The Relationship between New Energy Vehicles and Environment

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Abstract. New energy vehicles (NEVs) are the focus of growth in recent years, people are increasingly concerned about the innovation of electric powered vehicles, environmental protection is now the main focus of people, is the main development of modernization of the way, green into people's lives, the national strategy tends to vigorously develop NEVs, so in recent years, China's new energy vehicle market soared rapidly. Nowadays, there is an important question arises which relate to the relationship between the energy vehicles and the environment, as well as the factors that affect energy vehicle sales. The article will first give the reader a clear understanding of the data set under study through different data sets, then lead the reader to analyze the data and summarize the conclusions of the data through the same techniques of data mining or analytic techniques for data that are different used between different data sets, and finally explore the internal relationship between new energy vehicle sales, environment, policy subsidies, and other factors.

Keywords: New Energy; Environment; New Energy Vehicles; PM 2.5; Data Analysis; Relationship.

1. Introduction

There is a trend that people's awareness of environmental protection is growing. In the previous years, traditional fuel vehicles release a lot of greenhouse gases and harmful gases, which seriously affecting the environment. To release this problem, new energy vehicles have become a popular topic, and many enterprises have begun to invest a lot of manpower and financial resources in this field.

The mainstream data analysis methods include trend analysis, Granger causality analysis [1], robustness analysis, comparative analysis, panel data analysis[2], etc., which data analysis methods are the core of the research in the researching area of analytic techniques for data that are different, they have these following common points: 1. These data analysis methods are able to play the role of finding the internal structural relationship and internal correlation of the original variables. 2. These analysis methods can find the relationship between the filtered data and the original data. 3. These analysis methods are widely used by companies and customer satisfaction, sales volume and other research scope.

This article focuses on analyzing different data analysis methods for different objects or single object data. The results of different analysis methods are analyzed. These results are used as a guide to discuss the link of NEVs, environment, and government policies. The steps are as follows: 1. First, Granger causality analysis is used to determine the relationship between PM2.5 and new energy vehicle sales, as well as the relationship between government subsidies and other factors and the cost and sales of new energy vehicles.[3] 2. Sample trend analysis, panel analysis and comparative analysis based on scenario assumptions are used to determine how new energy vehicle sales are affected by policies such as PM2.5 and government subsidies. 3. The final results of the analysis are discussed to determine whether there is an indirect causal relationship between these three. And whether such a relationship also exists in the data of other countries.

2. Main Dataset and Analysis Method

2.1 Analysis Method based on Granger Causality

The link between new energy cars and PM2.5 was investigated in a paper published in The Journal of Environmental Management titled "Can new energy vehicles aid in achieving carbon neutrality

goals?"[4] In addition, as the table (Table 1) below shows, this study primarily uses Granger causality data test analysis to determine whether the employment of new energy cars as a solution to environmental pollution concerns is indeed successful. In lieu of assessing Granger causality with test statistics such as Wald, likelihood ratio, and Lagrange multiplier as in conventional vector autoregressive models, this study employed the residual bootstrap approach (RB), which was proposed by Shukur and Mantalos for robust thresholds. They suggested that this technique might increase the precision of causality testing. In addition, they conducted an analysis and analyzed the size and effectiveness features, proving that the likelihood ratio statistic may be adjusted despite small sample sizes. The sample data included the monthly average PM2.5 concentrations from January 2013 to September 2020 (data from Chinese Ministry of Ecology and Environment) and the average sales of electric cars month by month. The association was investigated using the correlation analysis. (Data set 1)

The article "An evaluation of government incentives for new energy vehicles in China focusing on vehicle purchasing restrictions"[5] from the journal Energy Policy investigates the efficacy of China's recent NEVs guidelines, various purchasing restrictions, and subsidies on the the emerging market for alternative-energised vehicles. In addition to the standard Granger causality correlation analysis, a panel co-integration model is employed to examine the stability of the variables market share, gasoline price, subsidies, and demand. Using error correction models and comparative analysis, this experiment investigates further the long- or short-run correlations between the variables as the table below shows. (Table 1)(Data set 2)

