Explanatory Differences in Idiosyncratic Volatility: Evidence from Fama-French Three- and Five-factor Models

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Abstract. Based on the idiosyncratic volatility anomaly, this study discusses the differences between the interpretation of idiosyncratic volatility by FF-3 and FF-5 models and the interpretation degree and difference of the real return of A-shares after the addition of idiosyncratic volatility. Through the empirical analysis of data from FF-3 model to FF-5 model, this paper studies the explanatory degree of the two investment models on Chinese market pricing and whether the explanatory degree of the two models has significantly changed. It is found that the idiosyncratic volatility risk of stock pricing obtained by FF-5 model is significantly different from that obtained by FF-3 model, and the idiosyncratic volatility risk obtained by FF-5 model is 0.9092 times that obtained by FF-3 model. These differences are caused by the addition of two new factors, the profitability factor, and the investment level factor, from FF-3 to FF-5 models. However, even if the FF-5 model is good, it still has a poor explanation of expected returns in a long period of 8 years from March 2014 to March 2022. The explanation degree is lower than 50%, which is still a low level.

Keywords: volatility; Fama-French; expected return of stocks.

1. Introduction

Yu Xinyao pointed out that since the implementation of the reform and opening up, China's economy has taken a crucial step. With the progress of science and technology and the pace of economic globalization, the financial market has been constantly maturing and improving. The booming development of the financial market has put forward new requirements for its transaction mode and level, and quantitative investment has begun to emerge [1]. Zhang Xiaoyan believes that with the development of China's economy and the rapid accumulation of residents' wealth, more and more people have investment needs. At present, there are a large number of individual investors in China's stock market. As institutional investors have the advantages of more professional investment and higher risk control levels, more individual investors in China will gradually turn to rely on institutional investors in the future [2]. At present, the scale of quantitative investment in China is about 350 to 400 billion YUAN, of which 120 billion yuan are public funds, and the rest are private quantitative funds, more than 300, accounting for 3%(there are more than 9,000 private managers in total), and the amount is about 200 billion yuan. The total size of China's securities funds exceeds 16 trillion yuan, including 14 trillion yuan public offering and 2.4 trillion yuan private offering. Thus, it can be seen that with the further development of the financial market in our country, the scale of the investors is also growing, and quantitative change causes the qualitative change, people will learn more professional knowledge and choose a more rational way of quantitative investment, so need according to the specific situation of our country market, the quantitative investment for more research. The development of quantitative investment in China is not long, and the field of quantitative investment is still in the initial stage of development. Quantitative investment accounts for a low proportion of financial investment and has high professional requirements. Therefore, a more in-depth interpretation of relevant models is needed.

It has always been the basic idea of venture capital to compensate for high risk with high returns. According to the Capital Asset Pricing Model (CAPM), individual stock risk can be eliminated by a fully diversified portfolio, and only by taking the market risk can corresponding risk compensation

be obtained. However, with the development of efficient market theory, Merton believed that most investors could not master sufficient information and fully disperse idiosyncratic risk, so the idiosyncratic risk of individual stocks should also receive risk premium in the market with incomplete information [3]. Fama and French are in 1992 United States stock market of the stock income factors determine the differences the stock market beta value return on investment is can you explain the difference between the total market value of listed enterprises, book price, its price-to-earnings ratio from you explain the difference between the return on investment is going on right now. According to pham and French, the above excess earnings are compensation for risk factors that beta does not reflect in the CAPM. [4]. Further, Ang, Hodrick, Xing, and Zhang (AHXZ) used the Fama-French three-factor model (FF-3 model) to measure idiosyncratic risk and found that high idiosyncratic volatility would bring abnormally low cross-sectional expected returns [5]. Taking on high idiosyncratic volatility risk without corresponding high returns is a pricing anomaly.

