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An Empirical Study of A-share Stocks in the New Energy Sector

--Based on the Fama-French Three-factor Model and the CAPM Model

Zhilin Yang[1,a,*]

[1]*College of Economics and Trade, Henan University of Technology, Zhengzhou, 450001, China*
a. yangzhilin@stu.haut.edu.cn
**corresponding author*

Abstract: In recent years, the new energy industry has been developing rapidly, also, the new energy industry has drawn much consideration in corporate security choices. This paper selects 20 stocks with better performance in the new energy industry, constructs three explanatory variables based on the Fama-French three-factor model and the CAPM model, namely, the market factor, the size factor, and the book-to-market ratio factor, and carries out empirical analyses on the daily returns of the selected stock portfolios. It is concluded that all three explanatory variables have better explanatory power for the sample data, with the market factor having a stronger explanatory power than the rest of the factors, and the Fama-French three-factor model having a better explanatory power than the CAPM model.

Keywords: new energy industry, three-factor model, CAPM model, excess returns

1. Introduction

In order to satisfy the investment desire of pursuing high expected returns and avoiding investment risks as much as possible, Markowitz proposed the concept of "efficient portfolio" in 1952 [1]. In 1952, Markowitz proposed the concept of "effective portfolio". The main idea is to calculate the highest expected return under a given risk level through the weighted average and standard deviation of the expected return of the portfolio, however, due to the complexity of the concept of efficiency boundary, one of the theories in the application of certain difficulties. William Sharpe perfected the above portfolio theory, and proposed the capital asset pricing model (CAPM) in 1964, which is based on the efficient market hypothesis and can quantify the degree of market risk [2]. The CAPM model quantifies the degree of market risk, and describes the norms of people's behaviour in the securities market.

Many scholars have concluded that the CAPM model has some shortcomings, such as the risk measure is not comprehensive enough, ignoring the non-systematic risk in the market and many assumptions are too simple, real-life investors are not 100% rational, and there is no real risk-free securities in the market [3]. As a further refinement of the capital asset pricing model, Banz suggests that there is a significant small cap effect in the stock market [4]. Basu shows that buying low P/E stocks and selling high P/E stocks results in a risk-free return [5]. Btattman found that high book-to-advertise proportion stocks have higher anticipated profits than low book should showcase proportion

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stocks [6]. Bhandari found that the debt-to-equity ratio and expected return on stocks are significantly related [7]. Fama and French integrate the above factors and cross-sectionally demonstrate that the CAPM model βi does not work. Finally Fama and French proposed the Fama-French three-factor model, i.e., the three pricing factors of stocks market factor, market capitalization, and book-to-market ratio factor [8]. Adding two new factors can better predict the expected return of the portfolio.

Scholars have done a lot of research on the applicability of the CAPM model Fama-French three-factor model in China's financial market. Based on numerous predictive variables, Jiang Fuwei proposed that China's market portfolio and the portfolios of various components have significant in-sample and out-of-sample predictability, and there are significant differences in the predictability of different components [9]. This theory clears the way for further research on the capital resource valuing model in China's market. Jin, Yunhui, and Liu, Linargued that the CAPM model is not applicable in China's capital market due to the imperfections of China's market as well as excessive speculation, policy influences, and other factors [10]. In this study, Xia Xun argues that the CAPM model is not applicable in China's capital market due to market imperfections, excessive speculation and policy influence. Xia Xunproves that there are obvious scale effects and book-to-market ratio effects in China's A-share market, and the explanatory power of the traditional CAPM model is totally insufficient [11]. The illustrative force of the conventional CAPM model is totally insufficient. It shows that the Fama-French three-factor model has good practicality in China's capital market. In order to improve the persuasive power of the model, Qi Yue et al. introduced the corporate governance factor EMD into the Fama-French three-factor model, and found that a high level of corporate governance can indeed bring a return premium for enterprises [12]. Shao-Hua Zhang, Hui-Ling Chen concluded that total factor productivity is an effective factor and is negatively related to stock excess return [13]. In conclusion, the capital asset pricing theory and the three-factor model have high research value and research enthusiasm.

