

Research on the Development of China's New Energy Vehicle Industry Based on Spearman's Model

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Abstract. This study aims to explore the development of China's new energy vehicle industry and proposes a model and solution for two problems. First, by analyzing the impact of six factors on the development of the new energy vehicle industry, including policy support, technological development, individual purchasing ability, infrastructure, energy price and environmental awareness, and establishing a Spearman model to analyze the correlation between them and the industry development indicators. Based on the results of the analysis, the indicators of China's new energy electric vehicle sales, China's new energy R&D investment, China's number of charging piles and per capita GDP were selected, and the weights of the indicators were determined using the independent weight coefficient method, and a model of the development trend of China's new energy automobile industry in the next ten years was established by fitting the time variable. Finally, through the model prediction, we find that the new energy vehicle industry will develop rapidly and show exponential growth in the next decade.

Keywords: Spearman Model, China New Energy Vehicles, Development Trends.

1. Introduction

Globally, with the growing awareness of environmental protection and the transformation of energy structure, new energy vehicles are gradually gaining attention and favor as a clean and efficient means of transportation[1-2]. Especially in a new energy vehicle market like China, factors such as government policy support, technological innovation, and infrastructure construction are crucial to the development of the industry. Therefore, an in-depth study of the development trend of the new energy vehicle industry and the relationship between the influencing factors is of great significance in guiding future industrial layout and policy formulation. This study aims to systematically analyze the current development status of China's new energy vehicle industry based on the Spearman model and forecast the future development trend, so as to provide decision-making references for government departments, enterprises and investors [3].

2. Analysis of factors influencing the development of China's new energy automobile industry and construction of correlation models

2.1. Problem analysis and data collection

According to the information given in the title and the relevant information of the entire new energy electric vehicle industry, this paper believes that the development of new energy vehicles may be affected by the following factors[4-5]:

Factor 1: Policy support: government subsidies, preferential policies, and capital investment in the development of new energy technologies may affect the development of the industry. Based on this, we choose China Power (new energy) research investment (100 million yuan) as an indicator to quantify policy support.

Factor 2: Technological development: innovation is the first driving force for development. The development of technology may reduce costs, improve product performance, and gain more consumer preferences. Here we choose the Amount of new energy vehicle patent disclosure (piece) as an indicator to quantify technological development.

Factor 3: Personal purchasing ability: The demand is closely related to the market, and the development of the new energy automobile industry will be affected by the personal purchasing power of the public. Here, Per capita GDP (yuan) is used as an indicator for quantification.

Factor 4: Infrastructure: If new energy electric vehicles want to be widely used in the market, they cannot do without the support of charging infrastructure, so the Number of charging piles (ten thousand units) is used here as an indicator to quantify.

Factor 5: Energy price: The increasing shortage of non-renewable resources such as coal, oil and natural gas has made the importance and necessity of developing new energy increasingly enhanced. Here, the Average annual price of gasoline (RMB/L) was selected as an indicator to be quantified.

Factor 6: Environmental awareness: the public environmental awareness and attention to environmental issues may affect their acceptance of new energy electric vehicles, and thus affect the development of the industry. Carbon dioxide emissions (one hundred million tons) were selected as an indicator to be quantified.

According to the factors mentioned above, first of all, data were collected according to the 6 indicators selected above according to time series, and the annual values of each indicator were collected and combined. The development of new energy electric vehicles impact index data see Appendix 1.

Secondly, it is necessary to analyze the impact of various indicators as influential factors on the development of the new energy electric vehicle industry. We selected new energy vehicle sales in China (10,000 units) as the indicator to measure the development of the new energy electric vehicle industry, and built the Spearman model to analyze the correlation between each influencing factor index and the industry development index. Determine whether it is a linear relationship and find out the correlation coefficient corresponding to each index [6-7].

2.2. The establishment and solution of the Spearman model

First, the index data of New energy vehicle sales in China (10,000 units) and influencing factors of the development of new energy electric vehicles were normalized and standardized. Spearman model correlation considers a nonparametric measure of rank correlation (statistical dependence between the rankings of two variables), whose data does not need to satisfy a normal distribution, its correlation value is [-1, 1], and the correlation coefficient is ρ .

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2-1)} \quad (1)$$

Where d_i represents the rank difference of the data pair and n represents the total number of observed samples.

Bring the required data into the table of the relationship between the calculated influencing factor index and the industry development index. Influencing factor indicators and industry development indicators are shown in table 1.

Table 1. Influencing factor indicators and industry development indicators.

quota	Amount of new energy vehicle patent disclosure (piece)	China Power (new energy) research investment (100 million yuan)	Average annual price of gasoline (RMB/L)	Number of charging piles (ten thousand units)	Per capita GDP (yuan)	Carbon dioxide emissions (one hundred million tons)
correlation coefficient	0.907	0.986	-0.105	0.989	0.989	0.97
conspicuousness	notable	notable	non-notable	notable	notable	notable



Figure 1. Heat map of correlation coefficient of 6 indexes.