In 2015, Fama and French further optimized the Fama-French three-factor model based on market research, adding two new independent variables, RMW and CMA [6]. That is, based on the three-factor model, the Fama-French five-factor model (FF-5 model for short) is constructed by covering the profitability factor and investment level factor of the company. In this study, the difference of interpretation between FF-3 and FF-5 models on idiosyncratic volatility and the difference of interpretation on a-share real return after the addition of idiosyncratic volatility is discussed. Through empirical analysis of data from FF-3 model to FF-5 model, the degree of interpretation of the two investment models on Chinese market pricing is significantly changed. Based on this, this paper conducts regression analysis and empirical test on the two factor investment models and observes the explanatory degree of the idiosyncratic volatility obtained by the two models in the Chinese market. And then it leads to the thinking of China's stock pricing, which provides a new perspective on China's stock pricing.

This paper will start from the current research and background of venture capital, deeply analyze the existing research in the field of quantitative research and the environment of China's quantitative investment market, and put forward the main ideas of this research. Then describe in detail the thought and process of this research design. After the establishment of the corresponding model, use the data for empirical analysis, and get the required data and the corresponding chart. Finally, this paper discusses the empirical analysis results in detail, to draw specific conclusions in the end.

2. Research Design

In accordance with AHXZ's definition of idiosyncratic volatility, the daily return rate of each stock is regressed to the FF-3 model every month, and the idiosyncratic volatility risk of stock I in month T is defined as the standard deviation of the residual of the above regression model. In measuring idiosyncratic volatility risk derived from the FF-5 model, regression is performed with respect to the FF-5 model when regression is performed on a monthly basis. When FF-5 model is used, the 2*2*2*2 construction factor method with the best separation factor premium is selected.

FF-3 model and FF-5 model fitting were applied to the monthly data of each stock, and the standard deviation of the residual obtained was also known as monthly idiosyncratic volatility. Then, the monthly weighted idiosyncratic volatility of the whole period was obtained after equal-weight weighting of all stocks. Anova was used to analyze whether there was a significant difference between the two groups of data. If there is a significant difference, the magnitude of the difference is further analyzed using linear regression.

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$$r_t^i = c + \gamma\sigma_{t-1}^i + \lambda_\beta'\beta_t^i + \varepsilon_t^i \quad (1)$$

Where,r_t^i is the monthly return rate of the ith stock in the month t，σ_{t-1}^i is the idiosyncratic volatility of the stock at the end of T-1, and β_t^i represents the risk load vector of FF-3 model or FF-5 model.

The specific steps of cross-sectional regression of time series are as follows: in each month of the sample period,

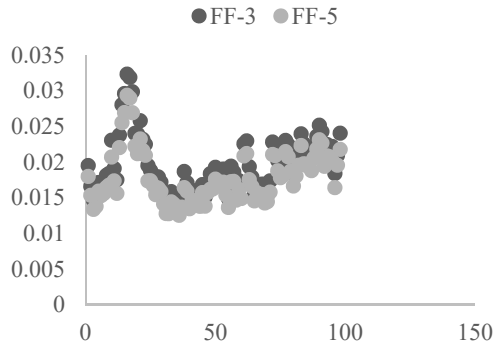

Fig.1. Monthly idiosyncratic volatility from 2014-01 to 2022-04

the corresponding data of each stock is taken as a sample point to make a cross-sectional regression for all stocks to obtain the time series of explanation degree, and then judge whether there is a significant difference between the time series of explanation degree of FF-3 model and FF-5 model on return rate.

All a-share data in this paper are from the CSMAR database. Considering the abnormal excess return rate of the initial listing of new shares, all data of the first month of listing will be removed. If the existing data of the stock does not meet the requirements of five months, the relevant data of the stock will be removed. The sample range is the data of all A-share individual shares from February 2014 to March 2022 for A total of eight years and one month.

