How Does COVID-19 Impact Chinese New Energy Vehicle Stock Market? - Research based on Fama-French Model

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ABSTRACT

While Chinese new energy vehicle (NEV) industry is emerging with the support of policies, the plague made damages on the industry by influencing the material supply and technological process of it. During the pandemic, the crude oil price decreased, causing new energy automobiles less attractive. This paper aimed to discover how does COVID-19 impact Chinese NEV stock market, which is helpful for investors, consumers, and the study in NEV field. The research is carried on by employing modified Fama-French model and regression analysis via Eviews. The coefficient of COVID-19 factor is -0.143360, which means the pandemic negatively influenced Chinese NEV stock market and the influence is gentle. This study can bring benefits to both investors and consumers. From the stock market perspective, investors are not recommended to make investments in the Second Board and Chinese NEV market unless risk lovers. Furthermore, since both big enterprises and companies with high book-to-market ratios are mostly overvalued in this market, investors should carefully examine the situation before buying stocks. For the consumers who eager to purchase new energy automobiles, it is not sensible to buy them when the pandemic is severe in the region.

Keywords: COVID-19 , Chinese NEV Stock Market, Fama-French Model, Regression Analysis

1. INTRODUCTION

In order to save energy and reduce car emissions, China aims to achieve carbon neutrality by 2060, which stimulates the development of New Energy Vehicle (NEV) industry [1]. The Chinese NEV industry is an emerging market and is dominant in the global, with a proportion of 56% sales volume of the world market [2]. To facilitate the industry, relevant policies are announced consecutively, including providing subsidies, energy policies and technology-oriented legislations and so on, which increase the investment incentives of new energy, exert a positive influence on the Chinese NEV stock market [1][3]. According to Liu et al, A series of policies that boost the NEV market positively impacted the stock prices [1]. Moreover, the price volatility was reduced and the risk of new energy index was lowered [3]. The weaknesses of the Chinese new energy automobile industry were obvious as well: from an energy perspective, the supply of energy was insufficient, and marketing was also a problem for

enterprises as the short-term profits were hard to earn and the costs of core technologies were high [4].

However, in 2020, the worldwide novel Coronavirus broke out, influencing various industries differently, including the NEV industry. In the first place, the pandemic directly halted the process of research and development, getting bogged down in advanced technology [5]. Furthermore, problems also emerge when facing the issues of materials and components of new energy automobiles. The key resources for NEVs battery production suffered from a huge gap between supply and demand, with nickel and cobalt highly dependent on imports and others rather insufficient, and the import dependence of core components Insulated Gate Bipolar Transistor (IGBT) reaches 90% [5][6]. International trades were seriously impacted by the COVID-19 , thus the supply of necessary materials and components was considered inadequate and the situation aggravated. On the other hand, during the pandemic, the price of crude oil showed extremely instability and the shock of oil price is predicted to be long-lasting, which

may reduce the consumption of cars and encourage the using of NEVs [7].

Compared with the effect of ongoing expansionary policies that encourage the development of the Chinese NEV industry, the shock and problems of the market made by COVID-19 seemed more enormous. Therefore, after the breakout of the Coronavirus, how Chinese NEV stock market goes needs examining. In this empirical study, the monthly provincial-level panel data are employed to examine the COVID-19 effect, other data are provided by CSMAR, and the Fama-French model and regression analysis are used to study how the coronavirus exerts an influence on the Chinese NEV stock market and other factors included in the model. This research is beneficial to investors and consumers who are interested in the Chinese NEV market, and several suggestions are provided.

2. THEORETICAL FRAMEWORK AND DATA SOURCES

2.1. Empirical models

According to Fama and French [8], the beta value of the stock market in capital asset pricing model cannot explain the differences in the returns of different stocks, while the market capitalization, book-to-market ratio and price-earnings ratio of listed companies can explain. The formula of the conventional Fama-French model is as follow:

$$R_{it} - R_{ft} = a_i + \beta_i(R_{mt} - R_{ft}) + S_iSMB_t + h_iHML_t + \varepsilon_{it} \quad (1)$$

However, a_i is not always 0, which means perhaps other factors also matter the returns of different stocks. In order to discover the effect of pandemic, A modified Fama-French model is employed:

$$R_{it} - R_{ft} = a_i + \beta_i(R_{mt} - R_{ft}) + S_iSMB_t + h_iHML_t + c_iCoV_t + \varepsilon_{it} \quad (2)$$

Where R_{it} indicates the tth month return of the stock market, R_{ft} is the tth month risk-free rate; a_i is the tth month intercept term; β_i, S_i, h_i and c_i means the sensitivity coefficient of Excess return on the market portfolio of explained variables, the gap between the returns of small and large companies (SMB), the difference between returns of companies with high and low book-to-market ratios (HML) and CoV_t respectively. E_{it} represents the random noise.

