The Test of CAPM and Fama-Franch Three-factor Model on China A-shares

Qisheng Zhang[1,a,*]

[1]*School of Economics and Finance, Central University of Finance and Economics, Beijing, 100081, China*
a. 2922139177@qq.com
*corresponding author

Abstract: William Sharpe et al. proposed the CAPM model in 1964, but subsequent empirical studies showed that the CAPM model still had limitations in practical application. In 1993, Fama and Franch proposed the three-factor model, which can explain the future return of the stock portfolio through the company size, the BM ratio of the companies, and express the excess return of a portfolio in the form of three factors. Based on the CAMP and Fama-French three-factor model, this study will use daily trading data of the constituents of the SSE 50 Index to analyze the A-share market by employing the market value factor, company size factor, and BM factor as explaining variables, so as to verify whether the CAPM and Fama-Franch three-factor model is suitable for China A-shares market. The final empirical results show that the CAPM model is applicable to China A-share market, but the validity test of the Fama-Franch three-factor model has not passed completely, that is to say, only in some industries, the Fama-Franch three-factors model can be effectively used.

Keywords: CAPM, Fama-Franch three-factor model, SMB, HML, SSE 50 Index.

1.   Introduction

Capital asset pricing has always been a focal point in the field of modern finance, leading to the generation of numerous related theories. Among them, the CAPM model proposed by William Sharp et al.in 1964 [1] has the greatest impact on the following studies, and the Fama-French three-factor model proposed in 1992 [2] is also widely recognized and influential. Especially based on the CAPM model, Fama and French innovatively found that company size and BM ratio were also important factors affecting portfolio returns, which has contributed to the enhancement of the capital asset pricing model to a certain extent in academic research.

Since compared with the American stock market, there are many differences in the regulatory system of China's A-share market, and the resource allocation function of the stock market has not been fully played. It is obviously not comprehensive enough to solely analyze the return rate of the A-share market only with the systematic risk of CAPM. Therefore, there is a need to enhance this analysis and conduct a validity test with the Fama-French three-factor model to determine its suitability to China's A-share stock market.

This paper conducts an effectiveness test on China's A-share market by CAPM model and Fama-French, and compares whether the two models are suitable for the China's A-share market. Additionally, based on the three-factor pricing model, this paper examines whether the profit factor

in the Chinese market can explain and predict stock return rates, and providing empirical evidence for the asset pricing model in China.

2. Literature review

In normal circumstances, the future returns of capital assets such as stocks and futures have certain uncertainties. The CAPM model found that there is a linear correlation between the excess return of portfolio and systemic risk, and this correlation is expressed by the beta coefficient. Therefore, the beta coefficient has become an important index in the financial market. Hao Xiaoyan believes that CAPM is based on the basic assumption that investors have the same expectations, that is to say, they have the same estimates of the expected return yield, variance and covariance of the security. [3]

Through the research on the effectiveness of the Fama-French three-factor model on Chinese A-share market, Chen Shoudong et al. found that A-shares had a significant company size effect and BM ratio effect through the study of A-share income data, and the Fama-French three-factor model could well reflect the stock market return rate of China.[4] Zang Xueqing believes that market value factors, scale factors and BM ratio factors can forecast the volatility of returns in the securities market, but there are other factors that need further evidence.[5] Tian Lihui and Wang Guanying compared the return rate of Chinese and English stock markets and found that the market risk factor and market value factor in the Fama-French three-factor model could explain the A-share return rate well, but the BM ratio factor was not significant.[6] Many scholars have also found that Fama-French three-factor model doesn't achieve ideal results on China's A-share market, which ultimately lies in the unique shell premium(Qu Yuanyu et al.)[7], high turnover rate(Pan et al.)[8] and other special phenomena in the A-share market.

Jiang Meihong argues that the Fama-French three-factor model can effectively explain and predict the future returns of portfolios containing assets with different sizes and BM ratios, thereby representing the portfolio's excess returns in terms of three factors. [9]

Analyzing a certain industry, EUCAR studied the three-factor model of real estate industry from 2014 to 2019 in China. The findings indicate that the size factor, and BM ratio factor are closely associated with the model. Further analysis shows that the future return of real estate stocks is affected by the above two factors.[10]

3. Methodology

The data selected is the daily trading data of 50 constituent stocks of SSE 50 Index as the research object from January 1, 2019 to December 31, 2023. The data is selected mainly from the CSMAR database. The risk-free yield rate is selected from the Chinese One-year treasury yield.