3. Empirical results

To discuss the difference in interpretation of idiosyncratic volatility between FF-3 model and FF-5 model, WE first use FF-3 model and FF-5 model to select all a-share individual stock data from February 2014 to March 2022 for 8 years and 1 month. In this study, monthly regression is performed on the daily return rate of each a-share stock (excluding the data of the first month of the newly listed stock, excluding the data of stock return rate that does not meet five months) to obtain the fitting residual and calculate its standard deviation to obtain the monthly idiosyncratic volatility of each share. Then all A-shares were equal-weighted to obtain the compound monthly idiosyncratic volatility of FF-3 model and FF-5 model during the whole period, as shown in Figure 1 below.

In the regression process, it can be obtained that the expected idiosyncratic volatility (E (X)) of FF-3 and FF-5 models during the whole period is 0.019558 and 0.017929, respectively. Then, one-way anova was conducted on the monthly characteristic volatility data obtained from the FF-3 and FF-5 models, and the P value was 2.86E-83, less than 0.0001.

Therefore, there is a significant difference between FF-3 model and FF-5 model in the interpretation of idiotypic volatility. Further, explore the difference in the interpretation degree of trait volatility between FF-3 model and FF-5 model. Plot the data of FF-3 model as X-axis and FF-5 model as Y-axis. It can be seen from Figure 2 that there is an extremely significant linear relationship between the two models, which can almost be considered a complete dominant correlation (R>0.99). The characteristic volatility obtained by FF-5 model is 0.9092 times of that obtained by FF-3 model. Therefore, the interpretation degree of FF-5 model on stock pricing in China's A-share market has

been significantly improved, and the idiosyncratic volatility risk of stock pricing obtained by FF-5 model is 0.9092 times that of stock pricing obtained by FF-3 model.

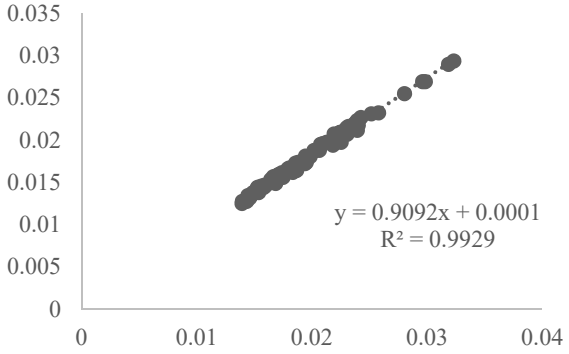

Fig.2. FF-3 Simulation

Applicable to the above conclusion time-series cross-section regression of verification, get with FF- 3 and 5 during the whole regression explanation for all a-share yields, explained to the extent that R single factor variance analysis, get the P value is less than 0.0001, can think type FF - 3 with FF - 5 degree of regression interpretation of A-shares yields has significant differences. In addition, among the REMAINING FF-5 models, the FF-5 model with the highest explanatory degree to the market return rate still has a low explanatory degree of less than 50%.

After linear regression, it can be concluded that, under THE FF-3 and FF-5 models, the explanatory degree expectation (E(X)) of the A-share return rate is 0.422121 and 0.459087 respectively, and the P value is 1.74E-36. It can be concluded that the profitability factor and the investment level factor added by THE FF-5 model have additional explanations for idiosyncratic volatility risk in the market, and the idiosyncratic volatility risk obtained by fitting the FF-5 model with the real return rate is 0.9092 times that of THE FF-3 model.

4. Discussion

In this paper, the research is carried out based on the two model theories OF FF-3 and FF-5, and the cross-sectional regression under the time series is used to verify the influence of idiosyncratic volatility in The Chinese stock market, making up for the previous neglect of idiosyncratic volatility in the use of quantitative investment models.

For policymakers, this study provides more dimensions of pricing thinking. AHXZ found that there was abnormal pricing of idiosyncratic volatility in the market. Moreover, such abnormal pricing cannot be explained by a variety of risk factors that have been discovered, such as size, book-to-market ratio, liquidity, momentum effect, degree of skewness, the difference in analyst forecasts, transaction costs, information delay factor, private information amount PIN, institutional shareholding ratio and skewness [7]. In the work of Yang Huawei et al., it is verified that similar pricing anomalies exist in The Chinese market and that such pricing anomalies are stable for most risk factors [8].

