# Research on the External Effects of China's New Energy Vehicles

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**Abstract:** ***Based on the analysis of externality theory, this paper firstly concludes that new energy vehicles have energy security effects, industrial correlation effects, and environmental protection effects, and makes corresponding calculations. Secondly, using real options to evaluate them, the three levels of option value are obtained. Third, analyze the factors that affect the external effects of new energy vehicles, and establish a regression model to obtain the positive impact of new energy vehicle subsidies and oil reserve-production ratio at the macro level, while the secondary industry investment, crude oil prices, and Keqiang index are inverse. Impact; at the meso level, subsidies, renewable energy consumption, and the proportion of clean energy power generation play a positive role, and the monthly average PM2.5 concentration and car price index play a negative role; at the micro level, the proportion of clean energy power generation, subsidies, The number of new energy vehicles per capita and the percentage of fixed asset investment completed in the tertiary industry have a positive impact, while the Keqiang Index has a negative impact. Finally, according to the research results, put forward corresponding countermeasures and suggestions.***

**Keywords:** new energy vehicles, external effects, real options, principal component regression

## 1. Introduction

As one of China's strategic emerging industries, the government attaches great importance to the development of the new energy vehicle industry, and has issued a comprehensive incentive policy, ranging from government subsidies for research and development, double points for production, to financial subsidies and tax reductions for consumption. In the use of unlimited licenses, unlimited purchases, charging discounts on the operating side, etc., almost covered the entire life cycle of new energy vehicles. Among them, the subsidy policy and double-point policy have the most profound impact on the development of the industry. However, financial subsidies have significantly declined since 2017, and the issue of irrational pricing of points has caused China's new energy vehicle development to fall short of expectations. The main reason is that insufficient consideration is given to the external effects of new energy vehicles. The discounted cash flow method does not take into account the future uncertainty of new energy vehicles, making its value undervalued, which is extremely detrimental to the development of the entire industry.

By combing the research literature on new energy vehicles at home and abroad, it can be seen that in the research on the pricing of new energy vehicles, there are more foreign countries than domestic ones, and most of them are discussing consumer pricing or utility issues. The domestic research on the pricing of new energy vehicles mainly considers its high cost, environmental protection, and demand uncertainty. It has less consideration of other external effects.

In addition to related research on new energy vehicles, most of the research at home and abroad focuses on the effect of new energy vehicle subsidy policies, mainly divided into two aspects. First, the government's analysis of the role of consumer-side subsidy policies has formed various views. Some scholars believe that government subsidy policies have no effect on consumer purchases. Most scholars have shown that government consumption subsidies will directly affect consumers' decision whether to purchase new energy vehicles. Second, most scholars analyze the effect of new energy vehicle subsidy policies from the perspective of R & D, and the conclusion is that new energy vehicle subsidies can allow companies to develop better. Overall, there are still insufficient considerations for the external effects of new energy vehicles. Therefore, this article will focus on studying the external effects and influencing factors of new energy vehicles.

## 2. Analysis and Calculation

### 2.1 Analysis

From the externality theory, we know that in actual economic activities, the activities of producers or consumers may be beneficial to other producers or consumers, or they may be harmful non-market effects called externalities. The good influence is called positive externality; the bad influence is called negative externality. The research object of this article is new energy vehicles, and his appearance has brought a certain degree of benefit to all aspects of society. Therefore, the large-scale production and sales of new energy vehicles by producers will produce positive external effects.

#### 2.1.1 Macro level

Since 2009, China has introduced various support policies to actively develop new energy vehicles. The arrival of new energy vehicles plays an important role in alleviating energy security issues. Because the energy it uses is a kind of renewable energy, more people using new energy vehicles can reduce their dependence on oil, especially reducing the source of oil from foreign countries, which is conducive to a country's energy security and smooth economic development.


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Because the car's dependence on oil is mainly reflected in the fact that the car needs to use gasoline and diesel fuel refined by petroleum during driving, this paper uses gasoline and diesel consumption to indirectly express the degree of dependence on oil. The smaller the consumption, the better. The lower the degree of dependence. The figure below shows the total consumption and growth rate of gasoline and diesel in China's automobile manufacturing industry.

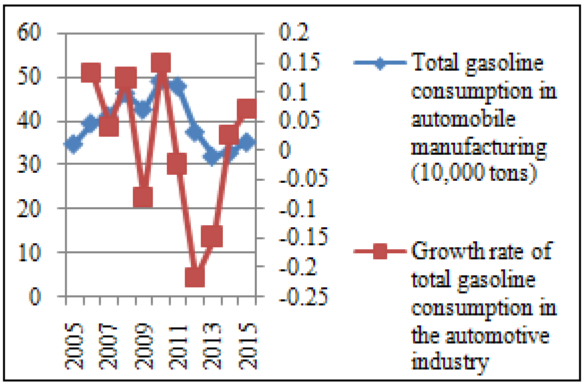


**Figure 2.1:** Total gasoline consumption and growth rate of China's automobile manufacturing industry from 2005 to 2015

It can be drawn from the figure that the total gasoline consumption of China's automobile manufacturing industry showed a trend of first increasing and then decreasing during the statistical period, and the decline point is basically consistent with the time point of the emergence of new energy vehicles in China, indicating Alleviating oil dependence plays a role. In addition, the growth rate of total gasoline consumption in the automobile manufacturing industry fluctuated sharply during the statistical period, and the sharp decline trend is roughly the same as that of new energy vehicles, thus further illustrating the above conclusions.