The variable representing the influence of COVID-19 is a dummy variable, which equals to 1 if a province showed that confirmed cases of the coronavirus existed on a monthly basis, and 0 otherwise. After that, in order to evaluate the variable value regarding the pandemic effect on the NEV industry in the whole country, weighted average method is employed based on the new energy vehicle sales volume distribution in China, which is considered as a control variable, and the values are based on data reported on China New Energy Vehicle Industry Development Report (2020) [9]. Since all provinces on the mainland had confirmed cases at the end of 2020, the variable is only evaluated in time dimension.

2.2. Data Source

Data from 29 provinces, municipalities and autonomous regions of mainland China are employed, excluding Qinghai Province and Tibet Autonomous Region. Table 1 indicates the definition of variables and their corresponding data source. All data is selected on a monthly basis from January 2020 to February 2022. For the number of risk premiums of the market portfolio, SMB and HML are from CSMAR database under the category P9705, which represents the Second Board, where the Chinese NEV stock market is located. The risk premium of the Chinese NEV stock market is the return of stock numbered 399417, which is an index share, minus risk-free rate, which is the interest rate of a 10-year treasury bill in China.

Table 1. The definition of variables and data sources

Variables		Data source
Explained variables	Risk premium of the NEV stock market	Shanghai Stock Exchange
Explanatory variables	Risk premium of the market portfolio; Gap between the returns of small and large companies (SMB); Difference between returns of companies with high and low book-to-market ratios (HML); Whole number of confirmed cases weighted averaged by NEV sales volume distribution (CoVt)	CSMAR; Official Website of the National Health Commission of China

Control variables	NEV sales volume distribution	China New Energy Vehicle Industry Development Report (2020)

2.3. Specific method

This research employed regression analysis to evaluate whether the modified Fama-French model fit the Chinese NEV stock market and how COVID-19 exerts an influence on it. By using Eviews to do regression analysis, the study aimed to discover the coefficient of each explained variables to see to what extent each variable impacts the Chinese NEV stock market, especially how Civid-19 have influenced on it.

3. MODEL RATIONALITY AND RESULTS

By employing Eviews to do the regression analysis, the respective coefficient and other results are presented in Table 2. The variables X1, X2, X3 and X4 in the table are risk premiums in the market, SMB, HML and CoVt respectively. Before finding out the result, the rationality of model needs to be examined through several indicators.

Table 2. Regression Analysis Results Table on Eviews

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.077515	0.039217	1.976537	0.0656
X1	0.923439	0.192792	4.789820	0.0002
X2	0.171667	0.243708	0.704396	0.4913
X3	-1.215049	0.432113	-2.811879	0.0125
X4	-0.143360	0.065148	-2.200516	0.0428

R-squared	0.718049	Mean dependent var	0.015052
Adjusted R-squared	0.647561	S.D. dependent var	0.088782
S.E. of regression	0.052707	Akaike info criterion	-2.843878
Sum squared resid	0.044449	Schwarz criterion	-2.595182
Log likelihood	34.86072	Hannan-Quinn criter.	-2.789904
F-statistic	10.18684	Durbin-Watson stat	2.093098
Prob(F-statistic)	0.000269		

3.1. R-Squared & adjusted R-square

R-squared and adjusted R-square are indicators showing the goodness of fit and adjusted goodness of fit of the model. The higher number, the higher explanation degree of the explanatory variables. As shown in Table 2, the R-squared is 0.718, which means the modified Fama-French model can explain 71.8% of the changes in excess return in the market portfolio, while adjusted R-squared is 0.648, indicating that after adjustment, the model can explain 64.8% of the changes. The numbers are relatively high, which means the model can well explain changes in explained variables.

3.2. F-test and t-test

According to Table 2, the F-statistic is 10.19, which is relatively high and indicates that the explanatory variables have comparably significant degree of explanation. The probability of F-statistic is only 0.0003,

meaning the probability to have special values is extremely small, thus the model is reliable.

The fourth column in Table 2 shows the t-statistic for each coefficient of explanatory variables and the fifth column is the corresponding companion probability. The smaller the probability, the higher explanation degree of the explanatory variables, normally we compare it with 5%. If the companion probability is higher 0.05, it means it is a small probability event and we should reject the hypothesis.

For the constant, the probability is 0.0656, which is slightly higher than 5%, which indicates it does not have a novel explanation for the explained variable. Thus, it can be roughly considered that the excess return of NEV stock market is basically decided by four factors drew. Except the probability of x2 is 0.4913 is much too big, the other variables have the companion probability that are 0.0002, 0.0125 and 0.0428 respectively, indicating that they have strong explanation power to the changes in the explained variable.

