Analysis of Shanghai Composite Index Yield Based on Stock Volatility

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Abstract. His paper selects the data of the Shanghai Composite Index from September 2011 to September 2019 in the Guotai Junan database, and divides the received data into four groups according to stock price volatility. The group with the highest share price volatility is used to represent the high volatility groupt. And the group with the lowest share price volatility is used to represent the low volatility group. The significance of the factor model at low and high volatility was analyzed by linear regression. And from the graphs provided by spss, we can draw the conclusion that in the months of low volatility, the three-factor model is significant, as a result that the stock returns can be analyzed by this kind of model. Although the information from spss shows that Carhart four-factor model is able to give a reliable explanation to the stock returns, the determinant factors are the same as three-factor model, so this model does not need to be used in the analysis. When analyzing the high volatility group, the factor models fail, and three-factor model cannot explain the stock return exactly. At this phenomenon, the stock return is mainly affected by the investment environment and the stock return has obvious uncertainty.

Keywords: Volatility, Stock Return, Three-Factor Model, SPSS

1 Introduction

It is well known that stocks are one of the most popular investment products for investors at present, so their prices have been closely watched. Investors want to grasp the laws behind stock markets to ensure that they minimize their losses or maximize their profits. Under this circumstance, a large number of experts have conducted a series of studies on the stock return rate, trying to grasp the changing law of the stock return rate. In recent years, some experts have established several kinds of factor models to analyze stock returns, and these factor models have effectively explained stock returns to a certain extent.

Although in most cases, the three-factor model is reliable when someone analyzes stock returns, these studies are mainly aimed at the stock markets of developed countries, and it is obvious that there are certain differences between the stock markets of developed countries and Chinese stock markets. On the one hand, models may perform differently in different markets due to the degree of market development. This paper

V. Escudero et al. (Eds.): BADS 2022, AHCS 11, pp. 1440–1447, 2023.
https://doi.org/10.2991/978-94-6463-102-9_151

focuses on the Chinese stock market, and uses the data of the Shanghai Composite Index from September 2011 to September 2021 to test the explanatory power of the Fama-French three-factor model and the Carhart four-factor model for the Chinese stock market, and to find whether the four-factor model is more efficient than the three-factor model on the Chinese stock market. On the other hand, the current analysis of dividends mainly focuses on the overall analysis of stock returns through factor models, and often ignores the impact of stock price volatility on stock price analysis. Compared with other factors, there is less research on the issue of stock market volatility, and most of the articles on stock market volatility explore the causes of abnormal market volatility. Ignoring stock price volatility tends to get people into trouble when using factor models to analyze dividends and not get the expected results.

This study mainly discusses the impact of stock price volatility on the return analysis of the Shanghai Composite Index using a factor model. Firstly, the historical data of the Shanghai Composite Index is divided into four groups according to the stock volatility, and the two groups with the highest and the lowest are chosen as control groups. Then, through the three-factor analysis of these two sets of data, this study tries to explore the difference between the factors that affect the dividend when the volatility is high and the factors that affect the dividend when the stock price is relatively stable. If the three-factor model can better explain the stock return, then further four-factor analysis is performed to find the optimal factor model. If not, the failure of the three-factor model is analyzed.

2 Literature review

In 1964, based on portfolio theory and capital market theory, Capital Asset Pricing Model was proposed by some American scholars such as William Sharpe and John Lintner. This model points out that the expected excess return of the market portfolio had postive influnce on the expected excess return of assets.

Then, in 1992, Fama and French [1] Fama and French discovered a phenomenon that in stock markets, besides the market beta value, there were still two other factors that were effective in analyzing the average stock return, these two factors were the size and book value ratio. Fama and French believed that the bigger the scale, the lower the yield on the stock. In addition, they also believe that the lower the book-to-market ratio, the lower the yield of the stock. Considering the scale effect of dividends in the market and the book-to-market ratio effect, they proposed a three-factor model in 1993. This model added scale benefit (SIZE) and value factor to the capital asset pricing model.

After that, in 1993, Jegadeesh and Titman realized that the momentum effect also affects stock prices in the stock market. Based on their point of view, in 1997, Carhart [4] added a fourth factor-momentum factor to the three-factor model, and obtained a four-factor model with higher applicability in the US stock market at that time. However, some experts in China such as Lu Zhen and Zou Hengfu (2007) [5], Ning Xin and Wang Zhiqiang (2012) [6], Yang Deyong and Wang Jiaqing (2013) [7] have doubts about the momentum factor. Experts believe that momentum effect is not reliable when

explaining the average stock return in China's capital market. They believed that China's capital market shown a reversal effect. They regarded that stocks that performed well in the past would perform poorly in the future, and the stocks that performed poorly in the past would perform better in the future.