According to figure 1, the Average annual price of gasoline (RMB/L), Carbon dioxide emissions (one hundred million tons) and Amount of new energy can be divided in addition to vehicle patent disclosure (piece), China Power (new energy) research investment (100 million yuan), Number of charging piles in China (ten thousand units) And there is a strong and significant correlation between Per capita GDP (yuan) and New energy vehicle sales in China (10,000 units). Therefore, the stronger the personal purchasing power, the more the government supports technology research and development, and the better the infrastructure. The better the development of the new energy electric vehicle industry [8-9].

3. China's New Energy Vehicle Industry Development Forecast for the Next Ten Years and Associated Modeling

3.1. Problem analysis and data collection

According to the data known above, we predict the development situation of China's new energy automobile industry in the next 10 years

According to the problem 1, China Power (new energy) research investment (per 100 million yuan) Number of charging piles in China (ten thousand units) and Per capita GDP (yuan) have a great impact on the development of the industry, and can positively reflect the development of the industry.

Therefore, the data of these three indicators are selected in attachment 1. Firstly, the data is pre-processed, normalized and de-dimenalized, and then the weight analysis is obtained by using the independence weight coefficient method. A new evaluation index is calculated according to the weight of the three selected indicators, and finally it is fitted with the time variable to make the relationship quantified. Finally, the development trend of China's new energy automobile industry in the next 10 years is obtained [10].

3.2. Establishment and solution of independent weight system and curve regression model

The independent weight coefficient method is an objective weighting method. The idea is to determine the weight of indicators according to the strength of collinearity between indicators and other indicators. If the collinearity relationship between indicators is stronger, the easier it is to be represented by the linear combination of other indicators, and the more repeated information, the smaller the weight of the indicator should be. After model analysis, the weights of each index are shown in the following table 2:

Table 2. List of policies.

index	Weight (%)
Number of charging piles (ten thousand units)	34.423
China Power (new energy) research investment (100 million yuan)	32.434
Per capita GDP (yuan)	33.143

The time series data of the evaluation indicators calculated according to the weights are shown in the following table 3:

Table 3. Time series of evaluation indicators.

year	evaluating indicator
2012	0.033
2013	0.038
2014	0.044
2015	0.050
2016	0.054
2017	0.061
2018	0.069
2019	0.084
2020	0.102
2021	0.182
2022	0.283

Since the year is a fixed variable, it is recoded and 2020 is regarded as the value 1, and so on, for the purpose of convenient analysis. Use the encoded data as the horizontal axis to draw the scatter plot, as shown in the figure 2.

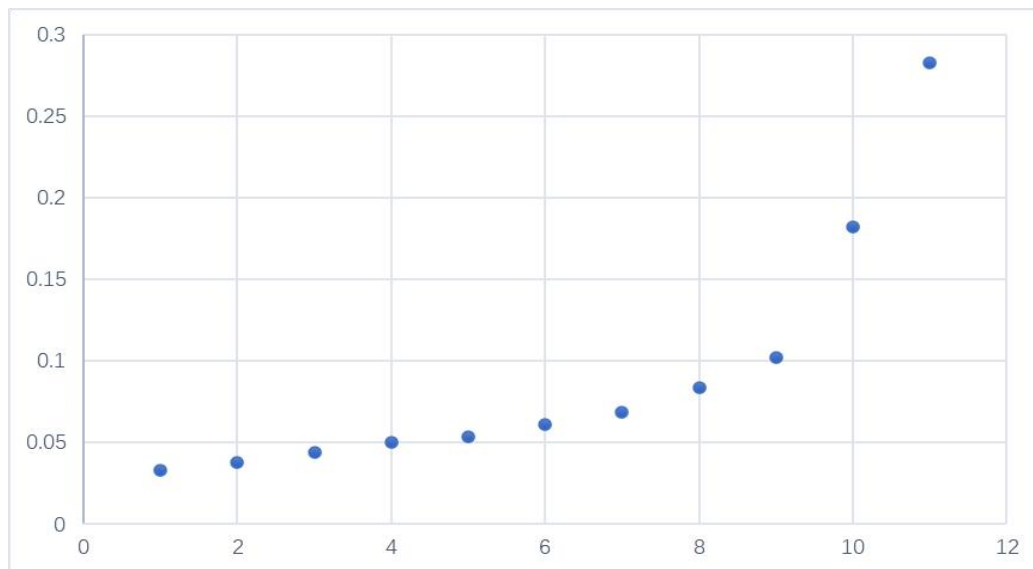


Figure 2. Scatterplot of evaluation indicators.

