Empirical Study on the New Energy Vehicles Market in China —Based on the CAPM Model

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Abstract—As an emerging market in China, the new energy vehicle industry has developed rapidly during the recent ten years. Supported by national policy and increasing market demand, many giant foreign companies like Tesla, as well as domestic vehicle corporations such as BYD and NIO entered the market, which made the market becoming competitive. As a result, the Chinese new energy vehicle market got attention from more and more investors. Therefore, it is meaningful to discover the influence of risk imposed on the new energy vehicles market. CAPM is a traditional model which can explain the relationship between risk and return. This study empirically researches the effectiveness and practicality of the CAPM model in the Chinese new energy vehicle market. Using the observations of 30 A-shares of Shanghai stock exchange from January 2019 to January 2021, the study performed a two-stage regression test on β coefficient of each stock and portfolio. The results find that although the β value is associated with the equity return of the market, CAPM model does not have strong explanatory power in Chinese new vehicle market. It might indicate that security's prices in Chinese new energy vehicle market are affected not only by systemic risk, but also by other factors.

Keywords- CAPM model; Chinese new energy vehicles market; β value

1 INTRODUCTION

The pricing of securities has become one of the core problems in the field of financial economy as the modern market economy has evolved. Markowitz, who creatively put forward a complete set of "mean-variance" analysis frameworks in his famous work 'Portfolio Selection', quantified the asset pricing theory [1]. After that, the capital asset pricing model (CAPM) was first put forward by William Sharp [2]. He analyzed investment market and then found the relationship between the expected return rate of securities and risk. John Lintner and Jesse Morssin studied further and perfected the model [3][4]. However, studies questioned on reasonableness of the model's assumptions occurred since the 1970s as more empirical investigations have been done.

CAPM model can be regarded as a financial asset pricing model which can be examined by measurement [5]. It was built based on Markowitz's theory which regarded that the correlation between the expected rate of return and the risk of the asset is positive. The risk can be measured as β coefficient. In China, the relevant research on CAPM is still in the primary stage and many empirical studies showed the applicability of the CAPM model in the Chinese stock market is low [6]. However, after years of improvement, Chinese stock market has gradually become mature. Therefore, it is necessary to observe whether the former conclusions are still effective by re-testing the applicability of CAPM according to new data.

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In China, the new energy vehicles industry will surely be an important role in the future domestic economic development. The promotion of citizens' environment awareness, advanced technology and national policies' support make the industry being widely favored by investors. Therefore, the study on the relationship between the return of stocks and the risk in the new energy industry can better guide investors.

2 LITERATURE REVIEW

Since the CAPM model was introduced, many empirical tests have been done to examine whether the model is effective in practical stock market. Sharp was the earliest scholar who selected 34 American mutual funds from 1954 to 1963 and then calculated their annual average rate of return and yield. After finishing the standard deviations and regression analysis, the results showed that average returns and the β coefficient have a similar linear relationship. Additionally, Black, Scholes and Jensen supported the model based on the test on the data from stocks of listed companies on the NYSE between 1926 and 1966 [7]. However, since the study conducted by Reinganum and MarcR found that the correlation between the average stock earnings and the β coefficient was not positive based on the data after the 1970s, the validity of the CAPM model has been questioned [8].

In China, the study on empirical tests on the CAPM model began in 1990s. Yang and Xing were the first scholars who showed that there was no relationship between the return rate of stocks and system risk in Shanghai stock market [9]. After that, the study results found by Jin also proved that the CAPM model was not suitable for the Chinese stock market [10]. Many results pointed that in Chinese stock market, there was no linear relationship between the rate of return and β, which means there are other influencing factors except for system risk.

3 THEORETICAL ANALYSES ON CAPM

3.1 Assumptions

If CAPM model is expected to be effective in empirical study, several strict assumptions must be satisfied. First, all the investors in the market are rational, which means if the risk level is same, they will choose to invest securities with higher returns. At the same time, they will choose in securities with lower risk under the same level of return. Second, the market is totally effective, all assets can be divided completely in capital market. Third, the discount rate is fixed, and inflation is not considered. Investors can dispose of assets without tax and transaction costs. Besides, investors' behavior cannot influence market price. Fifth, all investors in the market can get full information in time. The expected value for return and risk is the same to them.

