An Analysis on the Impact of CAFCC and NEVC on R&D Investment of New Energy Vehicle Enterprises Under the "Double Credits" Policy

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Abstract. In order to promote the high-quality and rapid development of China's new energy vehicle industry, the government made adjustments to the "double credits" policy: increase the requirements for the assessment of the credits proportion and give preferential treatment to enterprises with low fuel consumption vehicles in the calculation of credits, which have a certain impact on the R&D investment of new energy vehicle enterprises. This study select relevant data of 8 domestic passenger new energy vehicle listed enterprises with high annual output from Wind database and "the 2021 China passenger car enterprise average fuel consumption and new energy vehicle credit accounting table", with enterprise R& D investment as the explanatory variable, and corporate average fuel consumption credit (CAFCC) and new energy vehicle credit (NEVC) as the explanatory variables for descriptive statistics and regression analysis. The research conclusion is that there is a significant correlation between them. Finally, a conclusion is drawn on the impact of the "double credit" policy on the R&D investment of new energy vehicle enterprises: "double credit" policy can promote enterprises to increase R&D investment by increasing the application proportion of advanced energy-saving technologies and improving the efficiency of industrial resource allocation.

Keywords: New energy vehicles, "Double credits" policy, R&D investment, Eviews.

1 Introduction

In the stage of large-scale and rapid development of China's new energy vehicle industry, in order to promote the high-quality and rapid development of the new energy vehicle industry, the government has issued a series of policies. Xiong et al. [1] believe that the "subsidy" policy is gradually "declining", and the role of "non-subsidy" policies such as "technology acquisition" and "consumption support" should be effectively played. For consumers, Huang et al. [2] believe that product perception has a significant positive impact on consumers' purchase intention, and Du et al. [3] research shows that

H. Mallick et al. (Eds.): ICEMCI 2022, AEBMR 231, pp. 899–907, 2023.
https://doi.org/10.2991/978-94-6463-098-5_103

consumers' acceptance of government policies also has a positive and significant impact. This shows the importance of government policies and product development, which need to be further improved. For example, the research of Yang et al. [4] shows that the government should provide more specific and feasible incentives and subsidies. Ma et al. [5] believed that the impact of technological progress was greater than the subsidy policy for economic growth, so R&D subsidies should be increased. Since 2017, the government has issued the "double credits" policy. The research of Zheng et al. [6] shows that the combination of the "double credits" policy and the R&D subsidy policy of "reverse spillover rate change" can better improve the market mechanism and promote technological innovation. Therefore, it can be seen that the R&D investment of new energy vehicle enterprises is extremely important, and the impact on it should also be analyzed when the government launches relevant policies. This study will explore the relevance of corporate average fuel consumption credits (CAFCC) and new energy vehicle credits (NEVC) to the R&D investment of new energy vehicle enterprises after the modification of the "double credits" policy in 2021. First, it improves the research perspective of the relationship between the "double credits" policy and enterprise R&D investment in terms of specific credits. Secondly, the degree of correlation between the two can be obtained according to the analysis results, so as to make suggestions for the next policy. This study selects 8 domestic passenger vehicle listed enterprises with high annual output of new energy vehicles in China, and collects 48 pieces of relevant data from the Wind database and the "2021 China passenger vehicle enterprise average fuel consumption and new energy vehicle credit accounting table" for descriptive statistics. Secondly, the enterprise R&D investment is set as the explained variable, the two credits data are set as the explanatory variable, and the enterprise scale and other data are set as the control variables, then the study uses Eviews to establish a model for multiple linear regression analysis, and does statistical analysis such as coefficient test and heteroscedasticity test to verify hypothesis. Finally, the conclusion is drawn to state the specific impact.

2 Empirical Design

2.1 Methods and Hypothesis

This study uses Eviews statistical software as the empirical analysis tool to carry out descriptive statistics, multiple regression analysis and residual diagnosis on the collected sample data.

Since the implementation of the "double credits" policy, there is an important impact on the R&D investment of new energy vehicle enterprises. However, during the first version of the policy from 2018 to 2020, the data shows that the correlation between R&D investment and two kinds of credits of enterprises is not significant. Since January 1, 2021, the "double credits" policy has been revised, stipulating that the NEV positive credits assessment proportion of new energy vehicle enterprises must meet 14%, 16%, 18%, which is 175% higher than the previous version of the policy. Moreover, in order to guide enterprises to increase investment in energy-saving technology research and development, the new policy gives preferential treatment to enterprises that produce or

supply low fuel consumption vehicles when calculating the score of new energy vehicles. This measure has adjusted the corporate average fuel consumption credits (CAFCC) and new energy vehicle credits (NEVC), which is bound to greatly change the intensity and scale of enterprise R & D investment.

