

# Environmental and Health Benefit Assessment of New Energy Vehicle Promotion in the United States

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**Abstract.** The development of the new energy automobile industry has had a great impact on the American economy. However, in the growth of the new energy automobile industry, whether it has produced certain environmental and health benefits needs to be discussed urgently. Therefore, this paper evaluates the short-term and long-term environmental and health benefits of the new energy vehicle promotion through theoretical review, factual analysis, and metrological tests. The results are as follows. Firstly, the current promotion of new energy vehicles in the United States has given rise to significant emission reduction and energy-saving effects, but it has failed to effectively reduce per capita medical expenditure and improve residents' health; Secondly, from a long-term perspective, the health benefits of the new energy vehicles promotion will gradually emerge, so it is vital to consistently develop the new energy vehicle industry; Finally, the new energy automobile industry in the United States will still be in a fluctuating growth trend in the future. Strengthening its risk avoidance ability is of indispensable practical significance for optimizing the industrial structure of the United States, guiding the development of emerging industries, and solving environmental and health problems.

**Keywords:** New Energy Vehicle Promotion; Environmental Benefit; Health Benefit; Benefit Assessment.

## 1. Introduction

The United States is one of the major markets for new energy vehicles in the world. Since the advent of new energy vehicles, the new energy vehicle industry in the United States has been in continuous development in the midst of shocks and fluctuations, from the end of the 20th century to the sales volume exceeding 600,000 in 2021. At the same time, local governments have also issued relevant policies to help the industry, such as the enactment of the *Energy Independence and Security Act* put forward by the Federal Government, the *Zero Emission Vehicle Act* implemented by California, Massachusetts, and other States, etc. It can be seen that the potential of the new energy industry in the United States is unprecedented. However, with regard to the essence of its advent, that is, "developing new energy to improve environmental pollution and residents' health", we do not know what environmental and health effects the new energy automobile industry has produced. Thus, to fully reveal the environmental and health effects brought by the development of the American new energy automobile industry, this paper will study three aspects. (1) Combining the historical data of the American new energy automobile industry as well as the environment, energy, and medical treatment, this paper analyzes the realistic environment of new energy automobile promotion, which is convenient for us to understand the factual context of its development and evolution; (2) From a short-term perspective, this part examines the policy effect of the new energy vehicles promotion and the impact of new energy vehicles on the environment and health. This part analyzes the development of the new energy vehicle industry in the United States from a quantitative perspective; (3) we forecast the sales volume of new energy vehicles from a long-term perspective, and further analyze its time-varying effects on the environment and health, which provides abundant empirical evidence and theoretical reference for its long-term development.

## 2. Literature Review

Given that the new energy automobile industry is emerging and its development is short, there is not much existing research. Then, we will summarize and comment on the related research around the development and shocks of the new energy automobile industry.

Studies are abundant on the development of new energy vehicles and industry fluctuations, forming the following three arguments. First, the essential characteristics of the new energy automobile industry will cause the industry to grow in shock. Because new energy vehicles and even new energy industries belong to emerging technology enterprises, technological innovation will lead to strong competition inside and outside enterprises. According to the theory of competitive advantage, the survival of the fittest within the industry and a large number of emerging enterprises without advantages will withdraw, so the current new energy vehicle industry cannot guarantee stable development (Klepper, 1996; Carree & Thurik, 2000; Adams et al., 2019). Second, there is great technical uncertainty in the new energy automobile industry. Generally speaking, emerging formats have high technical uncertainty and unclear technical return. Therefore, many enterprises in the industry will choose a lower production capacity, which leads to weak risk aversion ability of enterprises. Once great changes have taken place in the industry, many enterprises will be forced to withdraw, resulting in industry shocks (Cabral, 2012; Furr & Kapoor, 2018; Bonaccorsi et al., 2020). Third, there are many factors affecting the development of the new energy vehicle industry, such as industry supportive policies, price subsidy policies, and consumer perception. The changes in these factors virtually inhibit the industrial development speed and change the impact path of the new energy vehicle popularization (Hao et al., 2014; Ma et al., 2017; Sun et al., 2019). In addition, few studies exist on the impact of new energy vehicle development and the direct policy impact on the environment (Liu et al., 2018), but few studies systematically expound on this issue.

