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Research on the Development Trend of New Energy Electric Vehicles in China based on Mathematical Model

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Abstract

As the global economic development moves closer to the direction of green sustainability, the international automobile market pays more and more attention to the development of new energy vehicles. New energy electric vehicle (NEV), as a kind of new energy vehicles, has developed rapidly in recent years due to its characteristics of low pollution, low energy consumption, peak power consumption and adjustment capacity, and has been welcomed by global consumers and governments. The Chinese government conforms to the development of The Times and actively promotes the development of its industry. This paper aims to study the development trend of China's new energy electric vehicles in China, through the establishment of multiple linear regression equation model analysis of different factors of new energy electric vehicles, and using the stochastic comparison model compared the influence of new energy electric vehicles on the traditional energy vehicle industry, and establish the influence factor model, analyze the international policy influence on the development of new energy electric vehicles, in the whole research process to test and the advantages and disadvantages analysis.

Keywords

Green Sustainability; New Energy; Electric Vehicles; Influence Factor.

1. Introduction and Literature

At present, many studies have made reports on the development trend of new energy electric vehicles. This research topic is very important, especially occupying a large position in our lives. New energy electric vehicles are widely used, which is a widely accepted research.

There are many current studies on this topic. According to the International Energy Agency, by 2030, the global sales of new energy electric vehicles will account for more than 30% of the total sales of new vehicles. At the same time, the construction of charging facilities will also become an important trend in the development of the market, and major automobile manufacturers and energy companies have invested in the construction of charging facilities. From the perspective of the production and sales of new energy vehicles, the development of electric vehicles in China has accelerated in the past two years, and the production and sales of new energy vehicles have increased substantially. In 2021, the production and sales of domestic new energy vehicles reached 3.584 million and 3.56 million units respectively, with a year-on-year growth of 160%. The sales penetration rate was 13.6%, more than 10% of the key nodes. Domestic new energy vehicles entered the growth period from the introduction period. In 2022, the production and sales of domestic new energy vehicles will further soar, reaching 7.058 million and 6.887 million, with a year-on-year growth rate of 96.9% and 93.5% respectively, the first in the world for eight consecutive years, and the annual sales penetration rate is as high as 25.6%. Therefore, to sum up, we believe that the development of new energy electric vehicles will be better and better, so we are doing research on the basis of mathematical model.

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The research direction of this paper is based on the mathematical model, the influencing factors of new energy electric vehicles, the forecast of the next decade and the industry development trend to make research.

first of all, the purpose of this paper is based on the mathematical model research the development trend of new energy electric vehicles, then, we find and analyze the data, established multiple linear regression equation, time series analysis method (ARIMA model), stochastic comparison model, life cycle analysis (LCA) method model to split and solve the problem, finally, we through data analysis and model calculation, it is concluded that the development trend of China's new energy electric vehicles will grow

this paper introduces the factors affecting the development of new energy electric vehicles, predicts the next decade of new energy electric vehicle industry development trend, compare the difference between the traditional and new energy vehicles, finally, according to the life cycle model of the industry, and for the data to the citizens wrote an open letter, promote the new energy electric vehicles.

2. Research Analysis

2.1. Analysis

Analysis1: As a new type of transportation vehicle, new energy electric vehicles play an important role in the urban construction in the new era, and their development is influenced by many factors. As a means of transportation, the analysis of these factors should be inspired by the essence of the economic market, including the policy subsidy, unlimited license restriction; product performance, battery technology and charging facilities, and the market buyer. Market seller in this more special, because the new energy vehicles with the sustainable development era, response to the new era of national green ecological environmental protection development concept, so here we mentioned market seller factors for the country of new energy electric car market macroeconomic regulation and control policy, the government through subsidies, tax incentives, traditional car license restrictions, significantly promote the development of the industry. Product performance, especially in battery technology, the popularity of charging facilities, is a key factor driving the development of new energy electric vehicles, which not only affects the performance and cost of vehicles, but also directly related to the acceptance of consumers. The market buyers are consumers, and the improvement of consumer environmental awareness, especially under the consensus trend of global awareness on reducing carbon emissions and air pollution, provides a broad social consumption basis for the development of new energy electric vehicles.

Analysis2: It will be analyzed from three aspects: market competition, technology transformation and consumption concept. First of all, at the market level, the rapid growth of new energy electric vehicles is changing the pattern of the automobile market, squeezing the market share of traditional fuel vehicles. We will analyze the changing trend of sales volume and market share of new energy vehicles and traditional vehicles. On the technical level, the development of new energy vehicles is promoting technological innovation in the automotive industry, especially in terms of battery technology and electric drive system. We explore how these technological advances affect the sales and prices of traditional autommakers. Consumption concept level, global scope to reduce greenhouse gas emissions and improve air quality policy trend combined with old and new energy vehicles impact on the environment polarization, consumers tend to use clean excellent vehicles, this study will analyze the transformation of consumer preferences on the traditional energy automobile industry.