During the "14th Five-Year" period, photovoltaic, wind power, biomass energy, geothermal energy and other energy systems, distributed applications, innovative development of China's response to climate change, to ensure that the energy security belt an important element. China will promote energy storage as the core of the establishment of a multi-energy complementary energy system, when photovoltaic will usher in the rapid development of wind power also has a larger space for development, while nuclear energy is developing steadily. Therefore, the new energy industry can still lead the Chinese stock market in the short term under the policy support. This paper is based on the CAPM model and Fama-French three-factor model of China's new energy industry shares to conduct empirical research, explore the two models in the new energy sector's ability to explain, and expect to give shareholders some investment advice.

2. Modelling and Data Collection

2.1. CAPM Model Construction

The general form of the model is

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \varepsilon_i \quad (1)$$

Where R_{it} represents the stock portfolio return, where i is a parameter representing the first i stock. R_{ft} denotes the risk-free rate of return or the risk-free interest rate, the α_i the intercept term, the β_i is the coefficient of the market risk premium factor, the R_{mt} is the market yield. R_{mt} -is the market rate of return. R_{ft} is the market risk premium. The subscripts of all the above terms t is a time parameter, denoting the daily data for a particular day.

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2.2. Fama-French Three-factor Model Construction

The general form of the model is

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \beta_{iSMB}SMB_t + \beta_{iHML}HML_t + \varepsilon_i \quad (2)$$

Added size factor compared to CAPM modelSMB_t and a book-to-market ratio factorHML_t .SMB_t represents the small-cap effect, which is the difference between the stock return of a small-sized firm and a large-cap firm.HML_t then represents the the distinction between the stock returns of high book-to-advertise proportion firms and low book-to-showcase proportion firms.

2.3. Data Collection and Processing

2.3.1. Data Collection

The study selects the daily data of 20 companies in A-share new energy sector with 485 trading days in 2021-2022, including daily market capitalisation, price-to-book ratios, up and down ratios and so on, for the construction of the factors. These companies are China Nuclear Power, Lithium Ion, Chang'an Automobile, Yangtze River Power, etc., to ensure the diversity and universality of sample points and enhance the persuasiveness of the sample. All data are sourced from the Wind Wardell database.

2.3.2. Factor Construction

The factors required for the model are constructed by processing the above data. First, the weighted average return of the stock portfolio for each trading day is calculated by taking the percentage of each company's daily closing price in the total market capitalisation of the 20 companies as weights, Ri. The average daily return of A-shares for 485 trading days in 2021-2022 is obtained from the Wind Ward database and used as the market rate of return, Rm. The three-year time deposit interest rate is obtained from the official site of Individuals' Bank of China, and the converted daily interest rate is used as the Risk-free rate Rf.

Second, pricing factors are constructed. The market capitalisation to the book-to-market ratio of each stock on the last trading day of 2022 is used to group stocks. Based on the closing price, 20 stocks are equally divided into two gatherings: little market capitalisation (S), and huge market capitalization (B). The 6 stocks in the top 30% of the book-to-showcase proportion are arranged into the high book-to-advertise proportion bunch (H), the 8 stocks in the center 40% are ordered into the medium book-to-showcase proportion bunch (M), and the 6 stocks in the bottom 30% are classified into the low book-to-market ratio group (L). The above groupings are cross-combined to finally obtain six portfolios SH, SM, SL, BH, BM, and BL. The daily weighted average return of each portfolio is calculated for the stocks in each portfolio using the daily market capitalisation as a level of the all out everyday market capitalisation of that portfolio, denoted as SH_t, SM_t, SL_t, BH_t, BM_t, BL_t. And construct the factors according to the following equation:

$$SMB_t = (SL_t + SM_t + SH_t)/3 - (BL_t + BM_t + BH_t)/3 \quad (3)$$

$$HML_t = (SH_t + BH_t)/2 - (SL_t + BL_t)/2 \quad (4)$$

The size factor SMB is the arithmetic mean distinction among little and huge market cap portfolios, and the book-to-market ratio factor HML is the arithmetic mean distinction between high book-to-advertise proportion portfolios and low book-to-showcase proportion portfolios.

