy vehicles is set as the reference sequence X0, and the number of public charging stations, new energy vehicle prices, electricity prices, new energy battery prices, new energy vehicle safety incidents, and carbon emissions are used as relevant factor comparison sequences. According to the above formula, use Matlab software to calculate the correlation between the production of new energy vehicles and related influencing factors, as shown in Table 1.

Table 1. Correlation Table

Variable	index	Relevance
X1	Number of public charging stations	0.8080
X2	New energy vehicle prices	0.8046
X3	Electricity price	0.6801
X4	Price of new energy batteries	0.6925
X5	New energy vehicle safety incidents	0.6971
X6	carbon emission	0.6327

Draw the correlation curve between the production of new energy vehicles and various influencing factors using Matlab, as shown in Figure 1.

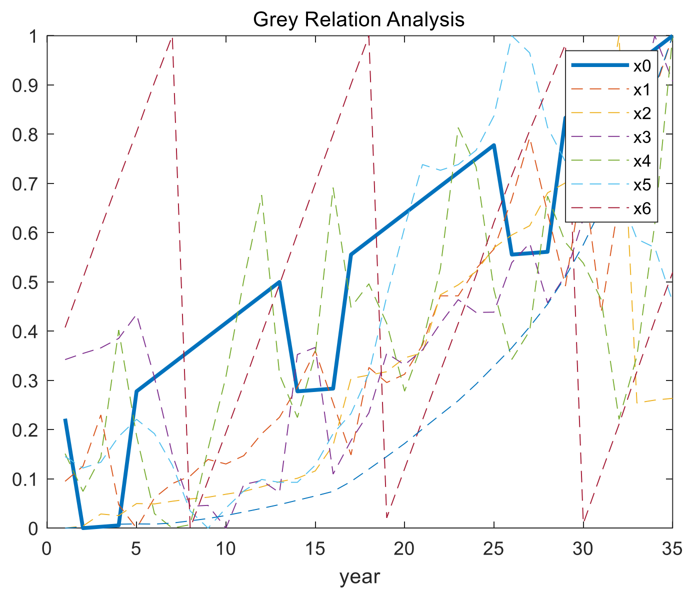

Figure 1. Relevant Curve Chart

According to the grey correlation analysis results in Table 1, it can be seen that the six influencing factors of the number of public charging stations, new energy vehicle prices, electricity prices, new energy battery prices, new energy vehicle safety incidents, and carbon emissions have varying weights on the development of new energy vehicles in China, with correlation degrees of 0.8080, 0.8046, 0.6801, 0.6925, 0.6971, and 0.6327, respectively. These weights are all above 0.5, indicating that the selected impact indicators have a significant impact on China's new energy development. In order of impact, the order is the number of public charging stations>new energy vehicle prices>new energy vehicle safety incidents>new energy battery prices>electricity prices>carbon emissions. The strongest correlation between the number of public charging stations and the development of new energy vehicles in China indicates that infrastructure construction has a significant impact on the development of new energy vehicles, which is consistent with the research results of many scholars; The correlation between the price of new energy vehicles and the development of new energy vehicles in China has reached 0.8046, indicating a strong correlation between the purchase price of new energy

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vehicles and the production of new energy vehicles in China; The correlation degree of new energy vehicle safety incidents ranks third, indicating that new energy vehicle safety incidents have a strong correlation with the development of new energy vehicles in China. As an emerging vehicle, new energy vehicles have important and complex safety issues. The battery system of new energy vehicles is prone to overflow, short circuits, high temperatures, and even fires. When there are product manufacturing defects, uncontrolled internal chemical reactions, and improper temperature management in the power battery, fire incidents are also prone to occur. From the perspective of correlation, other influencing factors rank relatively low, and their relationship with the production of new energy vehicles is not as close as the top three, but they still have a certain impact on the development of new energy vehicles. Therefore, the government should adopt a "holistic approach" and formulate comprehensive policies to promote the development of new energy vehicles in the future.

4. Conclusion and Suggestions

4.1. Conclusion

This article collects monthly data on the production of new energy vehicles and related influencing factors in the past three years, and combines relevant reality to explore the influencing factors of China's new energy vehicle development from the perspective of low-carbon economy. The main factors affecting China's new energy vehicle development are revealed through the use of grey correlation analysis. The research results show that the number of public charging stations, prices of new energy vehicles, electricity prices, prices of new energy batteries, safety incidents of new energy vehicles, and carbon emissions all have an impact on the development of new energy vehicles in China; In order of impact, the order is the number of public charging stations>new energy vehicle prices>new energy vehicle safety incidents>new energy battery prices>electricity prices>carbon emissions.

4.2. Suggestions

Based on the above empirical research conclusions, the following countermeasures and suggestions are proposed:

One is to guide policies and depict a new low-carbon blueprint. The government's incentive policies are an important way to enhance the comprehensive production capacity of new energy vehicles and promote the sustainable development of new energy vehicles. Carbon emissions and electricity prices are both factors that affect the development of new energy vehicles. The government should actively play its leadership role, formulate relevant financial support policies, tax incentives, financial support policies, low-carbon green development policies, control electricity prices, encourage people to use more advanced and green modes of transportation, and provide economic security for users, provide corresponding technical support, and provide policy guidance and support.

The second is to empower industries and build a new stage of development. Enterprises are the main body of innovation, and no technology can remain stagnant. It is necessary to innovate and improve to ensure better development and user satisfaction. In response to the issue of high prices for new energy vehicles, enterprises should strengthen technological innovation and research and development, improve battery energy density, and encourage more enterprises to enter the new energy vehicle market, thereby reducing the production and manufacturing costs of the entire vehicle. For the problem of insufficient or excessive number of charging stations in some areas due to the uneven layout of public charging facilities in China, local governments should encourage capital investment in the construction of charging infrastructure, set up public charging stations, combine with intelligent transportation

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management systems, improve the coverage of charging facilities, build a high-quality charging infrastructure system, and meet the charging needs of new energy vehicles.

Thirdly, technology builds the foundation and injects new impetus into safety. To solve the safety hazards of new energy vehicles, it is necessary to start from multiple perspectives. Firstly, strengthen the research and development of battery safety technology, develop safer battery materials, such as solid-state batteries, and reduce the use of flammable materials; Improve the accuracy and response speed of the Battery Management System (BMS), monitor the battery status in real-time, and prevent issues such as overcharging, over discharging, and short circuits. Secondly, improve the vehicle design by designing a more reasonable battery layout to ensure that the battery pack is not easily damaged in the event of a collision, and enhance the vehicle's fire and insulation design, such as using fire-resistant materials and insulation layers; Furthermore, strict production quality control is implemented, and a strict quality management system is implemented to ensure that every new energy vehicle meets safety standards. Key components such as batteries and motors are subjected to strict quality testing and lifespan testing. Finally, establish a sound safety supervision system for new energy vehicles, including the supervision of the entire process of production, sales, use, and recycling. Regularly conduct safety inspections on new energy vehicles to promptly identify and solve safety hazards.

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