According to the existing research, it is not difficult to find that the new energy automobile industry in the United States is in steady development. There are many studies on the development of the new energy automobile industry, but few studies comprehensively analyze the growth model of new energy vehicles and give its impact on the environment and health. Therefore, this paper will systematically analyze the development of new energy vehicles, and answer the environmental and health effects of new energy vehicles from short-term and long-term perspectives, which will provide an important reference for the short-term transformation and long-term development of new energy vehicles in the United States.

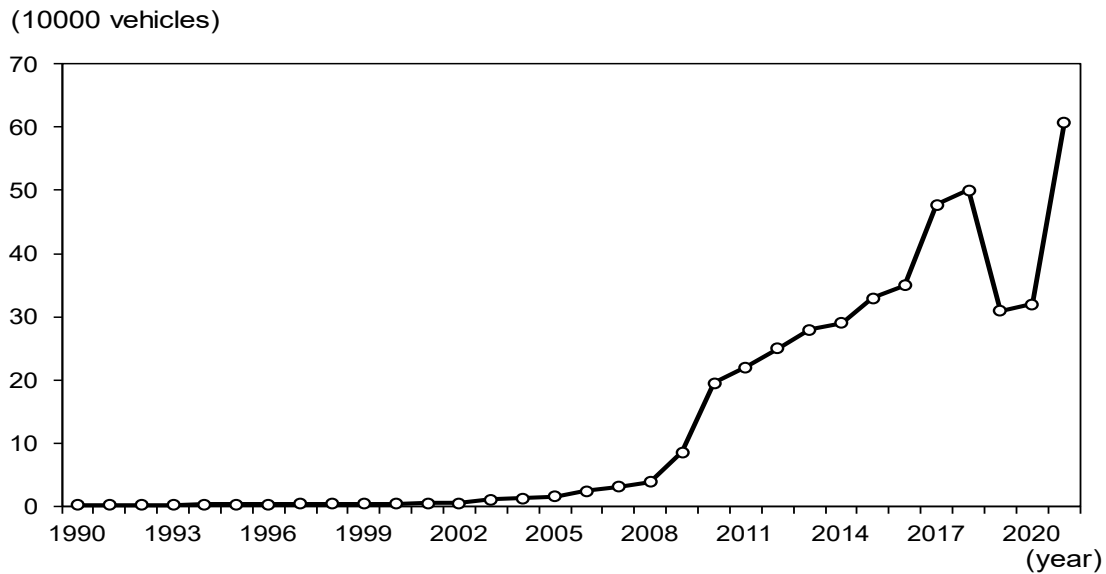
## 3. Study Area

This section will comprehensively expound on the general situation of the new energy vehicles development in the United States, and the changing trend of environment and health through the typical fact analysis of the main research indicators. This part not only explains the research environment and sample range, but also provides a crucial factual reference for empirical design. In the environmental effect assessment of the new energy vehicle industry development, we chose the carbon emission index representing pollution and the electricity consumption index closely related to new energy vehicles representing energy consumption; In the evaluation of health effects, we choose per capita medical expenditure as the evaluation index. The research scope is locked in 1990-2021 (the annual data of 2022 has not yet been released), that is, the initial new energy automobile industry to the present period.

### 3.1 New Energy Vehicle Industry

Figure 1 shows the changing trend of new energy vehicle sales in the United States. It is not difficult to see from the figure that the growth trend of new energy vehicles in the United States is divided into three stages. First, the initial period of new energy vehicles before the 21<sup>st</sup> century, that is, after the advent of new energy vehicles, due to the lack of vehicle types, high prices, low recognition, and other factors, the demand for new energy vehicles is extremely low, which leads to

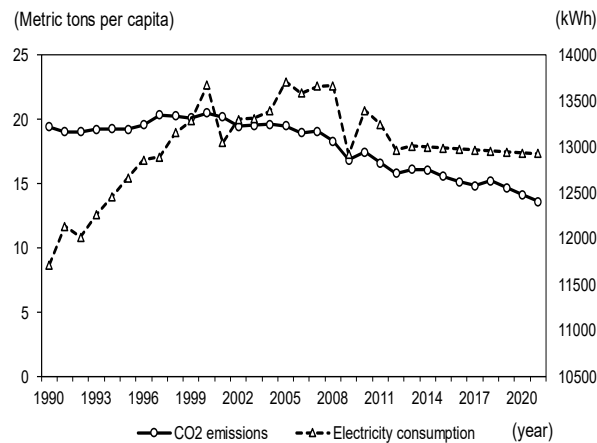
the market sales always sluggish; Second, during the development period of new energy vehicles from 2010 to 2016, driven by the majestic development of leading enterprises such as Tesla, the market was successfully opened, and the new energy vehicle industry grew slowly under the free development mode. However, the market potential needs to be further explored, because market norms have not yet been formed (Zhang et al., 2018); Third, in the period after 2017, the sales volume of new energy vehicles in this period showed bumpy fluctuation. This was caused by the interweaving influence of factors such as the expansion of the new energy industry and the withdrawal of the United States from the *Paris Agreement*, which seriously aggravated the uncertainty of industry development (Yang et al., 2019).