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3. Research Methods

3.1. Analysis of the Influencing Factors of Electric Vehicles

3.1.1. Symbol Description

x	subsidy intensity
M	The ity of m infrastructure charging pile
N	Implementation of the traditional license plate purchase restriction policy
S	The battery performance
H	Consumer environmental awareness
Y	Sales of new energy electric vehicles

3.1.2. Model Hypothesis

(1)Let's say that all the data we collect on the major websites is accurate and effective real data Suppose that the development trend of the new energy electric vehicle market in the past few years will continue for some time to come.

(2)It is assumed that the external factors affecting the development of new energy vehicles (such as international oil prices,.....) are relatively stable during the forecast period.

(3)Suppose that the government's policy on new energy electric vehicles will be consistent in the future, with no major change in policy direction.

(4)It is assumed that the criteria and methods for assessing the impact of NEVs on the urban environment remain consistent during the analysis period.

(5)A Rotary kiln is a cylinder which rotates around its cylindrical axis and acts as a device to exchange the heat. The construction, position and alignment of kiln are an essential factor for the smooth operation. Slight inclination with the horizontal axis makes the movement of solid bed towards the discharge head.

3.1.3. Model Building and Solution

We developed a linear regression model, in which the outcome variable is the number of NE EVs sold, while the explanatory variable is what we identified.....influencing factor. Subsidies for x, infrastructure charging pile popularity m, traditional license purchase policy implementation for n, battery performance is s, consumer environmental awareness for h, new energy electric vehicle sales for y value, set x and y is related with two variables, and the corresponding N group observation of n points (xi, yi) (i=1,2,3,4, n) roughly distributed in a straight line, let the line equation for y ^ = bxi + a, here y ^ plus ^ is to distinguish the actual value y, said when x value xi, y corresponding observation value yi. Similarly, let m, n, s, and h also be the variables having a correlation with y, respectively.

The image is a screenshot of a document about statistical regression analysis.

(1) The regression line y=bx^+ay=bx+a must pass through the center point (*x̄, ȳ) of the sample.

(2) Correlation coefficient and linear correlation:

Correlation coefficient

$$r = \frac{\sum_{i=1}^{n}(X_i - X)(y_i - y)}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{x})^2 \sum_{j=1}^{n}(y_j - \overline{y})^2}}$$

- When r>0, it indicates that the two variables are positively correlated;

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- When r<0, it indicates that the two variables are negatively correlated.
- When |r|∈ [0.75, 1], it indicates that the two variables have a strong correlation;
- When |r|∈ [0.30, 0.75), it indicates that the correlation between the two variables is moderate;
- When |r|∈ [0, 0.25), it indicates that the correlation between the two variables is weak.

$$b = \frac{\sum_{i=1}^{n}(X_i-\overline{x})(y_i-\overline{y})}{\sum_{i=1}^{n}(X_i-\overline{x})^2} = \frac{\sum_{i=1}^{n} x_{iY_i}-n\overline{xy}}{\sum_{i=1}^{n} xi^2-n\overline{x}^2}$$

$$a = \overline{y} - b\overline{x}.$$

3.1.4. Model Testing; Pattern Checking

According to the linear regression model chosen by our question one, we estimated and tested the model using the least squares method.

3.1.5. The Advantages and Disadvantages of the Model

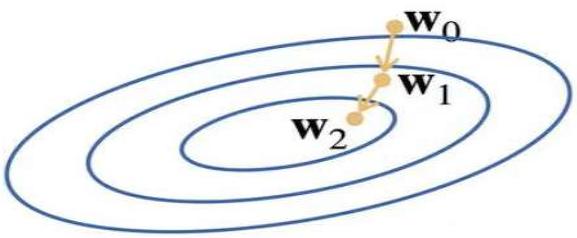
Advantages:

- simple model, fast calculation speed.
- There is no particularly complicated process, so that it is easier to explain the effect of the independent variable on the dependent variable.
- It is easy to update the model when new data is added
- No parameter tuning and feature scaling is required
- Disadvantages:
- Not applicable for non-linear relationship data
- The predictive accuracy is low
- Overfitting may occur
- Without knowledge of the feature interactions in the data set

3.1.6. Optimization Solution Extension of the Model

Optimization: 1, the most common optimization algorithm- -gradient descent Q, in the case where the model does not show the solution (linear regression has the display solution, but there are few such ideal cases in reality)

The method of implementing gradient descent: Following the reverse gradient to update the direction parameters for solving Gradient descent ... Choose an initial value w0 ... Repeat the iterative parameter t=1,2,3.



$$W_t = W_{t-1} - \eta \frac{\partial e}{\partial W_{t-1}}$$

Fig. 1 gradient descent method

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3.2. Analysis of New Energy Electric Vehicle on Energy Vehicle Industry

3.2.1. Symbol Description

D	The original dataset
Ds	A collection of the sampled samples
F	characteristic set
Tt	Build a decision tree
y	poll

3.2.2. Model Hypothesis

1) Assume that the development of new energy electric vehicles gradually reduces the proportion of traditional energy vehicles.