3.3. Results

According to Table 2, the result is:

$$R_{it} - R_{ft} = 0.078 + 0.923(R_{mt} - R_{ft}) + 0.172 SMB_t - 1.215 HML_t - 0.143 CoV_t + \varepsilon_{it}$$

As the t-test shows above, the variable SMBt and the constant do not have novel explanation degrees and correlation to the excess return of the Chinese NEV stock market. The excess return of market portfolio has a positive relationship with that of the Chinese NEV stock market; the gap between the returns of small and large companies (SMB) has a little positive relationship with the excess return of the NEV stock market, meaning that small companies tend to get higher excess returns because of undervaluation; However, Difference between returns of companies with high and low book-to-market ratios (HML) has a significant negative relationship with the excess return of the NEV stock market, indicating that companies with high book-to-market ratios have low excess return of NEV stock market. More importantly, the CoV has a negative relationship with the excess return of Chinese NEV stock market and the impact is mild.

4. DISCUSSION

The result indicates that the COVID-19 exerts a negative influence on the Chinese NEV stock market, and the degree of impact is mild. The study result that using one of technical analysis methods is basically the same as that of fundamental analysis mentioned in the introduction. However, some factors do not have the same effect as those in Fama-French model. The coefficient of variable SMB does not show novel degree of explanation of the explained variable, which may be because the Second Board in Chinese A stock market mostly includes innovative and small companies, while huge and international enterprises seldom exist in this market. Moreover, those small companies are likely not to be undervalued significantly. Furthermore, in the Fama-French three factor model, since companies with a high book-to-market ratio tend to have more excess return in market portfolio, HML is positively related to the excess return of investment portfolio, which is opposite to the result in the research. The reason may be high book-to-market companies are much overvalued on the Second Board so that the excess return is low.

In the market environment analyzed from the study, several suggestions to investors are provided. On the first place, investors are recommended to be prudent and cautious in the Second Board and Chinese NEV stock market, especially do not regard huge firms as a great chance to get high return since it is likely to be overestimated. From the risk premium value of the Second Board and research done by Cao et al. [10] showing that the NEV industry's risk is higher than average risk, the Chinese NEV market is popular with risk lovers who expect a high return and can undertake high risks. Secondly, the book-to-market ratio is not a good indicator to identify if the company could get a high return and adversely, according to the result, perhaps a high book-to-market ratio enterprise probably get a low return due to the notably overestimation. Last but not the least, as the pandemic negatively impact Chinese NEV stock market, and the influence degree is intermediate, it is not a good chance to make an investment in NEV now (March 2022) due to the increasingly severe plague. Similarly, based on fundamental analysis, it is also not a reasonable decision to purchase new energy automobiles during the period when the COVID-19 has huge influences on society.

There are several limitations in the research that can be improved in the following studies. Firstly, as the Fama-French model evaluates the excess return of the market and the difference between big and small firms, companies with high and low book-to-market ratios, it is more uniform to calculate the factor CoV as a gap between companies with high and low pandemic influence. Nevertheless, due to the limitation of data sources, this idea maybe achieved in future research when the data is accessible. Furthermore, the time period under study is only two years, meaning that the research only study on relatively short period of influence that COVID-19 has had on the on Chinese NEV industry. The period can be longer to better evaluate a more precise impact and draw a more universal conclusion in future studies.

5. CONCLUSION

The Chinese government encourages the development of the Chinese new energy vehicle industry to save energy and be environment-friendly by announcing policies such as providing subsidy. Under the situation, the NEV industry is emerging and is expected to have a great return. However, with the outbreak of COVID-19 , the material, technology, and costs of substitutes all do damage to the NEV industry. By the fundamental analysis, owing to the restrictions of international trade and technology stagnant, the supply of new energy automations' materials and production are negatively influenced, resulting in the price increase. Also, with the decline in crude oil prices, the ordinary vehicles seem more popular than new energy ones. In order to discover how the pandemic impact the Chinese NEV stock market, this paper employed modified Fama-French model and regression analysis as methodology, Eviews as a tool to draw the result. Through regression analysis via Eviews, the COVID-19 negatively influences the excess return of the Chinese NEV stock market, and the impact is mild instead of intense. Moreover, the excess return of the market portfolio has a positive relationship with that of Chinese

NEV stock market; the Gap between the returns of small and large companies (SMB) has a little positive relationship and the difference between returns of companies with high and low book-to-market ratios (HML) has a significant negative relationship with the excess return of the NEV stock market.

Future studies can make improvements in two aspects. First, with sufficient data sources, the COVID-19 factor can be evaluated by calculating the gap between companies with high and low pandemic influence. Second, the period of pandemic being studied can be longer to better examine a more precise influence in the future.

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