3.1. The Capital Asset Pricing Model (CAPM)

The Capital Asset Pricing Model (CAPM), proposed by American scholar William Sharp in 1964, provides a framework for evaluating the relationship between asset risk and expected return. CAPM model is the basis for the development of modern portfolio theory, which can help investors to construct an effective portfolio and make investment decisions. The CAPM model mainly explains the relationship between the systemic risk and excess return of the stock portfolio. CAPM contains the following hypothesis: (1) All investors in the market pursue utility maximization and select assets based on the expected return and standard deviation of the portfolio. (2)All investors in the market can borrow funds without any cost. (3)All investors have the same expectations, including the expect return of the asset, the variance and the covariance of the stock. (4) Assets can be subdivided indefinitely and have ample liquidity and no transaction cost. (5)Investors in the market passively

accept the price, and their behavior will not affect the stock price. (6)There is no taxes in the market. CAPM models can be written in the following form:

$$E(r_i) = R_f + \beta_i[E(r_m) - R_f] \tag{1}$$

In this formula, $E(r_i)$ is the future return rate of the stock; R_f is the risk-free rate, and $E(r_m)$ is the average rate of return of the stock market.

3.2. Fama-French three-factor model

This study will use the construction methods employed in Fama and French's three-factor model to test the robustness of the model. The thought of the model is mainly determined by the following formula:

$$\text{return} = \text{benchmark return} + \beta_1(\text{market return - benchmark return})$$
$$+ \beta_2 \text{ (size factor)} + \beta_3 \text{ (value factor)} \tag{2}$$

In the formula, the part containing three betas represents the model's three factors. The first beta aligns with CAPM, indicating the return from portfolio outperforming the market. The second and third beta (reflected by company size and BM ratio) respectively indicate that the company's size and value both have an impact on future stock returns. Firstly, the company's market value to book market value ratio forms six combinations: SL, SM, SH, BL, BM and BH, where S stands for small market capitalization, B stands for large market capitalization, H stands for high a BM ratio, and L stands for a low BM ratio. For example, SL stands for companies with small market capitalization and low BM ratio, and then the monthly future return of each group is calculated. The factor construction method follows the method of small and medium-sized market value reducing large market value (size factor SMB) and high BM ratio reducing BM ratio (value factor HML). The expression is determined by the following formula:

$$SMB = \frac{SL + SM + SH}{3} - \frac{BL + BM + BH}{3} \tag{3}$$

$$HML = \frac{SH + BH1}{2} - \frac{SL + BL}{2} \tag{4}$$

In the empirical study of Fama and French in 1993, they did not assume the problem about rational investors, but took a completely different way to explain the expected return. Based on two widely recognized pricing phenomena: one is that stocks with bigger market capitalizations tend to have lower returns, and the other is that stocks with lower BM ratios generally have higher returns. Fama and French conducted regression analysis through the data grouping of corporate finance and concluded that company size and BM ratio can explain the average return of corporate stocks.

Fama-French three-factor model is as follows:

$$E\left(R_{it}\right) - R_f = \beta_i \left[E\left(R_{mt}\right) - R_f\right] + s_i SMB_t + h_i HML_t \tag{5}$$

Where, $E(R_{it})$, R_f and $E(R_{mt})$ have the same meaning as variable in the CAPM model; SMB_t represents the group return of the market value factor at time (t); HML_t is the group portfolio income rate of the BM factor at time (t).

β_i, s_i and h_i represent the coefficients of each factor, respectively. The contribution of the three-factor model lies in that the capital asset pricing model attributes the returns solely to the market changes, while the arbitrage pricing model attributes the returns to different factors. Fama and French build a factor model and find three persuasive factors, so it enables a better explanation of the factors influencing returns and promotes further development of the CAPM model.

4. Results

4.1. CAMP model

Through the establishment of time series, regression analysis was carried out on each of the SSE 50 index, and the CAPM model results were obtained as shown in the following table.

Table 1 shows the results obtained by regression of 50 stocks (20 of which are shown) respectively. RMSE is the root-mean-square error of each model, and f_test is the f test of the model for each stock. As shown in the table, all models have passed the significance test. The CAPM model has been found to be effective for the 50 constituent stocks of the Shanghai Stock Exchange, demonstrating its significant universal applicability for China stock market (A-share market). This suggests that the CAPM model can be successfully applied in China's stock market.

Table 1: Test results of the CAPM model

α	β	RMSE	f_test
0.0354	0.5888	1.1623	331.23
0.0242	1.5054	1.2953	1723.26
0.0586	1.4504	1.9182	737.95
0.0181	1.1204	1.4766	743.21
0.0188	0.9112	2.0593	252.73
0.0048	0.9463	1.6536	422.69
0.1067	1.1946	2.1420	401.46
-0.0340	0.9698	1.5801	486.24
0.0985	1.0315	2.5688	204.28
0.0242	0.9018	1.8923	293.17
0.0960	1.2042	1.8640	538.69
0.0785	1.0224	2.1926	280.65
0.0867	1.0940	2.0138	380.92
0.1277	1.3809	2.7297	330.33
0.0875	1.0368	1.5455	580.86
0.0406	1.1772	1.7725	569.14
0.2013	1.2357	2.4393	331.23
0.0206	1.0240	1.5345	574.77
0.0426	0.3329	1.1475	108.31
0.1727	0.5729	1.9009	39.48

4.2. Fama-French three-factor model

Through the establishment of a time series for each stock regression analysis, the obtained three-factor model results are shown in Table 2; A three-factor regression analysis was carried out on the constituent stocks of the SSE 50 Index, yielding coefficients for each factor and the F-test value of the model (20 of which are displayed).