3 Method

This study uses the historical data of the Shanghai Stock Exchange for a total of ten years from September 2011 to September 2021, which comes from the Guotai Junan database. Firstly, according to the data and information provided by the Guotai Junan database, use python to obtain the market risk factor, equal-weight scale risk factor, equal-weight book-to-market ratio risk factor, risk-free return and stock return for each month. The market value factor (SMB) is constructed by sorting the circulating market value in June of year t, and calculating the difference between the equal-weighted returns of the small-cap stock portfolio and the large-cap stock portfolio from July to December of t year and from January to June of t+1 year. The equal weight book-to-market ratio risk factor (HML) is constructed by sorting the book-to-market ratio in December of t-1 year in June of year t, and calculated from July to December of year t and January to June of year t+1, The difference between the equal-weighted returns of the high book-to-market ratio portfolio and the low book-to-market ratio portfolio. The market risk factor (MKT) is represented by a weighted index of all A-shares' circulating market capitalization, and the selection standard for risk-free returns (Rf) is the one-year deposit rate. The return of the Shanghai Composite Index (R) is calculated by dividing the closing price of the last trading day of the month by the closing price of the last trading day of the previous month -1.

Then, using the closing price of each month's trading day in the historical data of the Shanghai Stock Exchange calculates the monthly stock price standard deviation which is used to represent the monthly stock price volatility. Through this method, we can get 120 sets of data. After that, we sorted the obtained stock price volatility in descending order and then divided the obtained data into four groups. At this point, we get four groups, each with thirty sets of data. Then, the group with the highest volatility, that is, the 25% with the highest volatility (30 sets of data), was selected as the high volatility group, and the group with the lowest volatility, that is, the 25% with the lowest volatility (30 sets of data), was selected as the low volatility group. After the above data processing, we can obtain two sets of data, which can be used as control groups for each other. With this pair of control groups, we can analyze the differences in the factors that determine dividends when volatility is different.

Finally, the two groups of data that have been processed are brought into the three-factor model, respectively. After that, we used SPSS to obtain the linear equations of stock returns under the three-factor model of the two groups as well as the significance of each factor. By observing the significance of each factor and the square of the multivariate correlation coefficient, we can judge the degree of influence of each factor on the stock return, and the degree of explanation of the three-factor model to the stock return. If the three-factor model can explain the dividend, this study will explore

whether the four-factor model is reliable when analyzing the dividend to find the optimal model. If the three-factor model cannot exactly explain the dividends, this study will analyze the reasons for its failure. The Fama-French three-factor model is expressed as Rit - Rft = ai + b (Rmt - Rft) + siSMBt + hiHMLt + εi. The Carhart four-factor model is as follows: Rit - Rft = ai + b (Rmt - Rft) + siSMBt + hiHMLt + mi MOM12 + εi.

4 Conclusion

4.1 Empirical test when volatility is low

4.1.1 Empirical test of three-factor model when volatility is low.

Table 1. Model Summary[b] [Owner-draw]

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate	Durbin-Watson
1	.955[a]	.913	.903	.008206717119778	2.550

a. Predictors: (Constant), rm-rft, hml_equal, smb_equal

b. Dependent Variable: r-rft

Table 2. Coefficientsa [Owner-draw]

Model		Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
		B	Std.Error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	-.004	.002		-2.384	.025		
	smb_equal	-.150	.068	-.136	-2.210	.036	.888	1.127
	hml_equal	.286	.058	.303	4.934	.000	.891	1.122
	rm-rft	.746	.047	.936	15.961	.000	.977	1.024

a. Dependent Variable: r-rft

Months with less volatility fit the three-factor model, and their returns can be well explained by the three-factor model. At the same time, this study also tested the four-factor model. The explained part has increased, but the improvement is limited.

First, this study performs linear regression analysis on real monthly excess return (Ri-Rf) and three-factor—market premium factor (Rm - Rf), equal-weighted market-to-market factor (SMB) and equal-weighted book-to-market risk factor (HML) of low volatility Fama-French portfolios. The regression results are shown in the table above. It is obvious that the value of the adjusted R2 statistic is 0.903. Therefore, from the

perspective of the regression effect, the three-factor model can fully explain the return of the Shanghai Composite Index when the volatility is low.

At the significance level of a=0.01, the market premium factor rm-rft is significant, and the market premium factor Rm-Rf plays an important role in the three-factor model, which captures the systematic risk of the Shanghai Stock Exchange Index well. At the same time, at the significance level of a=0.01, the coefficient of the equal-weight book-to-market ratio risk factor HML is significant, and it is obvious that HML has a significant impact on the dividend of the Shanghai Composite Index. At the significance level of a=0.01, the coefficient of the market value factor smb is not significant, indicating that the equal-weight market value factor (SMB) has no significant impact on the return of the Shanghai Composite Index. What's more, at the significance level of a=0.01, the constant term is tested for significance, and the result is not significant. Overall, the three-factor model can significantly explain the return of the Shanghai Composite Index.

