Proceedings of the 2nd International Conference on Financial Technology and Business Analysis
DOI: 10.54254/2754-1169/51/20230670

Development of China's Front-End Automotive Industry in a Carbon-Neutral Environment

Yi Sun[1,a,*]

[1]*Whitman Business School, Syracuse University, Syracuse, State of New York, America*
a. ysun195@syr.edu
**corresponding author*

Abstract: Carbon neutrality has a significant impact on China's ecological environment and sustainable economic development. In recent years, China has implemented many regulations on industries with high carbon emissions, especially onto the automotive industry. These regulations are not limited to controlling carbon emissions, relevant economic policies, and encouragement for the production of new energy vehicles. To investigate the potential factors that significantly influence the growth of the automobile sector, this article analyzes data from China's leading automotive industry in recent years. The findings show that the sales and carbon emissions of new energy vehicles have a significant positive correlation with the development of the automotive industry, while government subsidies have a negative correlation with the development of the automotive industry. This demonstrates the detrimental effects of carbon neutrality rules on the automobile sector, leading to the key conclusions that, from the standpoint of long-term growth, research on new energy vehicle should be prioritized.

Keywords: carbon neutrality, new energy vehicles, automobile industry

1. Introduction

Carbon neutrality is a profound transformation of the economic and social system. In the context of carbon neutrality, the real economy is undergoing a green transformation. As a major carbon emitter, the automotive industry has entered the "lightweight era" under policy constraints. Under the influence of carbon neutrality, we can see that the automotive industry is moving in three directions. Firstly, is automobile electrification, then comes the automobile lightweight, and finally comes zero emissions in the supply chain. Therefore, China's automotive industry is shifting towards low fuel, lower body weight, and the use of new energy sources.

The literature on the research of Chinese automobile enterprises both domestically and internationally, according to the literature, it is possible to explore the connections and relationships between automotive companies and the field of carbon neutrality. The requirement of switching from fuel to non-fossil fuels in the automobile sector is explained in the pertinent research on automotive firms in the context of carbon neutrality in China [1]. Similarly, the importance of the automotive industry in achieving carbon neutrality goals [2] and the impact of new energy on carbon neutrality [3], detailed methods should be used by the automotive industry to reduce carbon emissions, including electrification and waste recycling. There is a highly recognized saying in China that the development of new energy vehicles is affected by technology, market, and national policies, and

DOI: 10.54254/2754-1169/51/20230670

predicted the development of the industry [4]. From the perspective of foreign scholars, the competitive effects brought by foreign manufacturers and the automotive consumption tendencies of Chinese consumers in this competitive environment [5]. In this regard, the article will use the economic situation of China's front-end automotive industry (the top ten enterprises) in recent years as a reference to study what changes have occurred in the automotive industry under the impact of carbon neutrality policies, and what factors are closely related to the development of the automotive industry. One explanation is that carbon neutrality in China is aimed at achieving a balance between anthropogenic emissions and anthropogenic removals, known as "net zero" [6].

Based on the research content in the fields of automobiles and carbon neutrality, this article will take the financial situation of China's top ten automobile industries in recent years as a reference to study the changes that have occurred in the automobile industry under the influence of carbon neutrality policies, and what elements have a direct impact on the growth of the vehicle sector. The article conducted regression analysis on relevant data and concluded that the revenue of automotive companies is related to new energy vehicles, fuel emissions, and government policies.

2. Methodology

This article mainly studies the influence of new energy technologies and government policies on the operating capacity of China's top ten automotive industries in today's carbon emission environment. Therefore, the article requires data from the operating income of automotive companies, their carbon emissions, and government annual subsidy policies.