2.2 Trend Analysis

The new energy vehicle sector has always required the involvement of large piles of data and data analysis models. Among them, in the "China New Energy Vehicle Big Data Annual Report (2021)"[6], Wang used charts to show that there is a significant increase in the number of carbon emission reductions through the use of NEVs in China in 2020, and the sample is from all over China. From Table 1, we could see that this research mainly uses data visualization to determine the trend by the quantity of vehicle powered by electric for each year. Its data visualization is his main method of data analysis. (Data set 3)

2.3 Panel Co-integration Model

Similar to the second trial (Ma, Fan, and Feng, 2017), an additional intriguing study from the Journal of Cleaner Production, the third experiment (Ma, Fan, and Feng, 2017) "Does air pollution boost electric car sales? Evidence from twenty of China's largest cities"[7] (Guo, Zhang, Gu, Zhang, Fan, 2020), we can observe from the table below, investigates if air pollution increases the sale of electric vehicles and validates this via the experience of 20 major Chinese cities. Using the same factors and people, this study examines how air quality influences sales of electric vehicles. In addition to analyzing its significance, this study focuses on hourly varying PM2.5 concentrations and only analyzes EVs without a lengthy procurement procedure, thereby avoiding lagging requirements.

2.4 Scenario Assumptions and Comparative Analysis

The article "China's Electric Vehicle Subsidy Scheme: Rationale and Impacts"[8] from Energy Policy examines the first and second phases of China's NEVs subsidy scheme, from the table below (Table 1), reviews the major electric car models on the Chinese market, compares the cost of ownership for a species-defined electric passenger car model, and discusses the rationale behind the scheme. China's EV deployment promotion policies are discussed. The scenario assumption is one of the most particular analytic methodologies utilized in this investigation. The subsidy intensity of the policy is calculated by adding up the expenses of owning a vehicle in the first stage of the EVSS (2012), the second stage of the EVSS (2013), and the second stage of the EVSS under the phase-out method (2014 and 2015). this experiment can demonstrate the benefits and drawbacks of the subsidy strategy at the same time. (Data set 5)

Table 1. Attributes of data set and their analysis object

monthly data of new energy car sales from the 2013 to 2020 and monthly PM2.5 concentration	The monthly average price of final gasoline local government's subsidies on financial :NEV tax policy, etc	Carbon emission in 2020; monthly sales of new energy car	Monthly sales of EVs in the studied cities from 2014 to 2018	Vehicle cost from 2012 to 2020; Fuel price from 2012-2020
Granger Causality	Granger Causality	Linear Regression	Variable intercept panel model	Scenario assumptions
Trend analysis	Panel co-integration model	Trend analysis	Panel co-integration model	Comparative analysis
Wald, likelihood ratio, and Lagrange multiplier	Panel error correction model		Time series	
residual bootstrap method (RB)	Comparative analysis		Robustness check	
PM2.5 concentration	Government policy		PM2.5 concentration	Government policy, subsidy
NEVs sales	NEVs sales	NEVs sales	NEVs sales	NEVs cost

3. Results from Different Data Sets and Different Analysis Methods

3.1 Analysis Method based on Granger Causality and Their Results

In the first experiment of data analysis, Su, Yuan, Tao, and Muhammad Umar assess the causal interactions between new energy vehicles and PM 2.5 to determine whether new energy vehicles can be considered an effective measure for mitigating air pollution and aiding China in achieving its carbon neutrality goal. [9] Even if the findings of the sample test show that new energy vehicles are not the primary source of PM 2.5, we cannot rely on this conclusion due to the necessity to account for other variables, such as the instability of the parameters. In addition, the parameter stability test provides support for the hypothesis that the causal links between variables are subject to abrupt morphological shifts and exhibit time-varying features. Because of this, the authors of this paper recommend using bootstrap subsample rolling window causality tests in order to tackle the time-varying issue, which is a difficulty concerning the relationship between PM2.5 and sales of vehicles powered by electric. The most important takeaway from this research is that non-emission vehicles have a positive influence on PM2.5. These findings cast doubt on the use of electric vehicles as a means of decreasing air pollution.[10] The fundamental reason for this is that the percentage of vehicles, which only depend on electric on the road keeps still not high enough for them to fulfill the job that is naturally theirs, which is to play a part in lowering pollution in the environment. The aforementioned findings also suggest that renewable energy is ineffective at reducing air pollution[11], which is contrary to the idea that energy and the environment interact with one another. On the other hand, one may argue that the expansion of the NEVs market is reflected in the deterioration of air quality due to the negative impact of PM 2.5 on alternative-fuel vehicles.