In the following part, the evaluation index and year were fitted, polynomial approximation method was adopted, and the relationship between y and x obtained by matlab fitting results was as follows:

$$y = 3.846e - 0.6x^5 + 8.159e - 0.6x^4 - 0.0008537x^3 + 0.006163x^2 - 0.009161x + 0.03727 \quad (2)$$

x is the code of the year; y is the evaluation index, and the larger the y value, the better the development status of the industry. The fitting effect is good, as shown in the figure 3:

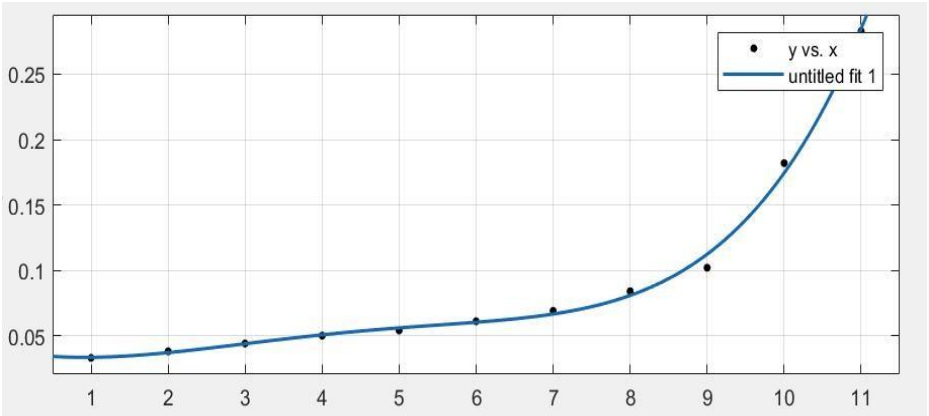


Figure 3. Evaluation index fitting curve.

Since the sales volume of new energy vehicles is selected as the measurement index of the development status of the industry, its time series is drawn as shown in the figure 4.

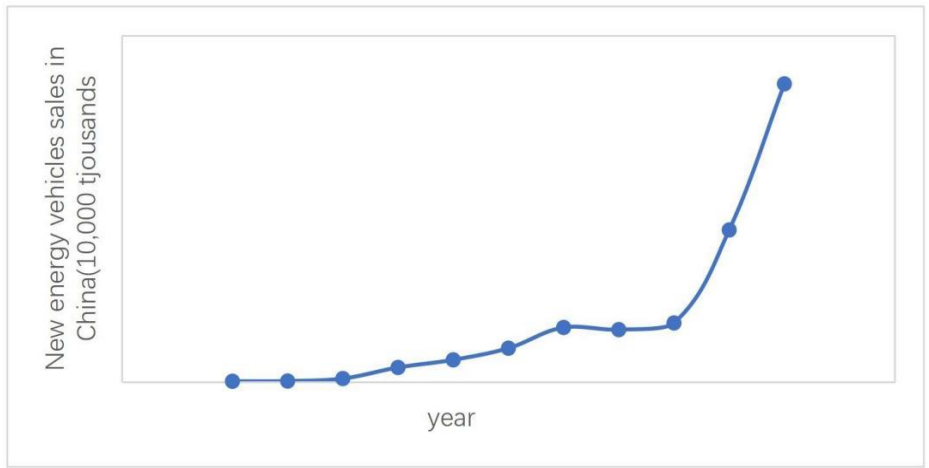


Figure 4. The time series of sales smoothed the marked curve.

As can be seen from the figure, the change trend of the evaluation index and the sales volume of new energy vehicles over time is roughly the same, so the evaluation index system constructed in this topic is reasonable.

Evaluation index forecast for the next ten years is shown in the figure 5.

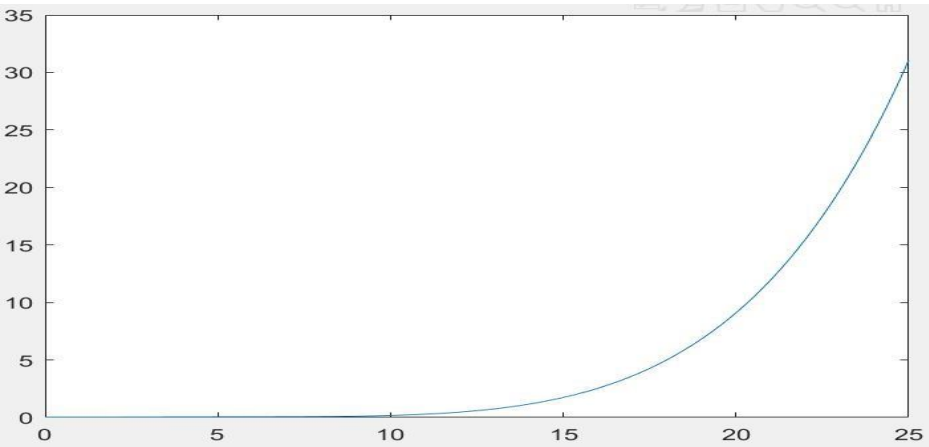


Figure 5. Evaluation index forecast for the next ten years.

It is known that the new energy automobile industry will develop rapidly and grow exponentially in the next ten years.

4. Conclusions

In summary, this study provides in-depth research and analysis of China's new energy vehicle industry based on the Spearman model. By considering various factors such as policy support, technological innovation, and infrastructure construction, we have made a comprehensive forecast of the development trend of the new energy vehicle industry. The results of the study show that the new energy vehicle industry will show a rapid growth trend in the next ten years, and its development will be influenced by a combination of factors such as policy, technology, and market. This study provides an important reference for relevant departments to formulate industrial policies, enterprises to carry out strategic planning and investors to make decisions. In the future, we will further improve the model and the accuracy of the forecast to contribute more to the sustainable development of China's new energy vehicle industry.

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