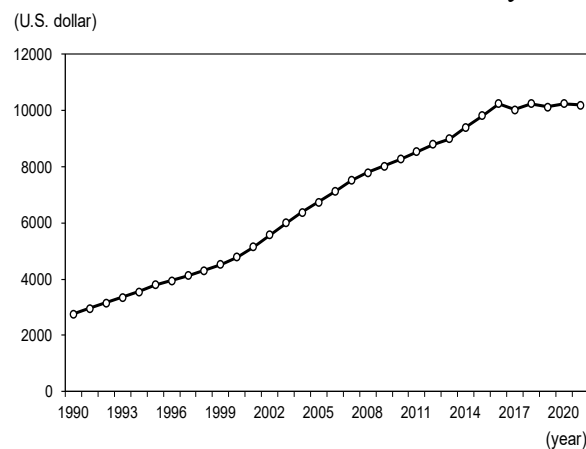
**Figure 1.** New Energy Vehicle Sales Trend Chart  
(Data source: Marlines, Argonne, Ping’an Securities Research Institute, etc.)

### 3.2 Air Quality

In addition to drawing the trend charts of CO<sub>2</sub> emissions and electricity consumption depicting environmental level, figures 2 and 3 draw per capita medical expenditure depicting health level. From the perspective of its own change trend, the three variables have entered a stable stage in recent five years, that is, there is no large fluctuation. Combined with the development of the new energy automobile industry, before entering the development period in 2010, the CO<sub>2</sub> emissions and electricity consumption in the United States showed a horizontal fluctuation or upward trend, and the per capita medical expenditure showed an increasing trend, which reflected that there was no environment-friendly and health-friendly growth model at that time. After 2010, CO<sub>2</sub> emissions showed a downward trend, and electricity consumption entered a stable change range, which indicated that the emergence of new energy automobile industry and related green industries played a certain buffer role on carbon emissions and energy consumption, while health expenditure was still on the rise. Until the third stage of the new energy automobile industry development, the per capita medical expenditure has entered a stable change range, which indicates that the current new energy development strategy in the United States is more inclined to a two-way model of balancing the environment and residents’ health, rather than a one-way model of simply reducing the environmental pollution. At the same time, the typical fact analysis also provides a certain mirror for our empirical research, that is, there is a big gap in the impact effects of new energy vehicles’ emergence on the environment and health. Meanwhile, with the passage of time, this impact effect will have great changes, so we must focus on short-term and long-term dual perspectives to systematically analyze and explain.



**Figure 2.** Trend Chart of CO<sub>2</sub> Emissions and Electricity Consumption Figure



**Figure 3.** Trend Chart of Per Capita Medical Expenditure  
 (Source: World Bank Database, EPS Database)

#### 4. Short-Term Environmental and Health Benefit Assessments

This section focuses on the short-term environmental and health impacts of the new energy vehicle promotion in the United States, making empirical analysis in two aspects. (1) The direct policy effects of the new energy vehicles promotion, that is, setting breakpoint estimation to observe its direct impact; (2) The influence of sales volume of new energy vehicles on environmental and health factors. By constructing a multivariate influencing factor model, this paper explores the influence effect and difference differentiation of sales volume change of new energy vehicles on environmental and health factors.