2.1. Data

In terms of data, in order to study which factors, namely, new energy, carbon emissions, and government policies, have the greatest impact on the income of automotive companies in a carbon-neutral environment, the article selects the operating income (Revenue) of these ten enterprises as the dependent variable. These data come from the company's annual report. Due to the diverse literature on carbon emissions and the inconsistent calculation of carbon emissions by different automobile companies, this article adopts the fuel points (Fuel) in the new energy points table issued by Chinese government departments as a substitute for carbon emissions. Simple government subsidies have a negative impact on automotive finance, and subsidies should be adjusted based on regional characteristics and the enterprise itself [7]. For government-related policies (Gov), due to regional differences, this article will introduce dummy variables based on whether there are new policies in the current year (1 indicates new policies, 0 indicates no new policies). New energy vehicles mainly use electricity as the main fuel [8]. In terms of new energy, this article selects the sales volume of new energy vehicles (NEvolume) from various enterprises as the independent variable. These data are from the website of the China Automobile Association. In order to observe the impact of various factors on automobile enterprises more clearly, and also to ensure more data, this article choose to use annual panel data from 2018 to 2022.

2.2. Method

This article uses multiple linear regression model and fixed effect model in this part, among them, this part mainly focuses on the coefficients corresponding to each variable, which correspond to the following formulas α_1 to α_3, γ_1 to γ_3, β_1 to β_3.

This research establishes the pooled OLS model (Base model) at first with the following equation.

$$\text{Revenue}_{it} = \alpha + \alpha_1 \text{NEvolume}_{it} + \alpha_2 \text{Fuel}_{it} + \alpha_3 \text{Gov}_{it} + \varepsilon_{it} \quad (1)$$

DOI: 10.54254/2754-1169/51/20230670

In this model, both timing and individual effects have no effect on the regression formula. In this formula, α is a constant, α_i (i=1, 2, 3) represents the degree of impact from the independent variable to the independent variable.

On the basis of the base model, this research establishes a random effect model, and the corresponding formula is as follows.

$$\text{Revenue}_{it} = \gamma + \gamma_1 \text{NEvolume}_{it} + \gamma_2 \text{Fuel}_{it} + \gamma_3 \text{Gov}_{it} + \gamma_4 U_i + \mu_t \quad (2)$$

In this model, the equation values the influence of random effects on the regression equation. In this formula, γ is a constant, γ_i (i=1, 2, 3, 4) represents the degree of impact from the independent variable to the independent variable. In this model, γ_1 is expected to be a positive value to prove that the sales of new energy vehicles have a positive impact on the revenue of automobile companies, γ_2 is expected to be a negative value to prove that limiting carbon emissions is beneficial for the profits of automobile companies, and γ_3 is expected to be a negative value because government policies are mostly inhibitory policies. U_i is the company specific random effect included in the model, with the corresponding coefficient γ_4.

Finally, this research establishes a fixed effect model with the following formula:

$$\text{Revenue}_t = \beta + \beta_1 \text{NEvolume}_t + \beta_2 \text{Fuel}_t + \beta_3 \text{Gov}_t + \beta_4 Y_t + \varphi_t \quad (3)$$

Due to the fact that the selection of annual sample size is greater than the annual fixed effects, individual fixed effects models may generate singular matrices, and the impact of relevant environmental policies on all enterprises is exogenous. Therefore, this study adds year-fixed-effect Y_t into the model, which uses β_i (i=1, 2, 3, 4) to reflect the impact from the independent variable to the independent variable.

3. Result

Regression analysis was assisted by Eviews software. Table 1 provides descriptive statistics on the data, integrating and analyzing data from observation, mean, maximum and minimum values, and standard deviation.

Table 1: Descriptive Analysis.

	Observation	Mean	Maximum	Minimum	Std. Dev.
Revenue (mn RMB)	50	258,714.2	902,194.1	5,099	261,486.9
NEVolume	50	184,286.1	1847,576	0	301,882.2
Fuel	50	396,492.5	5,398,071	-667,589	933,923.7
Gov	50	0.8	1	0	0.404

From the perspective of descriptive statistics, there is a dramatic difference among the value of mean, maximum, and minimum values of variables other than GOV, which can also be intuitively seen from the variance.

3.1. Regression Analysis

Due to the limited selection of data, there are only 50 observation data in each set of variables, which makes it difficult to reflect individual fixed effects and leads to the emergence of singular matrices.

According to the hypothesis, the individual random effects model and the individual fixed effects model are first tested. Due to the appearance of the near singular matrix in the individual fixed effects

DOI: 10.54254/2754-1169/51/20230670

model, it is removed. Subsequently, an individual random effect model and a year fixed effect model are developed.