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3. Empirical Analyses

The following analyses are quoted from the above data, applying the Fama-French three-factor model as well as the CAPM model, descriptive statistical analysis of the 485 data through Eviews, pearson's correlation coefficient matrix analysis, VIF test, and OLS least squares regression.

3.1. Based on a Three-factor Model

3.1.1. Descriptive Statistical Analyses

In terms of descriptive statistical analysis of explained variables, firstly, it can be seen from Table 1 it is concluded that the daily weighted average return of the selected stock group sum is 0.00096523>0, which indicates that the new energy sector moves in a generally positive direction during the two-year period of 2021-2022, earning positive returns. It is worth noting that the variance reaches 3.664, which is higher than the universal range, proving that there is a high volatility in the average daily return of this portfolio, which reflects the market movement more quickly. This characteristic also indicates that there is a greater risk of stocks in this sector, and shareholders should pay more attention to stock selection.

In terms of descriptive statistical analysis of explanatory variables, firstly, the average market risk premium of the stock portfolio was negative and the normal market return was lower than the gamble free pace of return during the information determination time span. The reason for this anomaly may lie in the downturn in the market economy due to the New Crown Pneumonia epidemic, the general pessimistic attitude of investors towards market returns, or other factors that warrant further investigation. Second, the size factor (SMB) also has a negative mean return with a large variance, and extreme variance. It indicates that the average return of large-scale companies is higher than that of small-scale companies in this stock portfolio and ihe new energy industry as a whole, but the variance of 2.131 and the maximum value of 8.48050604 also proves that there are individual small-scale companies in the portfolio that have a higher average return. Thirdly, the book-to-market ratio factor (HML) has an average return of 0.00010207, indicating that companies with high book-to-advertise proportions have higher normal returns than those with low book-to-showcase proportions, but the extremely high variance and the extreme variance of nearly 20 points indicate that the returns on this factor are extremely volatile and risky, and that investing in accordance with this factor can yield substantial returns.

Table 1: Results of descriptive statistics.

	count	mean	std	min	25 per cent	max
Riret	485	0.096523	3.664	-5.703470	-2.522837	6.675131
RiskPremium ($R_m - R_f$)	485	-0.025262	1.368	-6.039709	-2.736686	3.760203
SMB_t	485	-0.060401	2.131	-4.991760	-2.330038	8.480506
HML_t	485	0.010207	8.573	-10.04109	-2.254505	9.962629

3.1.2. Dependent Variable Correlation Tests

In Table 2, the correlation coefficients between the market factor, the size factor, and the book-to-market ratio factor are 0.226, -0.338, and -0.479 respectively at the 1% significance level, all of them are weakly and moderately correlated, and it can be judged that there is no serious linear relationship between the factors, which is similar to the results of the rest of the related Fama-French three-factor study. Among them, the size factor shows positive correlation with the market factor, which is in line

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with the original hypothesis. The book-to-market ratio factor is negatively correlated with the market factor and is only significantly weakly correlated. The book-to-advertise proportion is adversely corresponded with the size factor, but the correlation coefficient is low. From the above analysis, it can be basically determined that there is no redundancy of variables, which meets the conditions for subsequent regression test.

Table 2: Matrix of pearson correlation coefficients.

Correlation t-Statistic	$(R_m - R_f)$	SMB_t	HML_t
$(R_m - R_f)$	1.000000		

SMB_t	0.225627	1.000000	
	5.089922	-----	
HML_t	-0.337951	-0.478757	1.000000
	-7.891552	-11.98451	-----

3.1.3. Regression Feasibility Test

In Table 3, the VIF values of the three explanatory variables are less than 5, showing that there is no multicollinearity between the factors, which passes the VIF test and meets the conditions required for the subsequent regression test.

Table 3: VIF test table.