The emergence of FF-5 model improves the pricing anomalies in China's A stock market to A certain extent by further explaining idiot-specific volatility, enabling the stock market to be more reasonably priced. However, it can be seen that even the better FF-5 model still fails to explain the expected returns in a long period of 8 years from March 2014 to March 2022, and the explanation degree is less than 50%. It is speculated that for a long period, it cannot be considered that the expected impact of random events on stock prices is zero, leading to the occurrence of a situation with a poor explanation degree [9]. From the perspective of market pricing, pricing methods should further consider the idiosyncratic volatility and reasonably compensate for the risks caused by idiosyncratic volatility. Pricing methods still need to be improved, and reasonable pricing of financial products in the market should be carried out.

Zhang Bing proposed that the idiosyncratic volatility anomaly is more significant in the case of investors' risk preferences. Investors show the characteristics of risk preference in the face of the loss domain, risk preference is not significant in the face of the gain domain, and idiosyncratic volatility anomaly is more significant in the face of the loss domain [10]. When investors invest, subjective emotion will affect the idiosyncratic volatility anomaly. Therefore, from the perspective of investors, while being affected by investor sentiment, we should also pay attention to the risks caused by abnormal idiosyncratic volatility.

Existing studies have separated FF-3 and FF-5 from idiosyncratic volatility. In this paper, the differences in idiosyncratic volatility risk in the two models are obtained by combining them, and it is found that FF-5 model significantly improves idiosyncratic volatility in China's A-share market.

5. Conclusion

In this paper, the data of China's a-share market from February 2014 to March 2022 for A total of 8 years and 1 month are selected as samples, and FF-3 and FF-5 models are respectively applied to calculate the idiosyncratic volatility risk of China's A-share market. It is found that the idiosyncratic volatility risk of stock pricing obtained by FF-5 model is significantly different from that obtained by FF-3 model. And the characteristic volatility risk of stock obtained by FF-5 model is 0.9092 times that of FF-3 model. These differences are caused by two additional factors, the profitability factor and investment level factor, added to the FF-3 to FF-5 models. It can be considered that the two new factors, the profitability factor, and investment level factor, have an additional explanation for the idiosyncratic volatility risk of China's A-share market, which is 10% of the explanation degree of the three-factor model. The research shows that THE FF-5 model can significantly improve the idiosyncratic volatility in China's A-share market.

References

[1] X Yu, Comparative analysis and prospect analysis of quantitative investment and artificial investment, 2021.

[2] X Zhang and Y Zhang, Quantitative investment in China's development and impact analysis, June 2022.

[3] Merton R，A simple model of capital market equilibrium with incomplete information. J. Finance 42(3), 1987,pp.483–510.

[4] E. F. Fama and K.R. French, Common risk factors in the returns on stocks and bonds,University of Chicago. Chicago I .L 60637, USA.

[5] A.Ang, et al., 2006. The Cross-Section of Volatility and Expected Returns. The Journal of finance (New York), 61(1), pp.259–299.

[6] E. F.Fama. and K. R. French, 2015. A five-factor asset pricing model. Journal of Financial Economics, pp.1-22.

[7] AHXZ,The cross-section of volatility and expected returns. Journal of Finance 61, 2006.pp.259-299.

[8] H Yang, L Han,Journal of Beijing University of Aeronautics and Astronautics (Social Sciences Edition) 2009.pp.6-10

[9] Edwin,The Journal of Finance, Aug., 1999, Vol. 54, No. 4, Papers and Proceedings, Fifty-Ninth Annual Meeting, American Finance Association, New York, New York,Tanuary 4-6, 1999 (Aug., 1999), pp. 1199-1220

[10] B Zhang, The Researh of Idiosyncratic Volatility Puzzle in China’ Capital Market: From the Perspective of Prospect Theory.