According to the Hausman test, it makes a trade-off between choosing a fixed effects model or a random effects model. The alternative hypothesis is that time-series effects are related to regression variables (time-series fixed effects regression model).

Applying the Hausman test in the regression results of the random effects model rejects the original hypothesis, indicating that the explanatory variable is related to fixed effects, so fixed effects model is preferred.

Table 2: Regression Results (Dependent Variable: Revenue).

	Pooled OLS	Random Effect	Fixed Effect
NEVolume	0.627**	0.228**	0.411**
	(0.166)	(0.053)	(0.108)
Fuel	-0.148*	-0.015	0.073**
	(0.055)	(0.017)	(0.039)
Gov	246,460*	195,845.6	-69,152.5
	(41,396.29)	(161,684)	(79,052.87)
Adj-R^2	0.265	0.948	0.897
F-stats	26.643	74.807	33.776
Obs	50	50	50
Hausman Test			
AIC	27.537	25.057	25.576
MSE	217388.9	51502.74	65276.98

Notes: "* *" and "*" respectively indicate significant at the 5% and 10% levels; standard errors in parentheses.

According to Table 2, the coefficients of the three models are similar in size, but with different signs and significance. The regression coefficients of pooled OLS and random effects models in the three sets of models exhibit consistent positive and negative signs, with NEvolume and Gov being positive, but Fuel being negative. In the fixed effects model, the coefficients of NEvolume and Fuel are positive, but the coefficients of Gov are negative.

In terms of significance, the coefficient of the fixed effects model is better under the 0.05 significance condition, and in terms of the degree of influence, the positive and negative signs of the coefficients meet expectations.

Based on significance and p-values, as well as the evaluation of AIC and MSE in the Hausman test, the time series fixed effects model was ultimately selected, and based on assumptions, significance less than 0.05, do not reject the original hypothesis, therefore choose the fixed effects model.

From the result, it can be seen that the operating revenue of the selected automotive companies (leading companies) is significantly positively correlated with the sales of new energy vehicles, positively correlated with carbon emissions, and negatively correlated with government subsidies, which is consistent with the conclusions in the reference literature. At the same time, it is related to fixed impacts in different years, it has negative fixed impacts in 2018, 2021, 2022 and positive fixed impacts in 2019, 2020. From the perspective of impact, there are significant fixed impacts in 2018 and 2019.

In the research on the development of new energy vehicles in China, emphasized that new energy vehicles can bring better benefits to enterprises [9]. In order to achieve the target, a CROCS (commitment, reduction, offsets, communication, and stimulation) model, namely regulatory management and incentives, needs to be established [10]. This can increase the sales of new energy

DOI: 10.54254/2754-1169/51/20230670

vehicles through government control, thereby bringing better business revenue and greatly reducing carbon emissions.

4. Conclusion

To investigate the potential factors that significantly influence the growth of the automobile sector, this article analyzes data from China's leading automotive industry in recent years. The fixed effects in the regression equation have both positive and negative effects, with the positive ones mainly occurring from 2019 to 2020, which coincides with the improvement of China's new energy policy. In 2019, China carried out industrial restructuring to reduce carbon emissions, and set "30 • 60 target" in 2020, and released a five-year plan for new energy vehicles in 2020. However, due to the impact of the epidemic, the operation of new energy and carbon reduction did not have a positive impact in 2021 and 2022.

Regression analysis and the discussion on literature revealed that, from 2018 to 2022, the development of China's top ten automotive firms was restricted under carbon neutrality rules. In addition, government support for the industry also had an adverse effect on it. Although the epidemic had a negative impact on the new energy vehicle sector, the rapid emergence and growth of the industry have been attributed to the implementation of carbon neutrality policies. The automobile sector has gradually recovered from the epidemic's effects.

Chinese government has set ambitious goals for achieving carbon neutrality by 2060 and carbon peak by 2030. However, as a major developing country with coal as the main source and a relatively large proportion of fossil fuels, China has a daunting task to achieve carbon emissions peaking within 10 years and carbon neutrality within 40 years. New energy vehicles mainly use electricity as the main fuel, and indicated that taking pure electric vehicles as the development direction would bring better development to China's automobile industry.