Based on the above theoretical analysis, the research null hypotheses are proposed as follows:

H0: CAFCC and NEVC has no significant correlation with the R&D investment of new energy vehicle enterprises.

2.2 Samples and Data

In the wind database, taking the listed passenger vehicle enterprises of new energy vehicles in China as samples, this study collected the R&D investment and related financial data of 8 vehicle enterprises with high annual output, which represents certain situation of new energy vehicles' market. Among them, according to the "table of accounting for average fuel consumption and new energy vehicle credits of Chinese passenger car enterprises in 2021", in terms of the number of credits, the average fuel consumption of four enterprises meets the standard (BYD automobile / Automobile Industry Co., Ltd; Anhui Jianghuai Automobile Group Co., Ltd; Zhaoqing Xiaopeng New Energy Investment Co., Ltd; Great Wall Motor Co., Ltd), and the remaining four do not meet the standard (FAW-Volkswagen Automotive Co. Ltd; Zhejiang Geely Automobile Co., Ltd; Changan Ford Motor Co., Ltd; Dongfeng Motor Co., Ltd). Therefore, it is considered that it can comprehensively represent the R&D investment of new energy vehicle enterprises with different levels of compliance with the new proportion assessment requirements after the adjustment of the "double credits" policy in 2021. A total of 48 data were obtained, including R&D investment, average fuel consumption credits, new energy vehicle credits, total assets at the end of the period, return on net assets of the enterprise, and total asset turnover.

2.3 Variables and Model

In this study, the R&D of enterprises is taken as the explanatory variable, and the corporate average fuel consumption credits (CAFCC) and new energy vehicle credits (NEVC) are taken as the explanatory variables. In order to make the equation and conclusion of the fitting model more reliable, three control variables are added: Enterprise size (SCALE), profitability (ROE) and operating capacity rate (OPR). The specific financial indicators and calculation methods are shown in Table 1.

In order to verify the number of CAFCC and NEC has no significant correlation with the R&D investment of new energy vehicle enterprises in null hypothesis H0, a multiple regression model is constructed:

$$R\_D = C(1) + C(2)*CAFCC + C(3)*NEVC + C(4)*OPR + C(5)*ROE + C(6)*SCALE \quad (1)$$

The constant term is C (1), and the substitution coefficients are C (2), C (3), C (4), C (5), C (6).

Table 1. Related variables and descriptions

Variable Type	Variable Name	Variable Symbol	Calculation Method
Explained Variable	R&D Investment	R&D	
Explained Variable	Corporate Average Fuel Consumption Credits	CAFCC	
	New Energy Vehicle Credits	NEVC	
Controlled Variable	Enterprise Size	SCALE	LN(Total assets)
	Profitability	ROE	Return on net assets of the enterprise
	Operating Capacity Rate	OPR	Total asset turnover

3 Empirical Analysis

3.1 Descriptive Statistics

In the descriptive statistics stage, the data of 8 New Energy listed passenger car enterprises in China with certain market representation were used for analysis (the analysis results are shown in the Table 2). First of all, the sum of squares for deviation and the standard deviation of CAFCC and NEVC are both very large, which proves that different enterprises have great uncertainty or volatility in terms of the number of the two credits. This is because when selecting the data, two enterprises that meet and fail to meet the average fuel consumption requirements are selected, which also represents the two extremes of completing the new standard. Secondly, the maximum value of R&D investment data is 79.9, and the minimum value is only 4. The sum of squares for deviation and standard deviation is large, and the kurtosis is less than 3. This is a serious polarization phenomenon with low kurtosis, less intermediate data in the image and higher data at both ends. This shows that the R&D investment of new energy vehicle enterprises that meet the requirements of the new proportion assessment to varying degrees is also different. Similar to the data of CAFCC and NEVC, it shows great volatility and two extremes. Finally, there is less difference of the three control variables of enterprise size (SCALE), profitability (ROE) and operating capacity (OPR), which can easily control them well, so as to more efficiently complete the research and analysis of the correlation between CAFCC and NEVC on R&D investment.

