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An Empirical Study of China's Agriculture, Forestry and Fishery Industry Based on the Fama-French Three-Factor Model

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Abstract: Agriculture, forestry, animal husbandry and fishery enterprises have performed steadily and well during the epidemic period from late 2019 to the end of February 2020. But there is still a gap in empirical analysis, which deserves further research. This study examines the Fama-French three-factor model's application to China's agricultural, forestry, animal husbandry, and fisheries sectors, and analyzing and interpreting the related results. In this study, the daily return data of 27 Chinese agriculture, forestry and fishery listed companies in the past two years were obtained through the RESSET, and divided into six groups of stock portfolios according to size and book-to-market ratio size, and the relevant empirical and regression analyses were conducted for each portfolio using Python and Eviews. The findings demonstrate that the size impact and book-to-market ratio effect are two parameters in the model that have a high explanatory power on the return of the agriculture, forestry, and fishery stock portfolio in the sample period.

Keywords: Fama-French three-factor model, agriculture, rate of return, OLS regression

1. Introduction

Agriculture, forestry, animal husbandry and fishery are the primary industries. Due to little product variation and stable social demand, China's agriculture, forestry, animal husbandry and fishery industry was less affected by the New Crown epidemic [1]. Current studies related to this industry are mainly fundamental analyses, while there are relatively few quantitative analyses. Therefore, the econometric study of agriculture, forestry, livestock and fishery is beneficial to further understanding and grasping its characteristics.

Since the Fama-French three-factor model was proposed, much attention has been paid to its application in the stock market. The applicability of Capital Asset Pricing Model (CAPM) is limited because the Chinese stock market cannot yet be fully explained by systematic risk [2]. Based on this, the Fama-French three-factor model improves the CAPM by including 2 explanatory variables [3]. In this paper, based on the model, we obtain the return of 27 listed companies through the RESSET database, and use Python and Eviews to conduct regression analysis on China's agriculture, forestry and fishery industry to test the applicability of the model and analyze the results based on the results. RESSET Database offers expert services for model checking, investment research, etc. It makes full use of the design guidelines for common worldwide databases, blends them with the reality of the Chinese financial market, and uses empirical research as the overarching design criterion.

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The qualitative econometric analysis can further improve the research related to agriculture, forestry, fishery, and animal husbandry, and reveal the industry characteristics and industry conditions after the new crown epidemic. Meanwhile, since there are not many studies on Fama-French model in individual industries, this paper hopes to provide empirical research cases for individual industries to provide references for the development and improvement of related theories and models.

2. Literature Review

In the CAPM, Sharpe discussed the market risk premium [4]. Further, Fama and French found that the stock market's beta was unable to account for differences in the returns of different stocks. As a result, two additional factors with market risk premiums were added, creating the Fama-French three-factor model, a new approach to determining asset pricing. These two variables—the size factor and the book to value factor—are thought of as additional CAPM components. In recent years, many scholars have conducted empirical studies on the applicability of CAPM and Fama-French models in the Chinese stock market. Xu Jiayu found that the model does explain more accurately than the CAPM the movements of stock returns in the Chinese KSE [5]. While Yang Zunhan analyzed that the applicability of the model is industry related [6]. Empirical studies conducted in specific industries, such as the sports industry and the real estate industry, have illustrated the validity of the Fama-French model to some extent, but there are still relatively few industry studies [7-8]. Further, with the introduction of the five-factor model, the explanatory factors became more numerous [9]. However, its applicability is controversial: the empirical analysis of the five factors in manufacturing and health industries affirmed its significance relative to the three-factor approach [10]. However, it was considered inferior to the three-factor model in Chinese A-share steel companies [11]. The number of industry studies for the three-factor is small, and the empirical performance of the model varies across countries. However, the three-factor model had been considered the best performer among multiple models [12].

3. Methodology

3.1. Fama-French Three-Factor Model

According to the Fama-French three-factor model theory.

$$R_{it} - R_{ft} = \alpha i + \beta i\left(R_{mt} - R_{ft}\right) + siSMB_t + hiHML_t + \varepsilon it \quad (1)$$

In equation (1), Rit represents the return on assets, R_{ft} represents the risk-free return; $(R_{mt} - R_{ft})$ is the excess market return; SMB_t represents the market capitalization size factor, HML_t represents the book-to-market ratio factor, bi, si, and hi are the coefficients of $(R_{mt} - R_{ft})$, SMB_t, and HML_t, respectively, eit is the residual term, and ai is the intercept term [13].

Equation (1) reflects the relationship between individual stock returns and market returns, market capitalization size, and book-to-market ratio.

3.2. Data

In this paper, 27 stocks of agriculture, forestry, animal husbandry and fishery China A-share listed companies from January 1, 2020 to December 31, 2021 are selected for empirical testing of their daily returns. 27 listed companies have different sizes and specific industries to meet the requirements of sample differences in the model. In this paper, the daily return of Agriculture, Forestry, Animal Husbandry and Fishery Index (801010) is selected as the market return, and the Shanghai Interbank

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Offered Rate is chosen as the risk-free return, using the total market capitalization and shareholders' equity of the company for analysis. Data were taken from the RESSET database, and Python and Eviews were used to process the data.

27 stocks were split into six categories using the methodology. For size, the total market capitalization of publicly traded firms at year's end is first discovered, and then the groups S and B are created based on the size numbers. The book-to-market ratio is divided into 30%, 40%, and 30%, also known as L, M, and H, based on the book-to-market ratio of listed businesses at the end of the year. The cross portfolio of equities is then discovered.

