

Comparative Analysis on Fama-French Five-factor Model and Three-factor Model adopted in various Industries in A-share Market of China

Junjie Hu^{1, *, †}, Qiunan Jiang^{2, †}, Jie Song^{3, †}, Su Yan^{4, †}

¹King's University College, University of Western Ontario, London, Canada

²School of Mechanical & Automotive Engineering, South China University of Technology, GuangZhou, China

³Asia Australia Business College, Liaoning University, Shenyang, China

⁴College of Civil Engineering, Tongji University, Shanghai, China

*Corresponding author: jhu459@uwo.ca

[†]These authors contributed equally

Abstract. Asset pricing has always been a hot issue in the financial industry. The cutting-edge research achievements of Capital Asset Pricing Models are the Fama-French three-factor model and the Fama-French five-factor model. Although many scholars have studied the performance of Fama-French three-factor model and five-factor model in China's A-share market, there is still controversy about the explanatory power of these two model in the A-share market. This thesis discusses the applicability of Fama-French three-factor and five-factor models adopted in various industries. This thesis chooses A shares in terms of performances, with 14 years commencing from August 2007 to August 2021 as the samples, and utilizes the data of monthly transactions of listed companies in the market for calculation. The thesis has divided the samples into 18 industries. The Fama-French three-factor and five-factor models are used for regression to verify the model's applicability in China's stock market. Through the empirical test, this thesis found that the Fama-French three-factor and five-factor models have strong explanatory powers regarding the excess returns of 15 industries. The research obtained in the thesis has enriched and broadened the study of the Asset Pricing Theory in China, providing theoretical guidance for various investment entities in acts conducted in the market.

Keywords: Capital asset pricing; Factor model; Industry; A-share market; Applicability.

1. Introduction

1.1 Background

To understand the expected rate of return for stocks, quite a few academics researched the financial model for use in stock markets. The Fama-French three-factor model (FF3M) and Fama-French five-factor model (FF5M) are two of the most well-known models. Recent years have also seen the emergence of empirical and comparative analyses of these two models based on the stock markets of various nations. Although the two models based on the Chinese stock market have been studied by many scholars, For the service of other academics and investors, the relevant study based on the various industries of the Chinese stock market still needs to be enhanced and supplemented. Given the different policies, development prospects, business nature, and other factors in different industries, the stock returns of related industries may have different responses to the factors in the models, which leads to the differences in the explanatory ability of FF3M and FF5M in different industries.

1.2 Related research

Numerous academics have investigated and evaluated the FF3M's efficacy and application in various stock markets since it was first introduced by Fama and French in 1993 [1]. The FF3M based on Small Minus Big (SMB) and High Minus Low (HML) factors has been proven and widely

accepted in the stock market. The later FF5M, proposed again by Fama and French in 2015, added the Robust Minus Weak (RWM) and Conservative Minus Aggressive (CMA) based on the FF3M, which was also tested and empiricism by scholars in different stock markets. Fama and French found that HML was a redundant variable compared with RMW and CMA in the American market, and the FF5M was better than the FF3M [2]. However, a different result shows in the Chinese stock market with a history of only 30 years. Zhao et al. indicated that Chinese and American investors have different investment concepts and strategies, so RWM and CMA are instead redundant factors in Chinese stock [3]. This finding suggests that in the Chinese stock market, the FF3M has greater explanatory ability than the FF5M, which is contrary to U.S. stocks. What are the distinctions between the various industries in the Chinese stock market if the two models have varied explanatory capacities for different stock markets? Are the results consistent with the whole stock market? There are few comparative studies between Chinese stock market industries on the FF3M and FF5M. Li's comparative study on A-share agriculture, forestry, Animal Husbandry and Fishery shows that the explanatory ability of the FF3M and FF5M is relatively poor, and the FF5M is even worse [4]. Besides, Guo expressed that the FF3M has strong explanatory power in the steel industry [5]. There is still a circumstance when both models are not significant, despite the fact that the outcomes of these two studies are typically consistent with the conclusions of the whole stock market.

1.3 Objective

This paper will conduct a comparative study of the FF3M and FF5M for all industry sectors in A-shares and explore the applicability of the FF3M and FF5M in different industries and compare them. Fama-Macbeth regression will be used to test the significance of α values of FF3M and FF5M. According to the regression results, the essay will analyze the reasons for the differences and explain why the factors of the FF3M and FF5M cannot explain the expected return rate of the industry. The first chapter of this paper will introduce the models, the second chapter will describe the data and research methods, and the third chapter is the research results and discussion.