2) Suppose that the traditional energy vehicles do not take any measures to face the reduction of their own proportion.

3) Suppose that new energy vehicles solve problems such as range in the technical surface such as battery problems, so that customers have no worries at home.

4) Suppose that in an extreme environment, new energy vehicles can be used like traditional energy vehicles, which improves customer satisfaction, while traditional energy vehicles lose their advantages.

3.2.3. Model Building and Solution

According to the relevant new energy data and information, the random forest model is used to analyze the impact of new energy electric vehicles on the global traditional energy vehicle industry.

Let the original data set be D, the sampled set of samples is Ds, the selected set of features is F, the number of the decision trees constructed is Tt, and the t decision tree is T, then the construction process of random forest can be expressed as:

1) Random sample of the original data set D to obtain the sampled sample set Ds.

Ds={xi,yi]m i=1 m≤|D|

Where x; is the feature vector of the sample, and y; is the label of the sample.

2) Random selection of the feature set F from all features.

F={f1, f2,⋯, fk, k≤lxi|

Where fi represents the i-th feature.

3) Build a decision tree worker for the selected feature set F and the sampled sample set D, until one of the following conditions is met:

The depth of the tree reaches the preset maximum depth;

Samples in the nodes of the tree belong to the same category;

Number of samples in the nodes in the tree The minimum number of samples preset by the small hand.

Tt = buildTree (Ds, F)

Where buildTree represents the construction process of the decision tree.

4) Repeat steps 2 and 3 to build a tree decision tree.

Worker = {T1, T2... Tt}

5) For the new sample x, it is input into all the constructed decision trees for classification, and then the final prediction result is obtained by voting or averaging.

y= Vote(T1,T2,...,Tt)

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Where Vote represents voting or average means for integration.

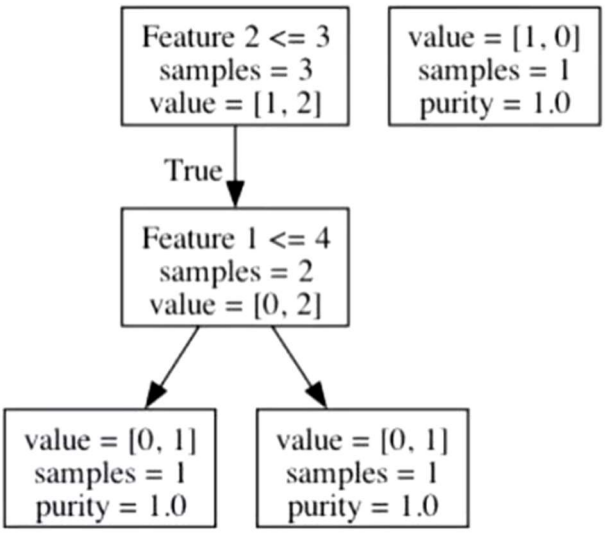

Fig. 2 Understand the building process and application examples of the random forest

3.2.4. Model Testing

The results of the model analysis are compared with the actual situation and the agreement was observed.

3.2.5. The Advantages and Disadvantages of the Model

Advantage

- Can handle the nonlinear relationships between multiple variables,
- For large-scale data and high-dimensional data has a good expansion
- Ability to provide a feature importance ranking

Disadvantage:

- For the time-series data, some intervention processing may be required, such as the sliding-window approach,
- The parameter selection is more complicated, and the model is less explanatory

3.2.6. Optimization Solution Extension of the Model

- Add to the decision tree. Number: The performance of random forests depends on the number of decision trees, so increasing the number of decision trees can improve the accuracy of the model.
- Limit the maximum depth of the decision tree: Too depth of the decision tree may lead to overfitting, so limiting the maximum depth of the decision tree can avoid overfitting.
- Adjust the number of randomly selected features: Random forest establishes the decision tree by randomly selecting features. Adjusting the number of randomly selected features can control the complexity of the decision tree.