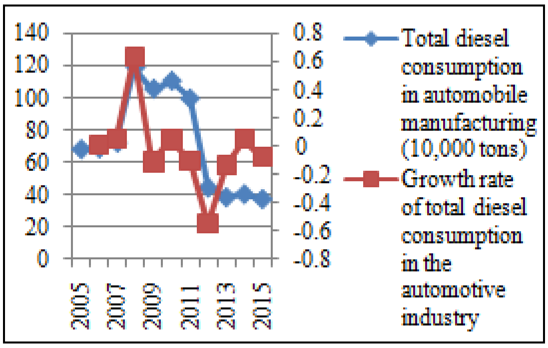


**Figure 2.2**Total diesel consumption in China's automobile manufacturing industry and its growth rate from 2005 to 2015

It can be seen from the analysis chart that the total diesel consumption of China's automobile manufacturing industry showed a watershed around 2008. Before that, the total diesel consumption of the automobile manufacturing industry showed an upward trend, and then began to decline. In addition, the figure also shows that the growth rate of total diesel consumption in the automotive industry also turned around in 2008, first increasing and then decreasing, and basically showing a negative growth rate after 2011, which can further explain its total consumption The trend of volume decline, and the decline of the two is basically consistent with the gradual development time of new energy vehicles, which shows that new energy vehicles have an effect in alleviating energy security problems. In short, through the analysis of the trend of total gasoline and diesel consumption in the automobile manufacturing industry and the time point of the emergence of new energy vehicles, it can be seen that new energy vehicles can help reduce dependence on imported oil.

### 2.1.2 Meso level

From the perspective of the industry value chain, the new energy automotive industry involves five links: mineral resource development, key component R & D, vehicle R & D and manufacturing, business model and technology application, and automotive aftermarket. Among them, the development of mineral resources includes lithium, copper, iron, nickel, cobalt, graphite, rare earth, magnesite, bauxite, etc .; key components include lithium-based power batteries, fuel batteries, drive motors, electronic control Systems, etc .; complete vehicle manufacturing includes passenger performance vehicles, commercial vehicles, and special vehicles; commercial applications include infrastructure, business models, and advanced technology; aftermarket maintenance, automotive electronics, training, leasing, finance, and Second-hand car. Recycle the battery for reuse, testing and certification.

In addition, from the comparison of the structure of traditional fuel vehicles and new energy vehicles, it can be seen that the new energy vehicle industry chain maintains the long chain characteristics of the traditional automobile industry, and also newly adds important links such as batteries, motors, and electronic controls. Since the power battery is the core of the new energy vehicle, coupled with data availability considerations, here focuses on the battery-related industry status driven by the new energy vehicle.

As can be seen from the foregoing, China's power production capacity is surplus and the utilization rate is low, and the development of the energy storage industry needs to be improved. New energy vehicles use electrical energy as their power source. Its promotion and application will effectively promote the energy storage of electrochemical methods such as lithium batteries and lead-acid batteries, which will effectively promote the further development of the energy storage industry and thus ease The role of excess electricity. The details are shown below.

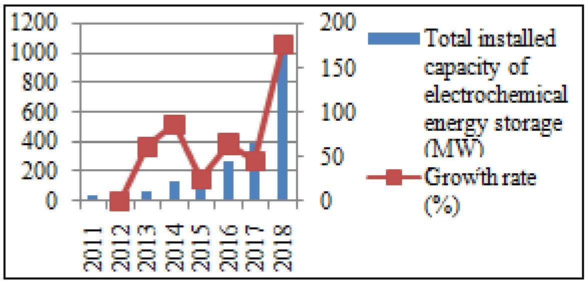


**Figure 2.3:** The cumulative installed capacity of China's electrochemical energy storage from 2011 to 2018


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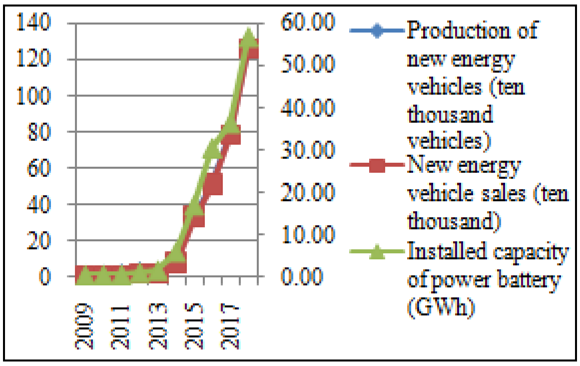