	RiskPremium $(R_m - R_f)$	SMB_t	HML_t
VIF value	1.136	1.305	1.398

ADF test of data smoothness is performed on the mean returns of the explanatory variables: market factor, size factor, and book-to-market ratio factor. The results are shown in Table 4 The ADF test t-value for the market factor is -21.82, the outright worth is a lot bigger than the basic worth at 1% importance level. Simultaneously the size factor and the book-to-showcase proportion factor ADF test t measurement outright worth are more noteworthy than 20, much larger than the critical value of 3.977 at the 1% significance level, it can be seen that the three factors can be rejected the original hypothesis, the time series is smooth. In addition, the P-value of the ADF test for all three factors is 0.0000<0.01, which can determine that there is no unit root in the data, supporting the conclusion that the above time series is smooth. Subsequent regression tests can be carried out.

Table 4: ADF inspection table.

	t-Statistic	1% level	Prob.
$(R_m - R_f)$	-21.81635	-3.443635	0.0000
SMB_t	-22.79974	-3.799131	0.0000
HML_t	-21.96617	-3.799131	0.0000

3.1.4. Regression Analysis

Intercept term analysis. In Table 5, the intercept term is 0.106694 with p-value of 0.01<0.05 and t-value of 2.54, which passes the 5% significance test. This small intercept term indicates that the

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difference between the market portfolio return calculated by the three-factor model and the real return of the selected stock portfolio is very small, indicating that the Fama-French three factors have a better explanatory ability for the stock portfolio, and can well explain the market changes and trends of the A-share new energy sector.

Market factor coefficientsβ_i Analyses. The coefficient of the market factor is 1.099094>1, it is not difficult to realize that the market factor is decidedly connected with the logical factors, while the excess return of the stock portfolio is$(R_m - R_f)$ is greater than the market excess return$(R_m - R_f)$ That is, the risk premium , it can be obtained that the development of new energy industry in 2021-2022 is favorable[14] and the development of the sector leads to the development of the A-share market, which has a positive impact.β_iThe standard error is only 0.038, the t-value is 28.7 much larger than the critical value, the P-value is 0.000<0.05, through the 5% significance test, which indicates that the market factor has a more grounded logical capacity for the progressions in the arrival of A-share new energy area.

Scale factor coefficientsβ_{iSMB} Analysis. β_{iSMB}The regression value is -0.344365<0, there is a negative connection between's the size factor and the portfolio overabundance return. p-value is 0.0000<0.05, the absolute value of the t-statistic is large indicating that the size factor is significantly correlated with the portfolio excess return at the 5% confidence level, what's more, that the component has a specific illustrative power for the stock portfolio. However, the negative correlation implies that the small cap premium effect is not prominent in the stock portfolio or even in the new energy sector. Putting resources into little measured organizations will decrease the gamble reward proportion of the new energy area, while putting resources into enormous estimated organizations might build the gamble reward proportion of the new energy area [15] Which is in accordance with the discoveries of the ongoing review.

Book-to-market ratio factor coefficients β_{iHML} Analysis. β_{iHML}The regression value is -0.314082 with a p-value of 0.0000<0.05 and the absolute value of the t-statistic is much larger than the critical value, and that really intends that there is over 95% conviction that the component is essentially connected with the portfolio abundance return. A negative coefficient suggests that the book-to-showcase proportion factor is adversely corresponded with portfolio overabundance return. Low book-to-market ratio, that is, high price-to-book ratio, high valuation of the company in the new energy sector performance is more prominent, such companies have growth, and in the industry up cycle, so it has the potential for growth in the short term, easier to attract capital inflow, and the possibility of obtaining a higher return. Therefore, in the new energy sector, choose to invest in low book-to-market ratio companies, in the short term to obtain a higher rate of return on investment.

Analysis of model fit. Read Table 5 It can be seen that the model adjusted decidability coefficientR^2 reaches 0.77, indicating that the three factors are able to explain the volatility of the portfolio excess returns to the extent of 77%. The overall F-value of 532.39 is a lot bigger than the basic worth, which proves that the Fama-French three-factor model fits well based on the selected stock portfolios.

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Table 5: Fama-French three-factor model regression results.