3.2 Explanation on the Model

According to the CAPM theory: $Ri = Rf + \beta i \times (Rm-Rf)$

To be specific, Ri means the rate of return of the stock at yield. Rf is the risk-free rate of return of capital market. βi means the coefficient of the capital asset i, Rm refers to the expected rate of return of the market. Under the equilibrium condition, (Rm-Rf) represents the excess market return.

β coefficient is the key index in this model, which is used to measure the degree of sensitivity of returns of a specific capital asset or portfolio to the changes of market portfolio returns. When β equals one, it means the return of individual stock equals the average rate return of capital market. When β is greater than one, it means the return of the capital asset is bigger than the average rate return of capital market, while if β is less than one, the return of the stock is smaller than the capital market's return. Therefore, investors need to make rational decisions on investment based on β coefficient.

3.3 CAPM Empirical Test

Based on the famous two-stage regression method put forward by Fama and Macbeth (1973) [11], the tests are proposed to combine the cross-section regression with the time-series regression method. First, the data selected as a sample will be divided into three periods. Second, calculate the β coefficient of individual stocks in the first period through time series regression. Then, construct the portfolio based on the size of βi, and perform time series regression of each group again in the second period to obtain the β coefficient of the combination, recorded as βp. Finally, use βp of the as independent variable, perform cross-sectional regression to test the effectivity of CAPM model by using the return rate of the third phase.

4 EMPIRICAL TEST ON CAPM OF CHINESE NEW ENERGY VEHICLE MARKET

4.1 Data

This paper selected 30 A-shares of Chinese new energy vehicle concept stocks from the Shanghai Stock Exchange from January 2018 to December 2020 and all the elected companies are representative. In this paper, the monthly rate of return is the measure of the sample stock returns. Selected monthly degree of the three-year treasury yield as the risk-free rate of return and defined the Shanghai Composite index as the market index. All the data were selected from Wind financial terminal.

4.2 Empirical test process

4.2.1 Calculate β of each stock

The first step is to divide the three-year time interval into three time periods: first, January 1,2018 to December 31, 2018; second, January 1, 2019 to December 31, 2019; third, January 1, 2020 to 12 December 31, 2020. Then, use the data of the first period to estimate β coefficient of single sample stocks based on the time-series regression results between excess return on single security and the excess market return on monthly basis. The regression process was performed through Stata 15 system.

The model applied is: $Ri-Rf=\alpha i+\beta i\ (Rm-Rf)+\varepsilon i$

Table 1: Time series regression results of the first period of stock

share code	β	R^2	Prob	share code	β	R^2	Prob
600563.SH	-0.3011055	0.0287	0.5986	600066.SH	0.7092528	0.0886	0.3474

601689.SH	-0.2164821	0.0153	0.7021	601777.SH	0.7359853	0.3571	0.0402
600733.SH	-0.1125757	0.0025	0.8779	603659.SH	0.7937156	0.0295	0.5938
600699.SH	0.0732583	0.0038	0.8499	601766.SH	0.8228096	0.238	0.1076
600166.SH	0.2163146	0.081	0.3701	600418.SH	0.8889913	0.1491	0.2151
600522.SH	0.2554622	0.0136	0.7178	601677.SH	1.106043	0.4369	0.0193
600143.SH	0.2584514	0.058	0.4508	600741.SH	1.148738	0.2052	0.1391
600885.SH	0.2957526	0.0129	0.725	600110.SH	1.293391	0.2578	0.0919
601717.SH	0.3320491	0.0307	0.5858	603026.SH	1.309526	0.1974	0.1479
600219.SH	0.4671963	0.242	0.1043	600875.SH	1.434416	0.6081	0.0028
600157.SH	0.474434	0.0322	0.5768	600104.SH	1.456045	0.4078	0.0254
600884.SH	0.4863341	0.0239	0.6314	600482.SH	1.477186	0.2968	0.067
601727.SH	0.5759962	0.1061	0.3016	601633.SH	1.52431	0.4096	0.025
601127.SH	0.6553232	0.2126	0.1314	600895.SH	1.619782	0.0994	0.3181
601238.SH	0.6700463	0.1808	0.1682	603799.SH	2.230262	0.3045	0.0629