##### 4.1 Policy Effect of New Energy Vehicle Promotion

Before the policy effect evaluation, we draw the environmental and health variables in the same trend chart. At the same time, we set 2010, the starting year of the promotion period of new energy vehicles, as the breakpoint, so as to identify and observe the change characteristics of the three variables before and after this time point. Looking at Figure 4, it is not difficult to find that the change model of carbon emissions in the United States before and after the promotion of new energy vehicles has changed greatly, and the slope of the curve has obviously become steep; As far as electricity consumption is concerned, after the promotion of new energy vehicles, the trend has changed from a slight increase to a moderate decrease, which is not obvious. We also need to identify and compare it with specific quantitative analysis; Finally, the growth trend of medical expenditure around 2010 has not changed significantly, which indicates that the promotion of new energy vehicles may not have

an impact on residents' health. We need to make further analysis based on the long-term perspective of the development and reform of the new energy vehicle industry.

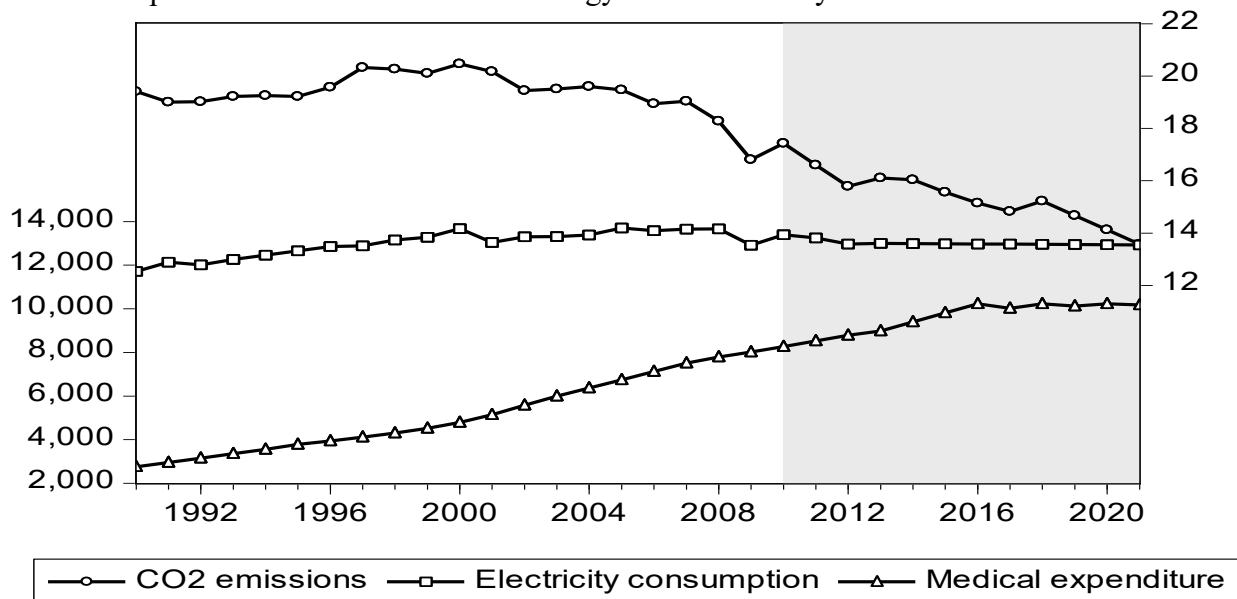


Figure 4. Direct Policy Effect of New Energy Vehicle Promotion

Next, we set a breakpoint with the event of promoting new energy vehicles in 2010, and record the period before 2010 as 0 as the control group; The period after 2010 is recorded as 1 as the experimental group, and then the policy effect test variable RD of new energy vehicle promotion is obtained. Taking RD as the core explanatory variable, a set of policy effect test models are established:

$$CO_{2t} = \beta_0 + \beta_1 RD_t + \beta_k CONTROLS_t + \varepsilon_t \quad (1)$$

$$ELE_t = \beta_0 + \beta_1 RD_t + \beta_k CONTROLS_t + \varepsilon_t \quad (2)$$

$$ME_t = \beta_0 + \beta_1 RD_t + \beta_k CONTROLS_t + \varepsilon_t \quad (3)$$

Where CO<sub>2</sub>, ELE, and ME respectively represent three types of environmental and health variables, per capita carbon dioxide emissions, electricity consumption, and per capita medical expenditure; β<sub>0</sub> represents a constant term; RD is the core explanatory variable of this paper, that is, the policy effect test variable of new energy vehicle promotion; β<sub>1</sub> is the effect coefficient of core explanatory variable RD on environmental and health variables; CONTROLS is the selected control variables in this paper, including per capita GDP level (PGDP), urbanization level (URBAN), and financial scale (FIN); β<sub>k</sub> is the effect coefficient of control variables on the environment and health variables. It is worth mentioning that we have carried out natural logarithmic treatment on numerical variables (generally referring to non-proportional variables in this paper), in order to avoid unclear calculation results caused by data dimensions.