Table 2: Test results of the Fama-French three-factor model

α	β1	β2	β3	RMSE	f_test
0.0823	0.7622	0.0447	0.4740	1.0077	279.79
0.0460	1.5774	-0.0845	0.1609	1.2760	604.64
0.0440	1.3868	-0.0677	-0.2195	1.9004	258.86

Table 2: (continued).

0.0705	1.2739	-0.4013	0.2229	1.3575	367.05
0.0812	1.1307	-0.1610	0.5430	1.9378	147.59
0.0301	1.0681	0.2183	0.4685	1.5385	225.56
0.0714	1.1041	0.3787	-0.0543	2.0896	161.62
-0.0258	0.9985	-0.0219	0.0706	1.5787	163.71
0.0945	1.0743	0.5066	0.3914	2.4561	112.35
-0.0021	0.7717	-0.2574	-0.5135	1.7687	6.28
0.0793	1.1328	-0.0686	-0.2423	1.8414	194.56
0.0220	0.8472	0.3487	-0.3138	2.1116	132.81
0.0407	0.8845	-0.2933	-0.7611	1.7694	283.36
0.0311	1.0449	0.2812	-0.8123	2.5141	202.05
0.0767	0.9420	-0.4621	-0.5232	1.3107	426.11
0.0370	1.1359	-0.2322	-0.2451	1.7288	220.55
0.1657	1.0375	-0.5402	-0.8625	2.1275	271.72
0.0039	0.9394	-0.1789	-0.3400	1.4675	9.53
0.0612	0.3872	-0.1423	0.0791	1.1295	50.64
0.1490	0.6807	0.5277	0.8752	1.6364	74.43

It can be observed from Table 2 that the F test of some models has not passed. This suggests that the application of the Fama-French three-factor model to China stock market (A-share market) may necessitate a specific analysis of individual companies or certain industries, rather than a blanket application across the entire A-share market. Therefore, it is preliminarily speculated that the Fama-French model can explain part of China's A-share market, or only in some industries, the three-factors model can be effectively used. Here, we need to further verify each industry, and this part of the content will not be further described in this paper.

5. Conclusion

This paper uses daily trading data of SSE 50 Index to analyze the A-share market, and the final empirical results show that the return rate of Chinese stock market can be effectively explained by CAPM model, but only in some specific industries, the Fama-French three-factors model can be effectively used.

In China A-share market, the vast majority of investors may be more concerned about the size of the company, so some investors will overlook other important factors such as a company's growth potential. Therefore, we can draw the following conclusion that Chinese investors' investment philosophy and capital market information transmission are somewhat different from American capital markets. For different markets, the explanatory and forecasting capabilities of the model are also different, and the specific construction of the model should change with the different market conditions

At present, most of the empirical studies in China are based on the CAPM model. The validity test conducted in this paper also demonstrates that this model is applicable to the general A-share index constituent stocks, basically targeting the overall China A-share market. However, there are few literatures to test the applicability of the whole A-share market with three-factor model or to conduct specific research on certain industry. Since the development time of China's capital market is short and its system and characteristics are different from foreign capital markets, the factors that affect future return of the stock market portfolio are also complex and numerous. Therefore, explaining

return rates solely through systemic risk is insufficient, and further optimization of testing methods for return rates is necessary.

References

[1] Sharpe W F. Capital asset prices: A theory of market equilibrium under conditions of risk[J]. The Journal of Finance, 1964, 19(3) -: 425-442．

[2] Fama, E., K.R., French. Common risk factors in the returns on stocks and bonds[J]. Journal of Financial Economics, 1993, 33: 3-56

[3] Hao Xiaoyan. Discussion on Capital asset pricing model theory and its application [J]. Journal of Zhongyuan University of Technology, 2002, (4) : 43-46

[4] Chen Shoudong, et al. Comparative analysis of FF multi-factor models in Chinese stock market [J]. Social Science Journal of Jilin University, 2003, (5) : 93-98.

[5] Zang Xueqing. Empirical research on application of Fama-French three-factor model in Household appliances industry in China [J]. Investment and Entrepreneurship, 2015, 32 (8) : 25-27.

[6] Tian Lihui, et al. Three Factor Model Pricing: How is China different from the United States? [J]. International Finance Research, 2014, (7) : 37-45.

[7] Qu Yuanyu, et al. Shell Premium: Mispricing or regulatory Risk? [J]. Financial Research, 2018, (3) : 155-171.

[8] Pan Y, Wang T Y, Weisbach M S. Learning about CEO ability and stock return volatility[J]. The Review of Financial Studies, 2015, 28(6): 1623-1666

[9] Jiang Meihong. Analysis of Shanghai Stock Exchange 50 Stocks based on Fama-French three-factor model [J]. Marketing Field, 2021, (18) : 98-100.

[10] Ou Zhonghang. Research on the applicability of Fama-French three-factor model to explain the stock return rate of China's real estate industry [J]. China Price, 2021, (8) : 95-97.