2. Introduction to FF3M and FF5M

To carry out the quantitative prediction on the stock return rate in the stock market, Fama and French created the FF3M [1] in 1993, which is made based on the CAPM model to solve the problem that the CAPM model's the beta value cannot provide an efficient explanation on the stock return rate. Compared with the CAPM model, the FF3M has been added with the SMB representing the scale of the enterprise and the HML showing the book-to-market by Fama and French; thus, the final model form is:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + e_{it} \quad (1)$$

In this model, R_{it} indicates the yield of stock portfolio i at time t ; R_{Ft} represents the return rate under risk-free conditions. The return rate can be obtained by investing capital in an investment object without any risk, which is the basis for taking the impact of risk on the rate of return of stocks into account. $R_{it} - R_{Ft}$ shows the risk premium. R_{Mt} stands for the yield of market portfolio which is weighted by market value; SMB_t and HML_t means the value of enterprises' SMB factor and the HML factor at time t ; e_{it} indicates the residual.

In 2015, after the Q factor model [6] having been proposed based on Tobin's Q theory and the assumption that the production scale and return of enterprise remain the same, Fama and French added new investment factors and profit factors into the former FF3M [2]. The FF5M has the form as follows:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + e_{it} \quad (2)$$

The explanation power owned by a specific factor will be subject to the judgment of whether they are remarkably not zero. In this model, R_{it} , R_{Ft} , R_{Mt} , SMB_t , HML_t have exactly the same meanings as that of the three-factor model. RMW_t indicates the difference of return rate of the portfolio existing between the companies with strong profitability and companies with poor profitability in the t period; CMA_t stands for the difference between the return rate of the portfolio of companies that have low investment levels and the portfolio of companies that have high investment levels in the t period. b_i , s_i , h_i , r_i , c_i respectively represent the coefficient parameter to be determined for the corresponding factor.

3. Results and Discussion

The data adopted in the research comes from the stock market transaction module in the CSMAR database. It has selected the monthly data of all A-shares listed in the Shanghai Stock Exchange and Shenzhen Stock Exchange from August 2007 to August 2021 (in total: 14 years, 168 months) to research the FF3M and FF5M in a more extended period.

In terms of research-related industries, this thesis has selected 18 industries featuring the largest scale and most representative in the A-share market for analysis. In the primary industry, this thesis mainly chooses agriculture, forestry, animal husbandry and fishing industry following the industry classification provided by the database. This thesis also has selected the leading industries in the secondary industry, including mining, manufacturing, construction, electricity, heating power, gas, water production and supply. In the tertiary industry, this thesis has mainly selected the wholesale and retail industry, transportation industry, storage and postal service industry, accommodation and catering industry and other industries. For the complete selection of industries, please see as shown in Table 1:

Table 1. Industry distribution corresponding to industries selected for empirical test

Industry	Primary industry	Secondary industry	Tertiary industry
Industry(Industries) chosen	Agriculture, forestry, animal husbandry and fishing industry	Mining industry, manufacturing industry, electricity, heating power, gas, water production and supply industry, construction industry	Wholesale and retail industry, transportation, storage and postal services industry, accommodation and catering industry, information transmission, software and information technology service industry, finance industry, real estate industry, lease and business service industry, scientific research and technology service industry, water conservancy, environment and public facilities management industry, resident service and other service industry, education industry, health and public work industry, culture, sports and entertainment industry

With each factor mentioned above as the independent variable and the stock return as the dependent variable, the thesis has carried out the Fama-Macbeth regression with the help of Python. This thesis obtained the alpha values and their significance of the FF3M and FF5M in 18 industries which indicate as follows:

Table 2. Regression Results of Industry Models in the A-share Market

	Fama-French Three-factor Model			Fama-French Five-factor Model		
	α	T Value	T value adjusted by Newey West	α	T Value	T value adjusted by Newey West
Agriculture, forestry, animal husbandry and fishing industry	-0.01	-1.29	-1.15	-0.00	-0.73	-0.59
Mining industry	-0.00	-0.81	-0.48	-0.01	-2.15	-1.08
Manufacturing industry	0.00	1.46	0.78	0.00	1.27	0.59
Electricity, heating power, gas, water production and supply industry	-0.00	-0.13	-0.11	-0.00	-0.05	-0.03
Construction industry	-0.01	-1.27	-0.96	-0.01	-2.00	-1.41
The wholesale and retail industry	-0.00	-0.38	-0.25	-0.00	-0.39	-0.23
Transportation, storage and postal service industry	0.00	0.01	0.00	-0.00	-0.33	-0.23
Accommodation and catering industry	-0.000	-0.15	-0.21	0.01	0.30	0.27
Information transmission, software and information technology service industry	-0.00	-0.95	-0.60	-0.01	-1.89	-1.12
Finance industry	-0.00	-0.08	-0.08	-0.00	-0.47	-0.33
Real estate industry	0.00	0.22	0.17	-0.00	-0.31	-0.19
Lease and business service industry	-0.00	-0.96	-0.66	-0.01	-1.11	-0.85
Scientific research and technology service industry	0.02	2.50	1.85	0.04	2.85	2.24
Water conservancy, environment and public facilities management industry	-0.00	-0.81	-0.92	-0.00	-0.78	-0.81
Education industry	-0.14	-0.80	-0.67	0.16	1.59	1.70
Health and public work	0.02	1.57	1.88	0.01	0.67	0.79
Culture, sports and entertainment industry	-0.00	-0.36	-0.33	-0.01	-1.21	-1.11
Resident service and repair and other services + integrated industry	-0.01	-0.58	-0.77	-0.01	-0.70	-0.89