From the table, it is clear that the β coefficient of 30 single stocks is not significant, which means the conclusion of the positive relationship between the system risk of new energy vehicle market and single stock's rate of return cannot be verified. The estimation of β value is between -0.3011055 and 2.230262 and the average of β coefficient is 0.76, which means a large proportion of stocks' risk in new energy vehicle industries is less than the market portfolio.

4.2.2 Build stock portfolio

Since the large non-systemic risk of a single stock might influence the regression results, making regression on portfolio was considered. In order to disperse non-systemic risks, the stocks were grouped into every 6 groups according to the size of β calculated in the first stage. The excess return rp−rf was calculated by the simple arithmetic average method using the data from second period. βp was set to be obtained by performing the time series regression according to the following formula: $Rp-Rf=\alpha p+\beta p\ (Rm-Rf)+\varepsilon p$

Table 2. Time series regression results of the second period of portfolio

	group 1	group 2	group 3	group 4	group 5	group 6
β	1.420639	1.092135	1.169743	1.045242	0.784821	1.739738
T	3.97	5.36	6.6	2.83	4.38	4.98
F	15.76	28.77	43.55	7.99	19.17	24.8
Prob	0.0026	0.0003	0.0001	0.0179	0.0014	0.0006
R^2	0.6118	0.742	0.8132	0.4443	0.6572	0.7126

From the table, the βp value of each combination is almost about 1 and the significance levels are basically small, indicating that the portfolios' returns are significantly affected by the market return. Besides, the determining coefficient R2 does not increase with βp, indicating that stock returns are still affected by other factors except systemic risk.

4.2.3 The cross-section regression of CAPM model

First, calculate the average of the monthly excess yield of the six combinations using the data from the third period. Then running the cross-section regression by the following model: rp-rf=γ0+ γ1βp+εp. βp is the value estimated in the second period.

Table 3: Cross-section regression result

	γ0	γ1	R^2	F	P
coefficient	-0.0511574	0.0614225	0.9044	241.48	0.0001
t	-7.53	15.54			

From the table, the R2 is 0.9044, which means the fit degree is great. γ0＞0, which indicates the return of the asset is significantly positively related to systemic risk and the income will increase if risk increases. It is consistent with CAPM model.

5 CONCLUSION

Through the whole analysis and empirical test on the effectivity on the Chinses new energy vehicle market, people can find that the results of the first time-series regression test are not significant, while the next two tests show that the CAPM model is almost effective after dividing single stocks into groups. It might be other factors, or the market cannot satisfy the assumptions of the theory that cause the deviation. In China, the current securities market has not been completely effective, therefore, many investors cannot obtain complete and effective information in time. Besides, securities prices might also be affected by the scale of assets and market to book ratio, resulting in the inconsistency of the test results. Currently, mature technology and the discovery of new environmental energy inspire the demand for the production of new energy vehicles. The market is getting competitive. Therefore, the Chinese new energy vehicle industry should make good use of policy effect and put efforts into an industrial upgrade to enhance the ability to resist risks from the market.

For this paper, since the data was selected within three years period, the sample might be a little small. It might be more accurate if five years of stock price were selected. Besides, in the empirical test process, β coefficient is the only dependent variable. However, in some cases of study, β2, the square of β can also influence the test results. It can be tested by FM test method. In the future study, to find the potential influence on stocks' price caused by other factors such as book-to-market equity and earnings per price, the capability of the Fama-French three factor model in the Chinese new energy vehicle market will be tested.

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