Table 1 shows the model estimation results. We can find that, first of all, the F statistics of the three models are highly significant, which shows that the econometric model established in this section is valid. At the same time, R<sup>2</sup> and adjusted R<sup>2</sup> are close to 1, which shows that the fitting degree of the three models is good and further confirms the accuracy of the model estimation. Then, from the performance of RD's action coefficient, the action coefficient in model (1) and model (2) is significant, but the action coefficient in model (3) is not significant. This fact profoundly demonstrates that the promotion of new energy vehicles in the United States has played a certain role in regulating the environment, but failed to play a significant impact on residents' health. Finally, comparing the coefficient of RD between model (1) and model (2), it is easy to see that the promotion of new energy vehicles has an obvious emission reduction effect, but its adjustment effect on energy consumption is weak. The high probability of this phenomenon is due to the fact that the new energy automobile industry in the United States is still on the rise. The substitution effect of traditional power

vehicles has produced an obvious emission reduction effect, while the technology of new energy vehicles is not mature and the energy-saving technology is not fully adapted to the design of new energy vehicles. Therefore, the dependence of new energy vehicles on electricity is still relatively high, so the promotion of new energy vehicles has not buffered energy consumption.

**Table 1. Policy Effect Test of New Energy Vehicle Promotion on Environment and Health**

Variable Name	(1) CO2	(2) ELE	(3) ME
<i>RD</i>	-0.092** (0.044)	-0.037* (0.020)	0.068 (0.059)
Control Variable	Control	Control	Control
<i>F</i>	53.28***	18.88***	393.65***
<i>R2</i>	0.888	0.737	0.983
<i>Adj R2</i>	0.871	0.698	0.981

Note: \*, \*\*, \*\*\* are significant at 1%, 5%, and 10% significance levels respectively.

#### 4.2 Analysis of the Impact of New Energy Vehicles on the Environment and Health

The following is an analysis of the impact of new energy vehicle sales on the environment and health. Table 2 shows the model estimation results. First of all, we can see that the sales of new energy vehicles have a negative impact on carbon emissions and electricity consumption, but they have no significant impact on per capita medical expenditure, which indicates that the promotion of new energy vehicles has mainly produced positive effects in emission reduction and energy saving. However, it has not yet been able to play the role of improving residents' health, which is highly consistent with the conjecture in the third section. In addition, from the perspective of control variables, the improvement of per capita GDP can reduce emissions and improve health, because the increase of per capita GDP marks the improvement of residents' living standards. When residents have sufficient spending power, they will also choose a low-carbon and healthy lifestyle. However, the improvement of urbanization has had a serious negative impact, which is manifested in increasing the level of carbon dioxide emissions and aggravating the per capita medical expenditure, manifesting that urbanization in the United States should maintain a certain intensity and not be too fast. Finally, the financial scale will increase energy use. This is the inevitable result of increased output, and the per capita medical expenditure will change in reverse. This is because the improvement of financial level optimizes people's capital use mode and improves their investment and consumption ability. At the same time, the financial scale is directly proportional to regional economic development. The development of financial scale means the effective improvement of the overall economy, thus contributing to the simultaneous promotion of residents' health levels.

**Table 2. Model Estimation of New Energy Vehicle Sales Impacts on Environment and Health**

Variable Name	CO2	ELE	ME
<i>NEV</i>	-0.046** (0.018)	-0.017** (0.008)	0.081 (0.090)
<i>PGDP</i>	-0.968** (0.469)	-0.337 (0.221)	-0.697*** (0.526)
<i>URBAN</i>	0.530** (0.213)	0.221** (0.101)	0.778*** (0.239)
<i>FIN</i>	1.130 (0.755)	6.619*** (0.357)	-4.141*** (0.847)
<i>_cons</i>	0.126** (0.054)	0.070*** (0.025)	0.215 (0.060)
<i>F</i>	57.58***	19.72***	609.56***
<i>R2</i>	0.895	0.745	0.989
<i>Adj R2</i>	0.880	0.707	0.987

Note: \*, \*\*, \*\*\* are significant at 1%, 5%, and 10% significance levels respectively.