**Figure 2.4** 2009-2018 new energy vehicle production and sales volume and installed capacity of power batteries

Looking at the graph analysis, we can see that the industry's forward correlation effect is obvious. From 2009 to the present, with the increase in the production and sales of new energy vehicles, it is obvious that the installed capacity of power batteries has also increased rapidly. At the same time, the cumulative installed capacity of China's electrochemical energy storage also shows a rapid growth with the year. The cumulative installed capacity of China's electrochemical energy storage was only 40.7MW in 2011, broke through 100MW in 2014, and increased to 2017 To 389.8MW, a year-on-year increase of 45%. This indicator broke through the GW mark for the first time at the end of 2018, reaching 1072.7MW, a year-on-year increase of 175.2%, accounting for 16.2% of the total size of the global electrochemical energy storage market.

### 2.1.3 Micro level

In recent years, the rapid increase in the number of automobiles has directly led to the consumption of automobile combustion raw materials and the increase of exhaust pollutants. Among them, the problem of automobile exhaust pollution has become more prominent. After statistics, in many large and medium cities, the number of cars is actually "overloaded". The pollutants they emit will produce a greenhouse effect, destroy the ozone layer, produce acid rain, black rain and other phenomena, endangering many aspects of people's lives. The harm to the human body is caused by various diseases, serious damage to the respiratory system, and also has a strong carcinogenicity. In this regard, the EU's environmental protection experts believe that changing the relevant policies of urban transportation is the most effective way to reduce this hazard. In simple terms, it is to reduce the number of private cars by a large margin, take the lead in introducing buses, and promote bicycle driving; at the same time, we must accelerate the development and popularization of environmentally friendly cars.

New energy vehicles have the characteristics of not emitting exhaust gas or reducing exhaust gas emissions. Compared with traditional vehicles, they are conducive to protecting the environment and human survival. The following are China's automobile carbon dioxide emissions, pollutant emissions and their growth rates.

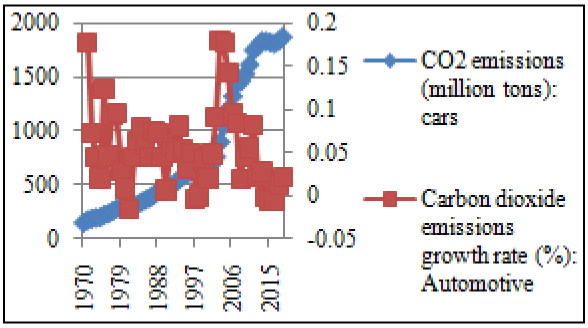


**Figure 2.5:** National automobile carbon dioxide emissions and their growth rate from 1970 to 2018

It can be seen from the figure that the overall amount of carbon dioxide emissions from automobiles in China shows an upward trend year by year. Judging from the growth rate of the amount of carbon dioxide emissions, roughly around 2009, its growth rate has dropped significantly. At this time, it is also the time for China to focus on R & D and promotion of new energy vehicles. With the increase of new energy vehicles, the growth rate of carbon dioxide gradually decreases, which shows that new energy vehicles have played a great role in reducing emissions.

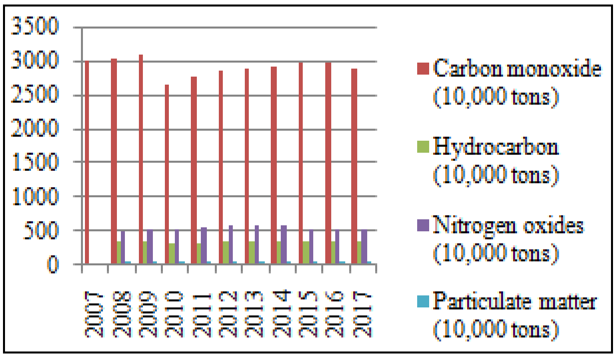


**Figure 2.6:** 2007-2017 national automobile major pollutant emissions

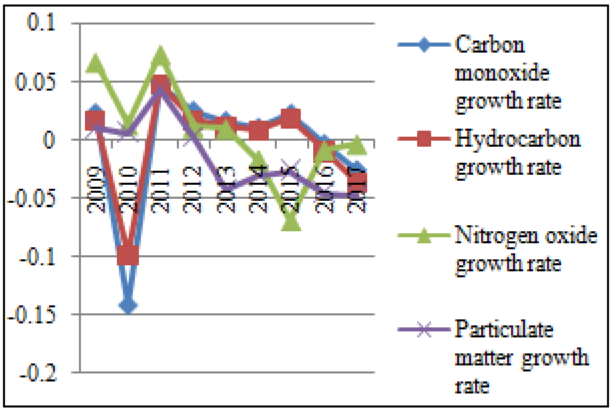


**Figure 2.7** 2009-2017 national automobile pollutant emission growth rate

It can be seen from the above that carbon monoxide emissions are the highest among the major automobile pollutant emissions in China, and their emissions began to decline after 2009. Followed by nitrogen oxides, hydrocarbons, and particulate matter, all declined slightly during the statistical period. From the perspective of the growth rate of various pollutants, the growth rates of carbon


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monoxide and hydrocarbons fluctuated significantly after 2009, with a negative value first and then tending to stability. Overall, the growth rate decreased while the growth rates of nitrogen oxides and particulate matter There is a downward trend, and the growth rate around 2012 is less than zero. In short, the time points at which the emissions of major pollutants in automobiles and their growth rates change are basically consistent with the emergence of new energy vehicles, which shows that new energy vehicles can help protect the environment on which humans depend.