Therefore, this article focuses on the sales of new energy vehicles. Among the top ten automobile companies in China, BYD Company Limited and SAIC Motor Corporation Limited are the main ones leading in new energy technology, and their sales are also far ahead of other automobile companies. It indicates that even in leading industries, the distribution of new energy is uneven, which requires government regulation.

When it comes to carbon emissions, although according to corporate data, companies with higher carbon emissions have higher profits, in the long run, on the one hand, the country has restrictions on carbon emissions, and on the other hand, new energy products will bring greater structural impact in the future, which will change the profit model of the automotive industry.

For the aforementioned situations, the government needs to strengthen market regulation and local government subsidies. Firstly, it is necessary to allocate resources reasonably, not allowing government subsidies to be fully distributed to the regions where leading enterprises are located, and controlling the channels of new energy materials to prevent some enterprises from forming industry monopolies. In addition, it is also necessary to change people's awareness through publicity, so that more people can choose more environmentally friendly new energy vehicles, reduce carbon emissions, and bring better development prospects for the automotive industry.

For this article, there are still a few limitations. Firstly, there are few observations selected for the data, and the differences are not significant, which fails to achieve the establishment of individual fixed effect models and double fixed effect models. In addition, insufficient research and understanding of the automotive industry make it difficult for this article to explain the source of resource inequality.

Future research can work on explaining the changes in the automotive industry before and after the establishment of carbon neutrality policies, and provide more reasonable suggestions for resource allocation in the automotive new energy industry.

DOI: 10.54254/2754-1169/51/20230670

References

[1] *Zeng, N., Jiang, K.,Han, P., Hausfather, Z., Cao J., Davidoff, D.K., Ali, S and Zhou, S. (2022). The Chinese Carbon-Neutral Goal: Challenges and Prospects. Advances in Atmospheric Sciences. 39, 1229–1238.*

[2] *Zhao, F., Liu, X., Zhang, H and Liu, Z. (2022). Automobile Industry under China's Carbon Peaking and Carbon Neutrality Goals: Challenges, Opportunities, and Coping Strategies. Journal of Advanced Transportation, Article ID 5834707.*

[3] *Zou, C., Xiong, B., Xue, H., Zheng, D., Ge, Z., Wang, Y., Jiang, L., Pan, S and Wu, S. (2021). The role of new energy in carbon neutral. Petroleum Exploration and Development, Volume 48, Issue 2, Pages 480-491, ISSN 1876-3804.*

[4] *Yu, P., Zhang, J., Yang, D., Lin, X and Xu, T. (2019). The Evolution of China's New Energy Vehicle Industry from the Perspective of a Technology–Market–Policy Framework. Sustainability, 11(6):1711.*

[5] *Govorova, A. (2023). History and Paradoxes of the Chinese Car Market: Eastern Strategies and the Asian Regulator. Stud. Russ. Econ. Dev. 34, 150–158.*

[6] *Chen, Y. (2022). Further Analysis of the Concept of Carbon Neutrality. China Population, Resources, and Environment, 32 (04): 1-12.*

[7] *Wang, X., Li, Z., Shaikh, R., Ranjha, R.A and Batala, L.K. (2021). Do government subsidies promote financial performance? Fresh evidence from China's new energy vehicle industry, Sustainable Production and Consumption, 28, pp. 142-153.*

[8] *Wang, H., Qi, S and Zhou, C. (2022). Peer effect in green credit induced green innovation: An empirical study from China's Green Credit Guidelines, Resources Policy, Volume 76, 102619.*

[9] *Bo, Y. (2022). Development of China's new energy vehicle industry under the goal of carbon neutrality [J] Management Engineer, 27 (05): 5-10.*

[10] *Jia, M., Yang, Q and Research Group of the High Quality Development Research Center for New Era Enterprises. (2022). Carbon Neutrality Strategy of Chinese Enterprises: Theory and Practice. Foreign Economics and Management, 44 (02): 3-20.*