In order to prove the rationality of the above analysis results, this paper selects the lag period of the explanatory variable NEV as the tool variable and uses the two-stage GMM method (IV-2s-GMM) to test the robustness. The results are shown in Table 3. It is not difficult to see that the model has passed the Cragg-Donald Wald F and Sargan tests, which shows that the use of tool variables is effective and the estimation results of the IV-2s-GMM method are credible. At the same time, the effect direction and significance of NEV on each explained variable have not changed, and the coefficients are almost the same, which shows that the benchmark regression model in this paper is robust and reliable.

**Table 3.** Robustness Test Based on IV-2s-GMM

Variable Name	CO <sub>2</sub>	ELE	ME
NEV	-0.043** (0.020)	-0.013* (0.006)	0.103 (0.100)
Control Variable	Control	Control	Control
R <sup>2</sup>	0.895	0.745	0.989
Cragg-Donald Wald F		53.54	
Sargan		< 0.001	

Note: \*, \*\*, \*\*\* are significant at 1%, 5%, and 10% significance levels respectively.

Furthermore, we take 2010, the new energy vehicle promotion period, as the sample segmentation point for time domain sub-sample regression estimation, with the estimation results shown in Table 4. We can find the following laws. First, in the initial stage of new energy vehicles (the period before 2010), the sales of new energy vehicles did not produce emission reduction and energy-saving effects, and the environment-friendly development model has not yet appeared; Second, although the promotion of new energy vehicles has not played a positive role in improving residents' health, from the estimation results of sub-samples, the promotion of new energy vehicles before 2010 will even aggravate people's health risks. This is because traditional power vehicles prevailed at that time, the new energy vehicle market has not yet opened, and synchronous competition increased production pressure, which caused unnecessary losses and reduced population welfare, increasing residents' medical expenses simultaneously; Finally, from the perspective of the period after the promotion of new energy vehicles, the emission reduction and energy saving effects of NEV (coefficients of -0.094 and -0.043 respectively) have been improved to a certain extent compared with the benchmark model (coefficients of -0.046 and -0.017 respectively), which shows that the environmental effects of the new energy vehicles promotion are still continuously improving and the potential of the new energy vehicle industry has yet to be fully activated.

**Table 4.** Time Domain Grouping Estimation

Variable Name	CO <sub>2</sub>		ELE		ME	
	Before 2010	After 2010	Before 2010	After 2010	Before 2010	After 2010
NEV	-0.024 (0.039)	-0.094*** (0.012)	0.003 (0.010)	-0.043*** (0.010)	0.065*** (0.019)	0.055 (0.068)
PGDP	0.362 (0.458)	0.431 (0.310)	-0.019 (0.111)	0.527** (0.246)	0.988* (0.472)	-0.142 (0.796)
URBAN	-0.162** (0.069)	-0.017 (0.035)	-0.020 (0.017)	-0.021 (0.027)	0.030 (0.053)	0.119 (0.121)
FIN	0.503 (0.403)	-0.009 (0.145)	0.359*** (0.098)	-0.136 (0.115)	-0.085 (0.220)	-0.351 (0.701)
_ cons	10.140*** (1.308)	-0.167 (0.452)	9.937*** (0.318)	6.130*** (0.358)	-3.841*** (0.687)	2.219 (2.275)
F	25.79***	25.72***	9.91***	52.06***	775.03***	10.18***
R <sup>2</sup>	0.937	0.873	0.850	0.933	0.995	0.853
Adj R <sup>2</sup>	0.900	0.839	0.764	0.915	0.994	0.770

Note: \*, \*\*, \*\*\* are significant at 1%, 5%, and 10% significance levels respectively.

## 5. Long-Term Environmental and Health Benefit Assessment

This section will discuss in detail the future development trend of new energy vehicles in the United States and their long-term impact on the environment and health. The empirical analysis will be made in two aspects. (1) Estimation of the growth trend and prediction of the future growth of new energy vehicles, which will intuitively give the change characteristics of new energy vehicle sales; (2) The dynamic impact of new energy vehicles on the environment and health of new energy vehicle sales, which will observe the environmental and health effects of new energy vehicle promotion from a long-term perspective.