In short, combined with the current development status of China and the emergence of new energy vehicles, new energy vehicles have played a positive role in reducing oil import dependence, driving battery and other related industries, and reducing pollutant emissions, that is, new energy Cars have positive external effects. Next, the specific external effects of new energy vehicles will be measured.

### 2.2 Calculation

The measurement of the positive external effect of new energy vehicles is to determine the external benefits brought by new energy vehicles. E represents external income, B always represents the total benefits brought by new energy vehicles, and B represents the income received by new energy vehicles. The size of total external income E = B total-B enterprise = (E1 + E2 + E3 + B enterprise) -B enterprise = E1 + E2 + E3, where E1, E2, E3 represent macro, meso, and micro levels respectively The external benefits of energy are the effects of energy security, industrial linkage, and environmental protection.

The specific calculation idea is that the external effects at the macro and micro levels are indirectly expressed by the national automobile effort, and the external effects at the meso level are expressed by the output value of new energy vehicles. Calculated as follows:

E1 = gasoline and diesel consumption multiplied by the average annual price of the corresponding oil
E2 = New energy vehicle industry output value = automobile industry output value multiplied by the share of new energy vehicle sales
E3 = National vehicle pollutant emissions multiplied by pollution control

## 3. Evaluation Based on Real Options

### 3.1 Option characteristic analysis and type identification

#### 3.1.1 Analysis of option characteristics

New energy vehicles belong to China's strategic emerging industries, with long cycles, large capital needs, and technologies that need to be improved. They are susceptible to government policies, regional economies, and market demand. Therefore, their social benefits are external effects There is uncertainty.

First, new energy vehicle policy changes. The new energy vehicle industry relies heavily on policies, and there are many unstable factors in related policies, so its future development is full of uncertainty.

The new energy vehicle policy will affect the long-term development of its entire industry, especially the current subsidy policy, which will affect the production and sales of new energy vehicles and the development of upstream and downstream related industries. The statement of “adopting a slope-reduction mechanism to appropriately reduce subsidy standards” was included in the pilot policy for private purchase subsidies that began in 2010. Subsequent subsidy policies also use the mechanism of gradually retreating slopes as the year increases, and the speed of slope retreat gradually becomes faster . In 2013, the new energy vehicle subsidy standard used the reference year as the reference object, and the words of dynamic adjustment in the downward direction according to the year appeared in the "Notice on Continuing the Promotion and Application of New Energy Vehicles" by the four ministries and commissions including the Ministry of Finance.

Specifically, on the basis of 2013, the subsidy standard will be reduced by 10% in 2014 and by 20% in 2015. In 2015, the deadline for fiscal policy subsidies was again clarified by the Ministry of Finance and other four ministries and commissions "Notice on the Promotion and Application of Financial Support Policies for New Energy Vehicles 2016-2020". The standard fell by 20%, and by 40% in 2019-2020. In the new national subsidy policy in 2019, compared with 2018, the amount of subsidies has also been significantly reduced, the overall retreat rate exceeds 50%, and the product requirements have been increased. Local subsidies were cancelled and replaced by basic facilities such as charging and hydrogenation. In general, the continuous adjustment and changes of subsidy policies have brought certain uncertainties to the development of the new energy vehicle industry.

Second, the regional economic situation. According to the different economic development conditions, the development status of new energy vehicles has also been differentiated. In addition to subsidies at the national level, they are also affected to some extent by local policies. Specifically, compared with other provinces and cities in the east, some provinces and cities in the northwest and some capital cities in the northeast, the proportion of local subsidies in the central government is relatively low. Lower. In summary, the subsidies for new energy vehicles are relatively higher in economically developed areas than in economically underdeveloped areas. The difference in economic development makes the policy support different to a certain extent affect the development of new energy vehicle industry.

Third, demand factors. In terms of market demand, the safety performance and technology of new energy vehicles have not yet matured and need to be further improved. Although most people's awareness of environmental protection is gradually increasing, the purchase of new energy vehicles takes into account their mileage, safety or not. Factors, there will still be concerns, resulting in new energy vehicles still lacking


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vitality on the demand side, and greater uncertainty in the future.

In short, the development of new energy vehicles is uncertain, and the resulting external effects will also be uncertain. Combining with the theoretical analysis of real options, we can see that it is scientific and effective to evaluate the external effects of new energy vehicles using real option methods.