Table 2 shows the results obtained through the Fama-Macbeth regression. It can be found from Table 2 that except for the scientific research and technology service industry, education industry, health and public work industry, the performances of the rest of the 15 industries are not significant at the 10% significance level. This phenomenon manifests that the FF3M and FF5M can reasonably explain most industries' monthly average excess return rate. The FF3M showed greater explanatory power in most industries than the FF5M.

The alpha values of the FF3M and FF5M of the Scientific Research and Technology Service (SRTS) industry are significant at 90% confidence intervals, indicating that the return rate of the SRTS industry is not affected by SMB, HML, CMA, and RMW. The primary criteria that can more accurately reflect the value of listed firms in the SRTS industry are scientific and technical innovation. However, this criterion cannot be determined by any factors of the FF5M. Chen mentioned that the support of relevant national policies for biomedicine belonging to the SRTS industry increased the relevant companies' revenue by 18% and profit by 33% in 2005 [6]. It is clear that the advancement of science and technology as well as the government's financial support for scientific and technological research favor the value growth of listed companies in the SRTS industry sector.

In the health and public work industry, the alpha value of the intercept term obtained under the FF5M is insignificant at the 10% significance level. In contrast, the alpha value obtained under the FF3M is significant, showing that the FF5M has played a better role in the explanation and effect in such industries. The thesis has conducted the T-test for the coefficients of the RMW and CMA which are added for FF5M, obtaining the results indicating that they are not remarkably zero. It can be judged from this result that the FF5M has strong explanatory power in such industries due to the two newly added factors having played a better role in the explanation. With the deepening of the top-level design reform of the new medical transformation, which has been conducted in the period commencing from the 12th Five-Year Plan to the 13th Five-Year Plan, the life health and medical industry has a steady development, indicating a long-time positive trend [8]. At the same time, with the increasing improvement of people's living standards, people have raised investment in the healthcare field, making the capital and market more optimistic for such an industry. Thus, the influences of RMW and CMA are more significant.

In the education industry, the alpha value under the FF3M is insignificant when the significance level is at 0.1. However, the alpha value under the FF5M is significant, showing that the FF5M cannot provide a full explanation for the excess return of this industry. It is found through the observation of the specific data that the coefficients of RMW and CMA are not significant in the test, representing that the profitability and investment level in the education industry will not have influences on the economic benefits of companies in such industries. The reason for this phenomenon may be lies in the fact that investors do not pay much attention to the future development and operation of companies in such industries, causing the profitability and investment level of the company not to be fully taken into consideration [9]. Concerning the macro factors, the education industry is most vulnerable to the social and environmental factors and the policies adopted in the country, making the model unable to explain the return of the stock. For example, after the issuance of the "double reduction" policy in 2021, the operating incomes and gross profits of companies in the education industry will remarkably decrease [10]. Thus, investors shall pay more attention to changes in the social environment and the policies to invest stocks in such an industry.

4. Conclusion

This thesis has conducted a comparative analysis of the explanation power owned by the FF3M and FF5M in various industries of the Chinese A-share market. Furthermore, this thesis carried out targeted research on industries with poor explanation powers. The main results this thesis found are as follows:

(1) In scientific research and the technology service industry, the FF3M and FF5M showed insufficient explanation power. The main reason is that the additional benefits generated by national policies and financial support cannot be explained by the FF3M or FF5M;

(2) Concerning the health and public work industry, people have paid more attention to personal health in recent years, causing the corresponding demands and expenses for private medical health to increase step by step. Relevant capital and the market are becoming more optimistic. Therefore, the FF5M, which can reflect the investment and profitability factors, has a better explanation power;

(3) In the education industry, as the country pays increasing attention to the industry, the impact of policy factors on the industry also becomes gradually significant. Thus, the results show that the FF5M with investment and profit factors cannot explain the industry well.

According to the analysis of the above industries, the thesis now proposes the following suggestions: it is more necessary to focus on the state policies, development planning direction, and other macro factors under the premise of focusing on the business data relating to the industries and the companies.

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