Table 2. Results of descriptive statistics of variables

	R&D	CAFCC	NEVC	OPR	ROE	SCALE
Mean	38.42750	491444.4	312709.4	0.861187	0.050400	6.792754
Median	38.14500	70313.00	128081.5	0.828552	0.055900	6.875349

Maximum	79.91000	3551754.	1655615.	1.473800	0.153500	7.992201
Minimum	4.290000	-447043.0	-102607.0	0.380366	0.088100	5.292400
Std. Dev.	23.47240	1347342.	576961.4	0.297610	0.072313	0.851194
Skewness	0.250662	1.625230	1.776994	0.684419	0.579497	0.376867
Kurtosis	2.564884	4.470473	4.893546	4.044847	2.997372	2.363920
Jarque-Bera	0.146884	4.242595	5.405450	0.988475	0.447758	0.324237
Probabil-ity	0.929190	0.119876	0.067023	0.610036	0.799412	0.850340
Sum	307.4200	3931555.	2501675.	6.889495	0.403200	54.34203
Sum Sq. Dev.	3856.674	1.27E+13	2.33E+12	0.620003	0.036605	5.071717
Observa-tions	8	8	8	8	8	8

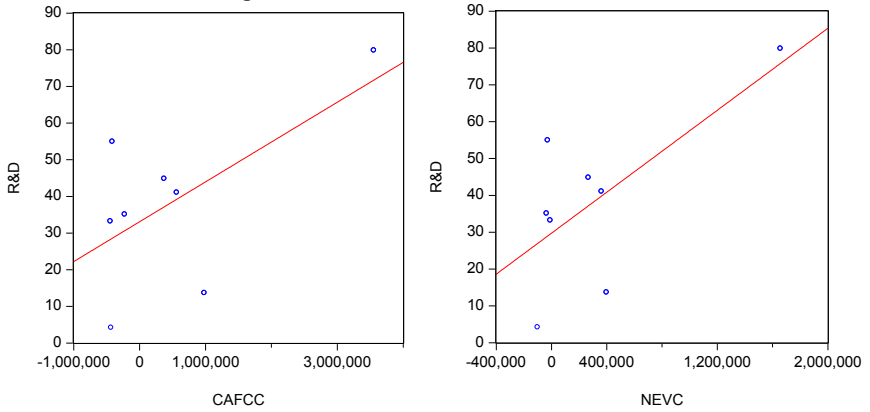
3.2 Regression Analysis

In the regression analysis, first the study uses Eviews software to draw the scatter plots and fitting lines of the R&D investment for the two explanatory variables CAFCC and NEVC, as shown in Figure 1. It can be seen that CAFCC and NEVC are in direct proportion to R&D investment. The two scatter diagrams both show a roughly linear relationship, and there is little difference between them. Next, in order to demonstrate the fitting model function relationship between the two kinds of variables more comprehensively and rigorously, the study carries out more specific analysis, establishes a multiple regression model with R&D investment as explanatory variable, adds control variables OPR, ROE, SCALE on the basis of explained variables CAFCC and NEVC, and get the multiple regression analysis table (Table 3) and model equation by using the least square method:

$$R\_D = -107.851136219 - 5.85628449974e\text{-}05*CAFCC + 0.00014610184035*NEVC + 0.733659127481*OPR - 63.5806812959*ROE + 19.4242651931*SCALE \quad (2)$$

It can be seen from the table analysis results that the probability P value corresponding to the F-test is 0.042, which means that the sample statistics has a 95% confidence to reject the null hypothesis above. The probability P values corresponding to the T-test of CAFCC and NEVC are 0.073 and 0.067, which shows that the two explanatory variables can also explain most of the differences of the explained variables. Among the three control variables, except that the T-test of SCALE can reject the null hypothesis and prove that the correlation with the explained variable R_D is significant, the probability values corresponding to OPR and ROE are relative large, which means that the correlation with R_D is not significant and will not be taken into account in the study. Moreover, the R-square value of the estimation equation is 0.94, which is very close to 1, and it means that the regression line fits the observed value well, the percentage of variability of dependent variables explained by this regression equation is very high.

Therefore, in the preliminary regression analysis, it can be concluded that after the "double credits" policy modifies relevant indicators and adds some new systems, there is a significant functional relationship between the influence of CAFCC and NEVC on the R&D investment of new energy vehicle enterprises, and the above null hypothesis H0 is rejected. However, considering the need to ensure that the estimators of regression parameters have good statistical properties, the residual diagnosis of the model is carried out in the next step.