#### 3.1.2 Option type identification

Through the above analysis, it can be seen that the external effects of new energy vehicles are uncertain. This article studies the external effects from the perspective of the government. Therefore, we consider the government's subsidies as an investment. The government's subsidies for new energy vehicles are expected to expand external effects, which is equivalent to buying a call option. When an enterprise applies to the government for subsidy funds, it can be regarded as when the government buys a call option. When the government issues a subsidy to the enterprise, it can be considered as an option. Myers pointed out that an investment project is regarded as the price of the underlying asset in the calculation of the discounted value of future cash inflows of real options, and the cost of the investment is the price at the time of option execution. In this option, the input cost is subsidized funds, and future returns are external effects. Therefore, an option profit and loss chart can be established, as shown below. The external effects of new energy vehicles are uncertain. According to real option theory, this is the uncertainty of returns. When the external income is higher than the subsidized funds, that is, the price of the underlying asset (S)> execution price (K) + option fee (C), the government is willing to buy a call option, when the external income is lower than the subsidized funds, the exercise , Loss K + CS. Since this paper studies the external effects of three levels of new energy vehicles, in order to facilitate analysis and comparison, so the method of calculating the value of options separately.

### 3.2 Model construction and parameter selection

#### 3.2.1 Model building

This method of real options not only considers the intrinsic value of the project, but also embodies the time value brought about by the uncertainty in the investment process, and more reflects the true value of the project investment. Therefore, based on the characteristics of the external energy options of new energy vehicles and the types of options included, this paper intends to use the Black-Scholes option pricing theory to construct a new energy vehicle external effect evaluation model. Calculated as follows:

$$C = S(t)N(d_1) - Ke^{-r_f(T-t)}N(d_2) \quad (1)$$

Where N (·) is the cumulative normal distribution function

$$d_1 = \frac{\ln(s(t)/K) + (r_f + \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}},$$

$$d_2 = d_1 - \sigma\sqrt{T-t}$$

In the formula: C is the price of European physical call options, that is, the option value of external effects of new energy vehicles; S is the price of the expected underlying asset, that is, external effects; K is the execution price, which is the subsidy fund; Market risk; T is the exercise period of options; r is the risk-free interest rate; N (d1), N (d2) are the cumulative probability distribution function of standard normal distribution.

#### 3.2.2 Parameter selection

**a) Expected future price of an asset S**

This article intends to use the external effects at the macro, meso, and micro levels measured in Chapter 3 to represent the expected asset price.

**b) The cost of acquiring the asset in the future K**

For the cost of acquiring assets, this article uses the government to promote the application of financial subsidies to express, because the proportion of local financial subsidies varies, so here mainly refers to the central financial subsidies. Because the liquidation of new energy vehicle subsidy funds has not yet been announced, and is announced in batches, it is not possible to determine the subsidy funds for each past year. However, on September 8, 2016, the Information Office of the Ministry of Finance issued the “Notice on the Opening of Local Budget and Final Accounts and Special Inspection of Subsidy Funds for the Promotion and Application of New Energy Vehicles”. The document said that the central government subsidized the promotion and application of new energy vehicles. Since 2009, the central government has allocated a total of 33.435 billion yuan in subsidies as of the end of 2015. Therefore, this article combines the published data on the liquidation of funds in 2016 to calculate the cumulative subsidy funds for 2009-2016, and then calculates the annual calculation according to the proportion of new energy vehicle sales. The subsidy funds for 2017-2018 are only pre-allocated data. Therefore, the calculation of the new energy vehicle sales growth rate is calculated to complete the subsidy funds for each year, and then the monthly subsidy funds are calculated based on the monthly new energy vehicle sales as a percentage of the annual sales.

**c) Timeliness of options T**

The term of option is the effective period of investment opportunity, that is, the time from the option to the expiration date. It refers to the period from when the enterprise applies for subsidy funds until the funds are issued. The new energy vehicle subsidy fund allocation method was first proposed in 2010 to provide subsidies for individuals buying new energy vehicles. The cities in trial operation are allocated and paid on a monthly basis. In 2013, the central government stipulated that the subsidy funds should be allocated to new energy vehicle production enterprises, which should be pre-allocated on a quarterly basis and annual inspection and accounting. In 2016, the capital appropriation was changed to the beginning of each year. After the production company submitted the previous year 's capital settlement report and product sales and operation, including sales invoices, product technical parameters and vehicle registration information, etc., the subsidy was paid. In order to simplify the calculation, this article is based on the application of the production company


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at the beginning of the year, and the period of end of year verification and liquidation of the Ministry of Finance is used as the option exercise period.

**d) Risk-free interest rate rf**

The risk-free interest rate refers to the rate of return obtained by investors investing in risk-free bonds, usually using the risk-free bond interest rate or bank deposit interest rate with the same duration as the option. The benchmark interest rate of the one-year fixed deposit of the central bank is used here. If multiple adjustments are made within a year, the average value will be taken, and the unadjusted calculation will be based on the benchmark interest rate of the fixed deposit of the previous year.