4.1.2. Four-factor analysis when volatility is low.

Table 3. Model Summary [b] [Owner-draw]

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate	Durbin-Watson
1	.957[a]	.915	.901	.008265670993624	2.583

a. Predictors: (Constant), umd_equal, rm-rft, smb_equal, hml_equal

b. Dependent Variable: r-rft

Table 4. Coefficientsa [Owner-draw]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std.Error	Beta	t	Sig.
1	(Constant)	-.044	.041		-1.073	.293
	rm-rft	.498	.349	.277	1.424	.166
	smb_equal	.884	1.437	.160	.615	.544
	hml_equal	.934	1.084	.219	.861	.397

a. Dependent Variable: r-rft

Regression analysis was performed on the actual monthly excess return and the four-factor—market premium factor, the weighted market value factor, the equal-weight book-to-market ratio risk factor (HML), and the equal-weight momentum factor (UMD) for each Fama-French portfolio, and the regression results are shown in the table below.

Adjusted value of the R2 statistic is 0.901. Therefore, from the perspective of regression effect, the inertia factor in four-factor model does not fully explain the return rate, and the result of four-factor model is not much better than that of the Fama-French three-factor model. At the significance level of a=0.01, the coefficients and significance levels of the equal-weight book-to-market ratio risk factor (HML) and the market premium factor (rm-rf) are not much different from the three-factor model. Both of them have significant effects on dividends. However, the influence of the weighted market capitalization factor (SMB) is not significant, indicating that the inertia factor has no significant impact on the return of the Shanghai Composite Index. What's more, the significance test was carried out on the constant term of the Shanghai Composite Index, and the result was not significant as well. All in all, there is no doubt that the four-factor model can effectively explain the dividends of Shanghai Composite Index Yield, but the ability of explanation is mainly depends on the market premium factor and HML, and both of them are included in the three-factor model.

Through the empirical analysis of the return rate of Shanghai Stock Index, the above analysis shows that the

regression results of the constant, the size factor, the value factor and the market excess return are similar to that of the above model, the newly added momentum factor is not significant, nor does it significantly improve the fitting results, and cannot effectively explain the dividends. Since the momentum factor in the four-factor model cannot explain some of the excess returns that the three-factor model cannot, we believe that the momentum effect has no effective effect on stock returns of the Shanghai Composite Index. Therefore, the four-factor model cannot explain the dividends better.

4.2 Empirical test when volatility is high

4.2.1. Three-factor analysis when volatility is high.

Table 5. Model Summary [b] [Owner-draw]

Model	R	R Square	Adjusted R Square	Std.Error of the Estimate	Durbin-Watson
1	.323[a]	.104	.001	.208736585947940	1.918

a. Predictors: (Constant), hml_equal, rm-rft, smb_equal

b. Dependent Variable: r-rft

Table 6. Coefficientsa [Owner-draw]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std.Error	Beta			Tolerance	VIF
(Constant)	-.003	.002		-1.958	.061		
smb_equal	-.147	.068	-.133	-2.148	.042	.885	1.130
hml_equal	.259	.067	.274	3.843	.001	.668	1.497
rm-rft	.748	.047	.938	15.866	.000	.975	1.026
umd_equal	-.034	.043	-.055	-.794	.435	.710	1.409

a. Dependent Variable: r-rft

In months with large price fluctuations, the three-factor model becomes unreliable.

Adjusted value of the R2 statistic is 0.323. From the point of view of regression effect, under the significance level of a=0.01, the coefficients of HML, the market premium factor (rm-rf) and the coefficient of the weighted market-to-market factor (SMB) are not significant. At the same time, the constant term of the Shanghai Composite Index was tested for significance, and the result was not significant as well. To sum up, the three-factor model cannot significantly explain the return of the Shanghai Composite Index when volatility is high.

4.2.2. The reasons for the failure of the factor model.

The Collaborative Market Hypothesis (CMH) proposed by Vaga (1991) believed that "the collective sentiment of investors" and "the external basic economic environment" are two factors which can influence the rate of return and the stock price in the capital market , Obviously, this assumption is reflected in the Shanghai Composite Index. It is easy to find that months with high volatility are often due to the occurrence of relevant policies or major events, and the impact of these policies or events on investors is often significantly greater than the impact of factors affecting stock prices in regular periods. For example, in the stock market crash in 2015, when the stock price rose abnormally in the first half of the year and the enthusiasm for investment was high, people often chose to blindly follow the trend of investment instead of objectively analyzing the value of the stock. At this time, some stocks that were originally priced soared due to the irrational investment of the masses. Unfortunately, with the sudden decline of the broader market, the stock market fell sharply, and investors fell into panic. As a result, the investors began to sell stocks on a large scale. This behavior further led to a drop in the stock price. In this process, we can easily find that it is no

longer the factors in the factor model that affect the stock price, but also the sentiment of investors and the atmosphere of stock investment in the whole society.

5 Advice

This study mainly discusses the factors that affect the stock returns of the Shanghai Composite Index. To explore the conclusions, we put two sets of data with significantly different stock price volatility into a three-factor model. By analyzing the results, we can find that when the stock price volatility is low, the three-factor model is reliable. However, when stock price volatility is high, it is not a wise chioce to use factor models to explain the stock returns of Shanghai Composite Index. Exploring the reasons behind this, we find that the coordinated market hypothesis (CMH) can explain this phenomenon.

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