3.3. Experimental Procedure

For six groups of stock portfolios, the market risk premium $(R_{mt} - R_{ft})$ is derived using the difference between the daily return of the index and the risk-free return, and the size factor (SMB_t) and the book-to-market ratio factor (HML_t) are constructed using the daily return data. The precise formula for calculation is as follows.

$$SMBt = \frac{(SL+SM+SH)-(BL+BM+BH)}{3} \tag{2}$$

$$HMLt = \frac{(SH+BH)-(SL+BL)}{2} \tag{3}$$

Least squares regressions were conducted with the three factors as explanatory variables and each group's return as the explanatory variable.

4. Results

4.1. Descriptive Statistics

Table 1: The descriptive statistics of different groups.

Group	Mean	Std
B/L	0.000527108	0.036385044
S/L	0.00366857	0.03232243
B/M	-0.001144713	0.023435205
S/M	0.002245114	0.030381896
B/H	0.000123405	0.028644847
S/H	-0.000169714	0.02409445

During the statistical period, the mean of group B/M and group S/H is negative and the returns are in a loss position, while the rest of the portfolios are in a profit position. Broadly speaking, the mean and standard deviation of returns are positively correlated.

4.2. Stationarity Test

The ADF test for the smoothness of the daily returns of the six portfolios was performed to ensure that the test results were valid when regression analysis was performed on the data. The p-value of the t-test for all six portfolios was tested to be 0, indicating that the series are all stationary. Therefore, the four portfolios can be subjected to regression analysis.

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4.3. Regression Analysis

Table 1: The Fama-French three-factor model results of different group

Group	Intercept	Correlation coefficient			F(P)	Goodness of fit	
	αi	MKT	SMB_t	HML_t		R^2	Adj--R^2
		βi	si	hi			
BL	-0.0003 (t=-0.325, P=0.745)	0.9971 (t=19.197, P=0)	-0.7416 (t=-15.239, P=0)	-0.7993 (t=-16.131, P=0)	0	0.814	0.811
SL	-0.0005 (t=-0.529, P=0.597)	1.1579 (t=23.168, P=0)	0.9070 (t=19.251, P=0)	-0.6944 (t=-14.564, P=0)	0	0.781	0.779
BM	-0.0017 (t=-2.212, P=0.028)	1.0020 (t=26.306, P=0)	-0.0661 (t=-1.841, P=0.067)	0.0285 (t=0.784, P=0.434)	0	0.758	0.755
SM	0.0003 (t=0.226, P=0.821)	1.0219 (t=15.303, P=0)	0.6362 (t=10.106, P=0)	0.0531 (t=0.833, P=0.406)	0	0.558	0.553
BH	0.0005 (t=0.585, P=0.559)	1.1678 (t=29.395, P=0)	-0.2419 (t=-6.458, P=0)	0.3179 (t=8.388, P=0)	0	0.824	0.822
SH	-0.0013 (t=-1.726, P=0.086)	0.9872 (t=25.592, P=0)	0.4027 (t=11.074, P=0)	0.1884 (t=5.120, P=0)	0	0.766	0.763

From Table 2, the R^2 of group S/M is 0.558, and the range of R^2 of the other groups is 0.758~0.824, which indicates that the overall goodness of fit is good. Meanwhile, the p-values of the F-tests are all 0, indicating that the regression models are significant.

The following paper analyzes the intercept terms and the regression coefficients of each factor:

A. Intercept term α_i. except for group B/M, the α_i values of the remaining combinations failed the t-test at the 5% confidence level, and all α_i values were close to 0, indicating that the influence of other factors on the stocks of agriculture, forestry, animal husbandry and fishery industries was small and basically negligible.

B. Regression coefficients of market factors β_i. regression coefficients of market factors in all portfolios pass the t-test, indicating that market factors are significantly influential. bi values are all greater than 0, demonstrating that the companies' excess returns follow the path of the industry market. Overall, the beta values of all six portfolios are relatively close to 1. Among them, the bi values of group B/L and group S/H groups are slightly less than 1, while the β_i values of the rest of the portfolios are greater than 1. This indicates that the fluctuations of listed companies the industry are basically in line with the industry.

C. Regression coefficient of size factor s_i. The group B/M is significant at 10% confidence level; the rest of the portfolios are significant at 1% confidence level. The regression coefficients are negative in the large-cap portfolio and positive in the small-cap portfolio, indicating that there is a scale effect in agriculture, forestry, animal husbandry and fishery, and the returns of the large-cap portfolio are negatively correlated with SMB_t, while the returns of the small-cap portfolio are positively correlated with SMB_tt.

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D. Coefficients of regression for the h_i book-to-market ratio factor. The factor's t-test findings in the B/M and S/M groups are insufficiently significant, meaning that the influence of the HML_t factor on portfolios with medium book-to-market ratios is not significant. The other portfolios' regression coefficients are noteworthy. According to the findings, companies with low book-to-market ratios and those with high ones have a negative correlation with the book-to-market ratio factor.

5. Conclusion

In this paper, an empirical study of China's agriculture, forestry and fishery industry is conducted using the Fama-French three-factor model. According to the results: first, the model has high applicability to the industry. Second, the volatility of listed companies in the sample is basically the same as that of the industry, which may be closely related to systematic risk because it is highly influenced by natural conditions. Third, there is a scale effect in the industry, which may be due to the fact that small-scale enterprises are perceived to rise and fall more, and receive more policy support, etc. Fourth, agriculture, forestry and fisheries have a book-to-market ratio effect. Companies with the higher ratio are more financially risky, and investors demand higher risk compensation.

The sample selection and time interval have an impact on the analysis results, which may become a shortcoming of this paper. This paper provides an overall description of systematic risk based on beta values but does not reveal the specific impact factors. This is also a reference direction worthy of future research.

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