**Table 3.1:** Summary table of risk-free interest rate values by year (unit:%)

| time | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 |
|---|---|---|---|---|---|---|
| rf | 3.06 | 3.06 | 2.625 | 3.25 | 3.125 | 3.125 |
| time | 2014 | 2015 | 2016 | 2017 | 2018 | - |
| rf | 2.75 | 2 | 2 | 2 | 2 | - |

**e) Volatility σ**

Volatility refers to the volatility of option price changes. This article refers to changes in external effects.

Energy security is mainly affected by changes in oil prices, so it is characterized by the volatility of oil and finished product price indexes. Variance and standard deviation are the most important in applied mathematics and the most commonly used indicators to estimate the degree of difference in data changes. However, in real statistical work, because the measurement units and dimensions of variance are inconvenient to explain in an economic sense, the arithmetic square root of variance or standard deviation is often used to estimate statistical data differences. Therefore, oil and the standard deviation of the product price index represents the volatility.

At the meso level, it mainly studies new energy vehicles to drive the upstream and downstream industries, which is conducive to the development of the entire industry chain. The changes in the industry chain are intended to be represented by the new energy vehicle stock price index, because the stock price contains investors' expectations of listed companies in the industry, and its volatility can better indicate the changes in the industry. The release date of the New Energy Vehicle Index (884076) was December 31, 2013, with December 31, 2009 as the base day, and the base point was 1,000 points. Moreover, the meaning of the index is consistent with the research object of this article. Various types of products, such as hybrid electric vehicles, pure electric vehicles, fuel cell electric vehicles, hydrogen engine vehicles, other new energy vehicles, etc. Relevant listed companies involved in new energy vehicles, power systems, spare parts and supporting facilities. Therefore, this selects the new energy vehicle index from the date of publication to the end of 2018, and then calculates its volatility based on the historical volatility of the stock.

At the micro level, because the quality of the environment will have a certain impact on human health, the changes in environmental effects are selected from the changes in the air quality comprehensive index of 74 cities in the country. The specific calculation method is to use the historical stock volatility method Calculation.

**3.3 Results analysis**

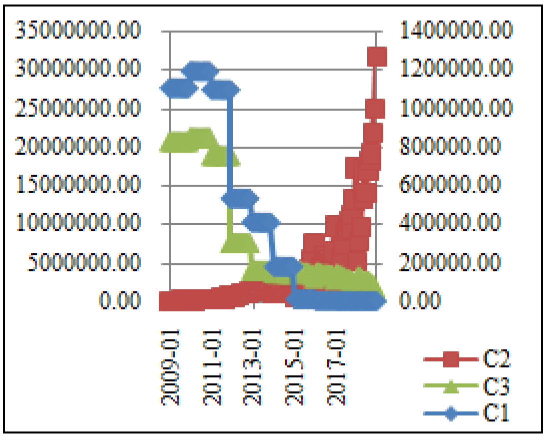


**Figure 3.1**Value of external effect options

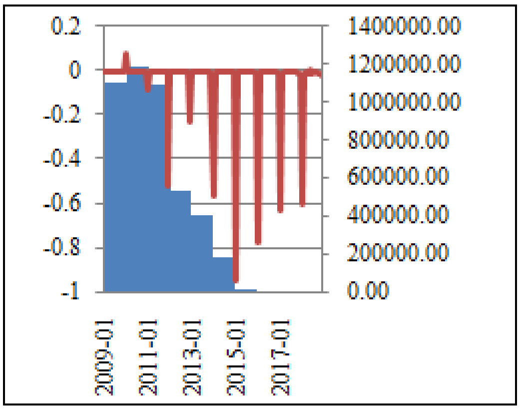


**Figure 3.2:** Value and growth rate of energy security effects on opposite options

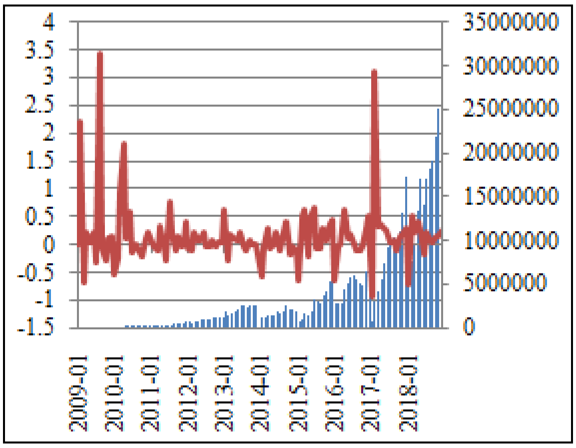


**Figure 3.3:** Option value and growth rate of industrial linkage effects


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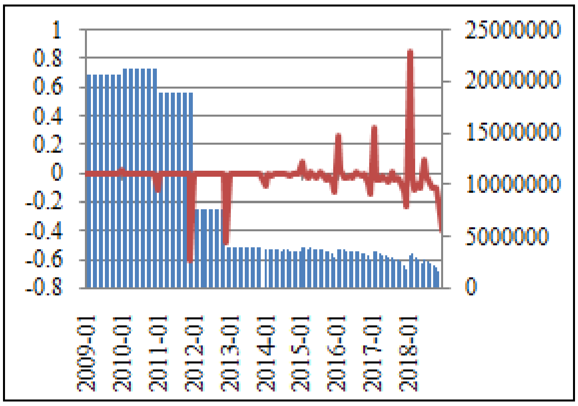


**Figure 3.4** The value and growth rate of the opposite option of environmental protection effects
Note: Blue bar chart represents option value, the red line represents the growth rate.