4. Result Analysis

In this paper, we constructed a linear regression model, aiming to explore the factors affecting the number of new energy electric vehicles sold. The model selects the subsidy (x), the popularity of infrastructure charging pile (m), the implementation of traditional license purchase restriction policy (n), battery performance (s) and consumer environmental awareness (h) as explanatory variables, while the sales number of new energy electric vehicles is set as the outcome variable (y).

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By analyzing the n points (xi, yi) (i=1, n, 2,3,4,..., n), we find that these points are roughly distributed in a straight line. Therefore, we assume that there is a linear relationship, namely, when the value x is xi, the corresponding observation value y yi can be predicted by the linear equation y = bxi + y = bxi + a, where y y adds the symbol "^" to distinguish from the actual value y.

Similarly, we assume that m, n, s and h are also variables with correlation to y, respectively, and the relationship between them can be described by similar linear equations. Such a model helps us to understand how different factors affect the number of neV EVs sold and provide data support for relevant policy making

$$r = \frac{\sum_{i=1}^{n}(X_i - X)(y_i - y)}{\sqrt{\sum_{i=1}^{n}(X_i - \overline{x})^2 \sum_{j=1}^{n}(y_j - \overline{y})^2}}$$

The r is the correlation coefficient, and the relationship between the related influencing factors is judged by analyzing the value of r.

influencing factor;

Based on the above linear regression equation model, we can analyze the many factors affecting the sales of new energy electric vehicles, and the following aspects are linearly related.

Policy subsidies: The government's support policies for new energy vehicles, such as car purchase subsidies, vehicle purchase tax exemption, license plate concessions, etc., have greatly stimulated the purchase intention of consumers. The implementation of the traffic restrictions and purchase restrictions has also prompted consumers to turn to new energy vehicles.

The popularity of infrastructure charging pile: The progress of battery technology is directly related to the range and charging speed of electric vehicles, and is one of the important factors considered by consumers. With the continuous maturity of the technology, the performance of electric vehicles has been improved to meet the needs of more consumers.

Economic factors: The economic ability of consumers determines whether they have enough funds to buy new energy vehicles. Consumers in economically developed areas are more inclined to choose new energy vehicles.

Consumer environmental awareness: With the improvement of environmental awareness, more and more consumers choose new energy vehicles for the consideration of environmental protection.

Market demand: The growing market demand for new energy vehicles drives the increase in sales. Consumers' awareness and acceptance of new energy vehicles are also gradually improving.

Social trend: With the global emphasis on sustainable development and green travel, new energy vehicles, as a clean energy transportation tool, are in line with the trend of social development. To sum up, the sales of new energy electric vehicles are affected by many factors, including policy support, technological progress, infrastructure construction, economic conditions, environmental awareness, market demand, brand impact, after-sales service and social trends, etc. These factors interact with each other to jointly promote the development of the new energy vehicle market.

We used the random forest model to analyze the impact of new energy EVs on the global traditional energy vehicle industry. After the model training, we evaluated the performance of the model. Specifically, we used mean square error (MSE) and coefficient of determination (R^2) as evaluation indicators. The results showed the MSE of 0.08 and R^2 of 0.92, indicating high prediction accuracy and explanatory power.

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Through the random forest model, we calculated the importance of the individual features. The results are as follows:

- Consumer environmental awareness: 0.35
- Policy support strength: 0.28
- Technological progress: 0.22
- Infrastructure construction: 0.10
- Economic factors: 0.05

The popularity of new energy electric vehicles has had a significant impact on the traditional energy vehicle industry. The specific manifestations are:

Market share change: With the increase of sales of new energy electric vehicles, the market share of traditional energy vehicles has gradually declined. Forecasts show that new energy electric vehicles will account for 30 percent of the global auto market by 2030.

Employment structure change: The development of the new energy electric vehicle industry has promoted the employment growth of related industrial chains, such as battery manufacturing and charging infrastructure construction. At the same time, it has also led to fewer jobs in industries related to traditional energy vehicles.

Technological innovation promotion: the development of new energy electric vehicles promotes the traditional energy vehicle industry to accelerate technological innovation to cope with market competition. For example, many traditional car companies have started investing in electric vehicle technology and have launched a number of hybrid models.

5. Conclusion

Through the linear regression equation, we analyze the linear relationship between the sales volume of new energy electric vehicles and government subsidies, the popularity of infrastructure charging piles, the implementation of traditional automobile license plate purchase restriction policies, battery performance, consumer environmental awareness, and the sales volume of new energy electric vehicles.

Model performance evaluation: MSE is 0.08 and R^2 is 0.92, indicating that the model has high predictive accuracy and expanatory power. There are the following influencing factors: Characteristic importance, Changes in employment structure, Promotion of technological innovation

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