### 5.1 Forecast of Growth Trend of New Energy Vehicles

Figure 5 depicts the calculation results of the sales volume of new energy vehicles and their potential growth trend, which is obtained by H-P filtering the sales volume of new energy vehicles. It is not difficult to see from the figure that the growth trend in the sales volume of new energy vehicles is obvious. Even though the sales volume has fluctuated greatly in recent years, the growth momentum is still fierce. Furthermore, we constructed an ARIMA model of the relationship between sales volume and time of new energy vehicles to predict the future growth trend of new energy vehicles, with the results shown in Figure 6. In the figure, the blue part is the real data, the red part is the forecast data, and the green part is the long-term growth trend. It can be seen that due to the interweaving influence of the policy environment, industry life cycle change, and other factors, the new energy automobile industry is still in a state of fluctuating growth in the future. Besides, the risks it faces will also intensify. Therefore, it is necessary to take corresponding preventive measures to avoid paralysis. At the same time, the long-term growth trend is slowing down, which indicates that American new energy vehicles will encounter growth bottlenecks in ten years. Therefore, if we want to ensure the growth momentum of the industry, we must seek new technological breakthroughs while developing the industry market stably, so as to inject new vitality into the new energy vehicle industry.

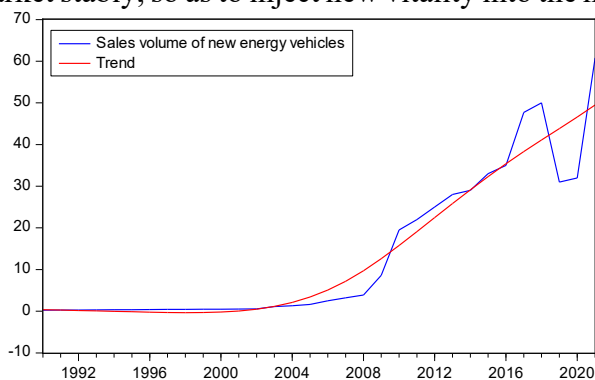


Figure 5. New Energy Vehicle Sales and Potential Growth Estimate

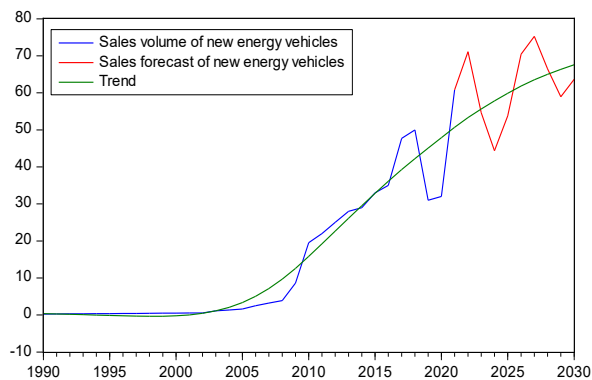


Figure 6. New Energy Vehicle Future Growth Trend Forecast



### 5.2 Dynamic Impact of New Energy Vehicle Sales on Environment and Health

In order to explore the long-term effect of new energy vehicle promotion, this paper constructs a set of TVP-VAR models to depict the impulse response diagram of environmental variables and health variables compared with the growing impact of new energy vehicles under the current development of new energy vehicles. The results are shown in figure 7 (a)-(c). It is not difficult to see that the emission reduction and energy-saving effects of the new energy vehicle promotion, in the long run, have not decreased. At the same time, with the continuous growth of new energy vehicles, their health effects will gradually appear, which is consistent with our views in the theoretical and factual analysis. Therefore, maintaining the stable development of the new energy vehicle industry has important practical significance for environmental governance and the gradual improvement of residents' medical level in the United States.