The research paper "An evaluation of government incentives for new energy vehicles in China focusing on vehicle purchase restrictions" looked at data from month to month for 66 categories from the beginning of 2011 to the mid of 2016 and came to the conclusion that the steps taken to promote the NEVs industry in China are working. The tax exemption policy will have the biggest impact for the longest time. The fact that new energy cars are allowed under a policy that limits the number of cars on the road shows even more how good these cars are. At the moment, the subsidies that the Chinese government is giving out are very helpful.[12] The subsidy should be kept at a typical constant level, while they should be cut back without stopping. It is possible for the companies that make new energy vehicles to build in too many subsidies directly into the price structure or into their personal accounts (Diamond, 2009). Unfortunately, these subsidies will not do what the government wants them to do, which is to get rid of the problem that NEVs are expensive. From another point of

view, the cost of government reforms is much more manageable than the cost of subsidy programs, which is very high. Because of this, it is important to keep playing the role of policymaker while also slowly lowering the amount of financial aid given.[13]

3.2 Trend Analysis and its Result

Wang explains in the China New Energy Vehicle Big Data Annual Report (2021) that data analysis enables more accurate forecasting of future development trends and objectives. He proposes that clean energy should be the objective, aggressively pushing the abandonment of coal in the power business[14], speeding the development of green goods, and encouraging carbon reduction in the automobile industry, which is a result of lightweighting and shrinking. The paper continues to employ data analysis to get further insight. According to Wang's analysis, the cumulative passenger vehicle volume of cars powered by electric in the top five areas increases starting from about 588,800 in 2018 to approximately 1,532,200 in 2020, based on the change in cumulative passenger vehicle volume of NEVs over years. The sum of passenger cars powered by alternative fuels in the top ten provinces increased from 889,700 in 2018 to 22,826,000 in 2020. Based on the total change in access to NEVs throughout years, Jiangsu and Hunan placed top in terms of cumulative access to electric cars. The total number of units in the top five provinces climbed from 78,500 in 2018 to around 143,900 in 2020, a rise of almost 53%. Guangdong will have more than 50,000 electric energy buses in 2020. The overall number of electric buses in the top ten provinces climbed from around 125,500 in 2018 to approximately 233,100 in 2020. The adding access to alternative special cars in the top five areas grew from about 95,600 in 2018 to 20.08 million in 2020, while the cumulative access to NEVs in the top ten areas climbed from 144,500 to 291,500. And this timeframe spans 2018 through 2020. Based on the concentration of access to various categories of cars over several years, the usage of NEVs in buses demonstrates a definite declining tendency.

3.3 Panel Co-integration Model and its Result

In "Does the smog in your city make more people want to buy electric cars? Hard data from twenty of China's most populous cities" (Guo, Zhang, Gu, Zhang, Fan, 2020) This research uses city-level panel data, which involves electric vehicle purchases month by month statistics from 20 major Chinese cities, to investigate the impact of matter 2.5 (PM 2.5) concentrations (indicating air pollution) on sales of electric vehicles through the application of panel data regressions (specified with FE models). This is done by comparing the population, output from industry, and disposable per capita income of typical cities from May 1, 2014 to April 30, 2018. Through statistical analysis, the experiment shows the commonly known that the environmental advantages of alternative energy powered cars [15] (i.e., a drop in PM 2.5 levels), which increases demand for electric cars. The robustness of the empirical results is confirmed by tests based on lower sample sizes.[16]