From the above chart, we can know the trend and speed of the change of external effect option value at the macro, meso and micro levels of new energy vehicles. The macro and micro levels measure the two opposites, that is, the cost value. Therefore, the option value of the new energy vehicle energy security and environmental protection in Figure 3.1 declines, and the meso level calculates the return value, so Is an upward trend. Figure 3.2 shows that the value of the opposite side of the energy security effect is declining, the growth rate is basically negative, and the absolute value increases, indicating that the decline is getting faster and faster, which indirectly indicates that the energy security effect of new energy vehicles is more significant. The value is getting higher and higher, and the rate of value added is also accelerating. Similarly, the analysis of Figure 3.4 shows that the environmental protection effect of new energy vehicles is obvious, its role in the environment is increasing, its value is gradually increasing, and it is in the acceleration stage. The impact of new energy vehicles on industry associations has also gradually increased, and the overall value of options has shown an upward trend, in which the amplitude of the rise has experienced several large fluctuations.

In short, the external effects of new energy vehicles appear, and their own value gradually increases. From the perspective of growth rate, the rate of value increase is accelerating. Although the growth rate has experienced a large fluctuation inconsistent with the overall during the statistical period, this is mainly due to changes in new energy vehicle policies, such as changes in purchase subsidies, etc. When trial subsidies began in 2009, the growth rate was relatively large, which mainly benefited from the government's subsidy policy.

## 4. Empirical Research

### 4.1Model building

It is assumed that external effects $Y_1$, $Y_2$, and $Y_3$ are expressed as effects on energy security, Industry related, and environmental protection, $X_1$, $X_2$, and $X_3$ ... represent the factors that affect the external effects of new energy vehicle $\alpha(\alpha_1,\alpha_2,\alpha_3\cdots)$, $\beta(\beta_1,\beta_2,\beta_3\cdots)$, $\gamma\ (\gamma_1,\gamma_2,\gamma_3,\cdots)$ represent parameters, that is, the degree of influence of the independent variable on the dependent variable, all greater than zero and less than one.

$$Y_1=\alpha_1X_1+\alpha_2X_2+\alpha_3X_3+\alpha_4X_4+\alpha_5X_5 \quad (1)$$
$$Y_2=\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5 \quad (2)$$
$$Y_3=\gamma_1X_1+\gamma_2X_2+\gamma_3X_3+\gamma_4X_4+\gamma_5X_5 \quad (3)$$

### 4.2 Empirical results

#### 4.2.1 Principal component regression

The principal component analysis method adopted in this paper is based on the factor analysis method in multivariate statistics. First, use statistical software to do orthogonal exchanges on the original variables to obtain new variables, that is, principal components; then according to the component matrix, through V1 / SQRT (initial eigenvalues of corresponding principal factors in factor analysis), we can know the eigenvectors of the principal components; then Then, the calculation formula of the principal component variables is listed by the feature vector as (4); again, OLS regression of the principal component variables to the dependent variables to obtain the equation (5). Finally, substitute (4) into (5) to get the principal component regression of the dependent variable to the original independent variable. This article mainly uses this method at the meso and micro level to eliminate the problem of multicollinearity.

$$Zi=\alpha_1X_1+\alpha_2X_2+\alpha_3X_3\cdots+\alpha_kX_k \quad (4)$$
$$Y=\beta_1Z_1+\beta_2Z_2+\beta_3Z_3\cdots+\beta_iZ_i \quad (5)$$

#### 4.2.2 Empirical results

(a) Energy security effect

$LNC1=-1.387X_1+0.280X_2+0.178X_3-0.675X_4+1.018X_5$

t test：$P_1=0.000$ $P_2=0.000$ $P_3=0.006$ $P_4=0.000$ $P_5=0.000$

F test：P=0.000

Goodness-of-fit test：$R^2=0.966$ Adjust $R^2=0.965$

**Table 4.1** Influencing factors of energy security

| Variable | LNC1 | Energy security |
|---|---|---|
| New Energy Vehicle Subsidies$X_1$ | - | + |
| Crude Oil Prices$X_2$ | + | - |
| Kraken Index$X_3$ | + | - |
| Oil Reserve-production Ratio$X_4$ | - | + |
| Investmentin The Secondary Industry$X_5$ | + | - |

Compared with the hypothesis, it can be seen that the crude oil price X2 is not consistent with expectations. This is explained as follows. The general situation is that the price of oil is high, the consumption of crude oil is low, and the amount of crude oil imports is small. The two have an inverse relationship, but the results in the model are inconsistent with the analysis. This is mainly because crude oil is the industrial foundation of a country 's economic development, and its rigid demand is large, and its supply is not greatly affected by prices. In addition, crude oil can be processed into derivatives such as gasoline, kerosene, and diesel after being mined. They are closely related to various industries in a country's economy. It can be said that the normal development of a country's economy is inseparable from the supply of crude oil. A necessity. Second, the possibility of oil being replaced is


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unlikely. In many fields, new energy cannot replace oil. In addition, crude oil production is cyclical and cannot be produced in the short term. Finally, China's oil reserve mechanism is not yet sound enough. When oil prices are at a high level, it cannot release oil reserves in a timely manner. Therefore, China still uses imported crude oil to meet the normal operation of the domestic economy.