	Coefficient	Std.Error	t-Statistic	Prob.
C	0.106694	0.041997	2.540546	0.0114
$(R_m - R_f)$	1.099094	0.038256	28.73010	0.0000
SMB_t	-0.344365	0.032862	-10.47913	0.0000
HML_t	-0.314082	0.016959	-18.51979	0.0000
R-squared		0.768546	F-statistic	532.3892
Adjusted R-squared		0.767103	Prob(F-statistic)	0.000000

3.2. Based on the CAPM Model

As shown in Table 6, the absolute value of the intercept term as well as the t-statistic of the risk premium factor are greater than the critical value, and the P-value is less than 0.05, both of which pass the 5% significance test. The coefficient of the risk premium factor reaches 1.267819>1, demonstrating that the variable has serious areas of strength for a capacity for the arrival of A-share new energy area. The intercept term is only 0.128551, indicating that the contrast between the overabundance return of the portfolio determined by the CAPM model and the genuine return of the portfolio is moderately little, which also proves that the model is more applicable to this stock portfolio.

Looking at the regression results again, theR^2It reaches 0.60 with a very large F-statistic of 725.1519, which proves that the model CAPM model is able to explain the portfolio excess return volatility to the extent of 60%. The above analysis shows that the CAPM model fits the selected stock portfolio well.

Table 6: CAPM model regression result.

	Coefficient	Std.Error	t-Statistic	Prob.
C	0.128551	0.055027	2.336140	0.0199
$(R_m - R_f)$	1.267819	0.047081	26.92864	0.0000
R-squared		0.600216	F-statistic	725.1519
Adjusted R-squared		0.599388	Prob(F-statistic)	0.00000000

4. Conclusion

Based on the Fama-French three-factor model as well as the CAPM model, this paper selects the daily correlation data of 20 better-performing stocks in the A-share new energy sector for 2021-2022 for empirical analysis. Combining the results of the above analyses, first, both models can all the more likely make sense of the overabundance return unpredictability of the relative gamble return proportion of the chose stock portfolios [16] and both model fits are better. In the future, it is recommended to cite the above two models to support stock selection, investment feasibility and a series of investment issues in the new energy sector of A-share. Secondly, comparing the two models, it is not difficult to know that the Fama-French three-factor model has upgraded its logical capacity in the wake of presenting the scale variable and book-to-advertise proportion factor comparative with the CAPM model, which increases the decision coefficients and the fitting effect is better, proving that the scale factor and the book-to-showcase proportion factor have a more grounded logical capacity for the new energy industry, and the three-factor model has a more outstanding performance compared with the CAPM model. Third, the market factor and market risk premium factor have strong explanatory power for China's new energy industry, and the analysis results show that the new energy industry has become a major thread of China's economic development since 2021 and has

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continued to lead the whole year, and although the collection of the impact of the new crown epidemic has resulted in lower expected market returns, this situation will recover quickly in the post-epidemic era. Fourth, the results of the analysis show that the small-cap premium effect on the new energy industry in China did not clearly reflected, at the same time, low book-to-market ratio of the company has a high price-to-book ratio, while having a high valuation, high dividend yield, so that the new energy industry companies in our country perform better. Fifth, combined with the conclusion of the previous article, the investment style of Chinese stockholders is biased towards high risk and high return, with fewer stockholders choosing to pursue the smooth return of blue chips with low P/B ratios. Sixth, the appropriateness of the Fama-French three-factor model and the CAPM model in China's new energy industry strays from that of Western nations, mainly because asset pricing theory is a doctrine based on the legal environment, market system and characteristics of the investment community. Therefore, the classical Western models cannot be directly applied to China's market, where the institutional background and investment groups are very different. To sum up, when investors invest in new energy in A-share market, they should choose companies with large scale, low book-to-market ratio, and high price-to-book ratio, such as BYD, LONGi Green Energy, and Northern Huachuang. This kind of company capital scale, stable operation, and high dividend rate, in order to obtain high returns at the same time to control the investment risk. After the analysis of this research, the author realised that the empirical study of specific stocks in conjunction with the economics model in enables us to acquire a more profound comprehension of the qualities of the stocks in the business, and also deepens the understanding of the model, which can be applied to subsequent economics-related research. At present, the practicality of the three-factor model in China's stock market needs to be further improved. In the subsequent research, the introduction of the market returns of different industry sectors as factors into the three-factor model can largely facilitate investors to make inter-industry investment decisions and enhance the logical capacity of the three-factor model China.

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