3.4 Scenario Assumptions and Comparative Analysis and its Result

With a focus on BEPVs, this article, titled "China's electric vehicle subsidy scheme: Justification and consequences," analyzes the reasoning behind both the Initial and Enhanced Phases of China's EVSS and assesses the impact on the cost of vehicle possession. Based on the results of the study, EVSS in China is essential if BEPVs are going to become competitive with CPVs in the near future, especially by 2015. Typically, subsidies for the private procurement of PHEPVs and BEPVs are reduced when the EVSS transitions from Phase I to Phase II. While a result, BEPVs' total cost of ownership will increase momentarily as EVSS Phase II gets under way. In spite of pure EVs' inferior pricing, the market has accepted their limited range.[17]

4. Discussion

New energy vehicles are closely related to environmental issues. Through the data I found in the csv file. I got an interesting fact that the production of NEVs has been increasing from 2011 to 2022.

the experimental results of Guo, Zhang, Gu, Zhang, Ying Fan say that the PM2. 5 concentrations have a correlation and a direct impact on the acquisition of alternative energy vehicles.[18] Therefore, by visualizing the ownership of cars depend on alternative energy through the data, we can similarly conclude that people are concerned about the environment and they are aware that conventional vehicles cause a lot of pollution. And as the figure 1 shows, the models of NEVs are increasing year by yeaer. Therefore, new energy vehicles can effectively alleviate this situation. It is foreseeable that new energy vehicles will become the mainstream in the future and gradually replace the traditional gasoline vehicles.[19]

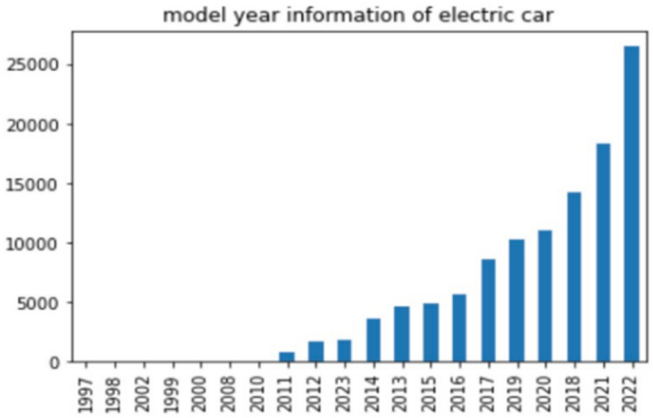


Fig 1. Each year's model sales

Although, we can confirm that PM2.5 and environmental problems are closely related. But its analysis also has its limitations, for example, in the experiment to study the influence of PM2.5 on people buying electric cars, PM2.5 is constantly changing, it is a time series, and its measurement unit is minutes or hours, which has been illustrated in the experiment, so how do we go about to solve this flaw? We can analyze the correlation by randomly selecting the time series of new energy vehicle purchases within a day and then applying the model.

In addition, Guo, Zhang, Gu, Zhang, and Fan showed a statistically significant link between PM2.5 and the rate of purchases. However, research by Hao, Ou, Du, Wang, Ouyang and Guo, Zhang, Gu, Zhang, and Fan shows that the prices of these vehicles and the financial incentives offered by the government are the most significant factors in determining whether or not consumers will choose to purchase an electric vehicle. In addition, the overall status of the environment will continue to show indications of improvement as the policy is refined, adding fuel to the fire that will keep the positive cycle burning.

And these data sets are all studied in China, does the correlation still hold if we face different countries? In fact, I think the correlation is valid, except that different factors may affect the proportion of electric vehicles depending on the country, maybe in European countries where electric vehicles are already common, government subsidies account for a large part, while in industrial countries like China, environmental pollution may promote people's consumption of NEVs.[20]

5. Conclusion

Because of the role of funding from the government have a direct affects on the cost of manufacturing electric cars, thus affecting the ownership of NEVs. And because the ownership and purchase of NEVs are tightly linked to environmental factors such as PM2.5. Therefore, we can conclude that government subsidies can indirectly affect PM2.5 concentration and other environmental issues, i.e. government subsidies and PM2.5 policies are correlated. And according to the different policies and prerequisites in different regions, government subsidies and PM2.5 will have an impact on the procurement of automobiles powered by alternative energies. In some heavily polluted areas such as heavy industrial countries, PM2.5 concentration may affect new energy vehicle sales a bit more. However, in regions and countries such as Europe where new energy vehicles are

already popular and environmental pollution problems are minimal, government policies and subsidies will be more influential.

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