(b) Industry related effects

$LNC2=0.925*Z_1-0.210Z_2$

t test：$P_1=0.000$ $P_2=0.025$

F test：P=0.000

Goodness-of-fit test：$R^2=0.691$ Adjust $R^2=0.686$

$Z_1=0.476X_1+0.516X_2+0.485X_3+0.144X_4-0.501X_5$

$Z_2=-0.297X_1+0.151X_2-0.225X_3+0.912X_4-0.084X_5$

Substitution available：

$LNC2=0.5027X_1+0.4456X_2+0.4959X_3-0.0583X_4-0.4458X_5$

**Table 4.2:** Influencing factors of industry association

| Variable | LNC2 | Industry related |
|---|---|---|
| NewEnergyVehicleSubsidies$X_1$ | + | + |
| Proportion of Clean Energy Power $X_2$ | + | + |
| Renewable Energy Consumption$X_3$ | + | + |
| Car Price Index $X_4$ | - | - |
| PM2.5 Monthly Average Concentration $X_5$ | - | - |

(c) Environmental protection effect

$LNC3=-0.360*Z_1+0.307*Z_2$

t test：$P_1=0.001$ $P_2=0.000$

F test：P=0.000

Goodness-of-fit test：$R^2=0.645$ Adjust $R^2= 0.639$

$Z_1=0.570X_1-0.064X_2+0.438X_3+0.559X_4+0.408X_5$

$Z_2=0.064X_1+0.839X_2+0.273X_3+0.141X_4-0.445X_5$

Substitution available：

$LNC3=-0.1856X_1+0.2806X_2-0.0739X_3-0.1580X_4-0.2835X_5$

**Table 4.3:** Influencing factors of environmental protection

| Variable | LNC3 | Environmental protection |
|---|---|---|
| NewEnergyVehicleSubsidies$X_1$ | - | + |
| Kraken Index$X_2$ | + | - |
| Percentage of Completed Fixed Asset Investment in the tertiary industry$X_3$ | - | + |
| Per Capita Possession of New Energy Vehicles$X_4$ | - | + |
| Proportion of Clean Energy Power Generation $X_5$ | - | + |

## 5. Conclusions and Recommendations

### 5.1 Conclusions

First, Based on the externality theory, this paper draws the external effects of China's new energy vehicles, specifically divided into three levels: energy security, industrial association, and environmental protection, and calculates them accordingly. At this stage, the government subsidizes Pigovian tax theory.

Second, Seen horizontally, the degree of influence of factors at various levels from large to small is as follows (in parentheses are the influence directions of various factors on external effects).

At the macro level, the new energy vehicle subsidies X1 (+),Investment in the secondary industryX5 (-),Oil reserve-production ratio X4 (+), crude oil price X2 (-),Kraken Index X3 (-);

At the meso level, the subsidies are new energy vehicle subsidies X1 (+), renewable energy consumption X3 (+), PM2.5 monthly average concentration X5 (-),Proportion of clean energy powerX2 (+), car price index X4 (-);

At the micro level, it is the proportion of clean energy power generation X5 (+),Kraken Index X2 (-), new energy vehicle subsidy X1 (+), per capita new energy vehicle ownership X4 (+),Percentage of completed fixed asset investment in the tertiary industryX3 (+).

Finally, From a longitudinal perspective, the impact of new energy vehicle subsidies on the three levels is in order of energy security, industrial linkage, and environmental protection, and all have a positive impact.

### 5.2 Recommendations

(1) From the horizontal and vertical comparisons, it can be seen that subsidies have an important impact on the external effects of new energy vehicles, specifically, the external effects have a positive effect, but from the past years of subsidy policies, the amount of subsidies has decreased year by year, and the standards have gradually increased. For this situation, this article suggests that the government should increase subsidies, especially in the new energy vehicle industry chain that requires key support links, such as charging pile construction, development and assistance to the new energy used car market.

(2) From a horizontal perspective, this article suggests the following points. Upgrade and adjust the industrial structure, vigorously promote fuel saving and consumption reduction; Improve exploration and development capabilities, improve energy supply level; Compete for the right to speak for crude oil pricing and improve the crude oil reserve mechanism; Strengthen clean energy research and development, and actively improve the energy structure; Practice the concept of green development, promote the construction of ecological civilization.

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