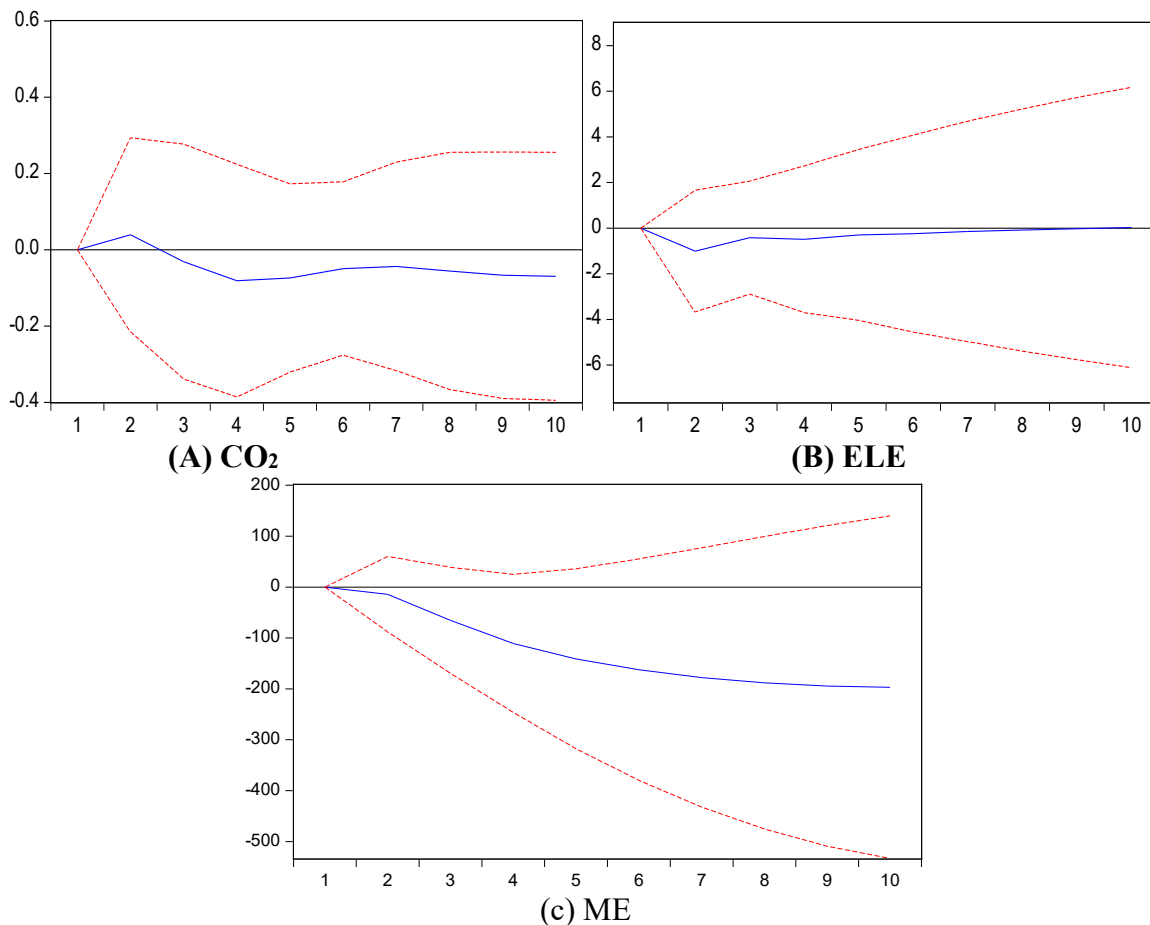


Figure 7. Impulse Response Function Diagram

## 6. Conclusion

The new energy automobile industry is an important emerging industry in the United States. Developing the new energy automobile industry is of indispensable significance for improving the living environment and improving the health of residents. This paper reviews the development of the new energy automobile industry and comprehensively analyzes the development of the environment and residents' health in the United States. Besides, we also empirically discuss the short-term and long-term environmental and health effects produced by the development of the new energy automobile industry, with the main conclusions shown as follows.

First, the new energy vehicle industry has gone through three major periods since its advent. In the current period, there have been great industry fluctuations. At the same time, the sales of new energy vehicles are not synchronized with environmental and health variables, and there are great differences. However, with the passage of time, this difference will be narrowed; Second, from the short-term

effect of the new energy vehicles promotion, the sales of new energy vehicles have a significant negative impact on carbon emissions and electricity consumption, which indicates that the promotion of new energy vehicles has produced emission reduction and energy saving effects, but has no significant impact on per capita medical expenditure. This means that the promotion of new energy vehicles has not yet been able to improve the health of residents; Third, the rapid growth of new energy vehicles in the future shows that the new energy vehicle industry still has great potential to be activated. From the perspective of quantity forecast, the growth of new energy vehicles still faces huge fluctuations, and attention should be paid to maintaining risk management and hidden danger warning; Finally, from the long-term effect of the promotion of new energy vehicles, the emission reduction and energy saving effects of the promotion of new energy vehicles have not diminished. At the same time, with the continuous growth of new energy vehicles, their health effects will gradually appear. Therefore, it is of great practical significance to persist in developing the new energy vehicle industry.

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