(a) CAFCC and R&D (b) NEVC and R&D

Fig. 1. Fitting lines

Table 3. Results of regression analysis of variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-107.8511	31.55383	-3.418004	0.0760
CAFCC	-5.86E-05	1.67E-05	-3.497087	0.0729
NEVC	0.000146	3.98E-05	3.673322	0.0668
OPR	0.733659	15.02274	0.048837	0.9655
ROE	-63.58068	70.09973	-0.907003	0.4601
SCALE	19.42427	4.076088	4.765419	0.0413

R-squared	0.982836	Mean dependent var	38.42750
Adjusted R-squared	0.939926	S.D. dependent var	23.47240
S.E. of regression	5.753066	Akaike info criterion	6.451048
Sum squared resid	66.19553	Schwarz criterion	6.510630
Log likelihood	-19.80419	Hannan-Quinn criter.	6.049198
F-statistic	22.90474	Durbin-Watson stat	2.322043
Prob(F-statistic)	0.042359		

3.3 Residual Diagnosis

In order to make the estimated parameters and model predictions effective and prevent the significance test of variables from losing significance, this study conducts a heteroscedasticity test, as shown in Table 4. Here, the White test with cross terms is used only for the two explanatory variables of CAFCC and NEVC. Taking the square of the residual as the dependent variable, the test equation is obtained by the least square method for regression analysis, and the p value corresponding to the F statistic is 0.088. Therefore, we believe that there is no heteroscedasticity in the residual, and the model estimation is effective. It further verifies that the multivariate linear regression analysis results obtained above are reliable and can reject the null hypothesis, proving the conclusion that CAFCC and NEVC have significant correlation with the R&D investment of new energy vehicle enterprises.

Table 4. Results of White Test of explantory variables

Heteroskedasticity Test: White

F-statistic	10.63564	Prob. F(5,2)	0.0882
Obs*R-squared	7.710031	Prob. Chi-Square(5)	0.1730
Scaled explained SS	1.567876	Prob. Chi-Square(5)	0.9051

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 11/12/22 Time: 22:56
Sample: 1 8
Included observations: 8

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-133.9640	199.0904	-0.672880	0.5704
CAFCC^2	-6.29E-09	2.97E-09	-2.120756	0.1680
CAFCC*NEVC	3.44E-08	1.63E-08	2.106512	0.1697
CAFCC	-0.003273	0.001646	-1.988815	0.1850
NEVC^2	-4.54E-08	2.18E-08	-2.076051	0.1735
NEVC	0.007936	0.004382	1.810973	0.2118

R-squared	0.963754	Mean dependent var	131.0502
Adjusted R-squared	0.873138	S.D. dependent var	142.9541
S.E. of regression	50.91688	Akaike info criterion	10.81197
Sum squared resid	5185.057	Schwarz criterion	10.87155
Log likelihood	-37.24789	Hannan-Quinn criter.	10.41012
F-statistic	10.63564	Durbin-Watson stat	2.495892
Prob(F-statistic)	0.088167		

4 Conclusion

Under the background of the "double credits" policy adjustment in 2021, the study selects new energy vehicle enterprises with different completion of new index requirements as the research object to establish a model and verify that CAFCC and NEVC has significant correlation with the R&D investment of new energy vehicle enterprises. Based on the analysis results, the following conclusions are drawn from the impact of the "double credits" policy on the R& D investment of new energy vehicle enterprises:

Increase the application proportion of advanced energy-saving technologies. The "double credits" policy implements mandatory fuel consumption points assessment, and gives preferential treatment to enterprises that produce or supply low fuel consumption vehicles when calculating new energy vehicle points. Under the guidance of assessment constraints and positive incentives, new energy vehicle enterprises continue to increase investment in energy-saving technology research and development, promoting the promotion and application of passenger vehicle energy-saving technology. Promote the efficiency of industrial resource allocation with market-oriented adjustment mechanism. The new market transaction regulation "credit-pool" flexibly adjust market supply and demand, and ensure the basic balance between supply and demand of credits. The credit trading mechanism has greatly improved the efficiency of industrial resource allocation. With the gradual rise of the activity of the credit market and the price of credits, it can promote enterprises to increase R&D investment and effectively improve the level of industrial technology. In terms of sample selection, this study only selects the data of some passenger car listed enterprises in China after the "double credits" policy adjustment in 2021, so the conclusion is not universal, and the impact of CAFCC and NEVC on enterprise R& D investment may lag. In future research, more data can be selected for phased research or compared it with the first edition of the "double credits" policy from 2017 to 2020.

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