

# The Research of Fama-French Three-factor Model's Applications in the Chinese Stock Market after the Financial Crisis

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## ABSTRACT

Nowadays, arguments about the three-factor model by Fama and French are becoming more and more various. In contrast, the effect that this model generates in China's stock market is still not confirmed. This study employed the three-factor model to determine factors that have a big influence on the Chinese stock market and tell whether the three-factor model applies to the Chinese stock market. The regression between the portfolio returns and three factors was explored in the procedure of this study. As a result, we obtain that the market risk plays an important role in determining the price of stocks. However, the "big company effect" also exists, and elements affecting the stock pricing had not been all explained with the model used, which revealed that the existence of other potential factors also affects stock pricing.

**Keywords:** Fama-French, The economic crisis, Chinese stock market

## 1. INTRODUCTION

With the continuous improvement of the financial market, various financial assets continue to emerge in the current financial market, and financial products are also increasingly popular in public. Moreover, asset pricing has always been the core issue of financial economics research. Since Sharpe, Lintner, Treynor et al. proposed the Capital Asset Pricing Model (CAPM) in 1964, the determination of the asset return rate through a single risk factor has been challenged by theory and the market. In order to improve the explanatory and predictive capabilities of the model, Fama and French established a three-factor model in 1993 to explain the excess returns of investment strategies [1-2]. The three factors are market asset portfolio, market value factor (SMB), book-to-market value ratio factor (HML). This model can better explain the expected return rate of stock portfolios on the cross-section, and it is quickly widely accepted by academia and practice circles. China's economy has entered an adjustment period under the influence of economic transformation and cyclical adjustment since 2008, and the COVID-19 hit even the since the beginning

of 2020. The direct impact of the US subprime mortgage crisis on China's macroeconomy is small. However, the indirect impact is relatively large, mainly through the change of RMB exchange rate, price fluctuations in the international market, the reduction of domestic demand in the United States, and other ways to make China's export, investment, and consumption demand vary degrees of decline. As far as the Chinese stock market is concerned, is the three-factor model applicable?

To test the feasibility of the three-factor model in China's A-share market, we selected several A-share stocks to establish the three-factor model and conduct a comparative analysis.

The remainder of the paper is organized as follows. Section 2 introduces the data analysis. Section 3 presents the method. In Section 4, the paper introduces the result and analysis. Finally, we summarize the conclusion in Section 5.

## 2. DATA ANALYSIS

Avoiding the expected investment growth before the end of 2009 influenced by the status of equity

restructuring, this article conducts empirical tests using the three-factor model on the CNI A-share stock market [3]. The sample period is from the 4th of Jan. 2010 to the 8th of Aug. 2021, covering a range of ten years to analyze whether the FF three-factor model is still applicable in China after the financial crisis. The four sample stocks, Wanke, Maotai, Keda, and Pingan, were chosen randomly to verify whether the Fama-French three-factors model fits well in the Chinese stock market.

The Fama-French three-factor model is specified by the following equation:

$$R - R_f = \alpha + \beta_1(R_m - R_f) + \beta_2SMB_t + \beta_3HML_t + \varepsilon \tag{1}$$

Where R represents the return on test portfolios, R<sub>f</sub> is the risk-free rate, and R<sub>m</sub> is the market return. As shown in the equation, the expected risk premium R – R<sub>f</sub> can be explained by three factors: the market factor R<sub>m</sub>-R<sub>f</sub>, the size factor which generates a return SMB, and the return on the book-to-market factor HML.

In order to identify which stock is more suitable for the OLS model, we conducted the following data processing: we observe the residuals of stock Keda, Maotai, Wanke, and Pingan firstly by analyzing the residual plots generated before we can judge whether each stock is suitable for OLS model by telling the coincidence degree of each residual plot.

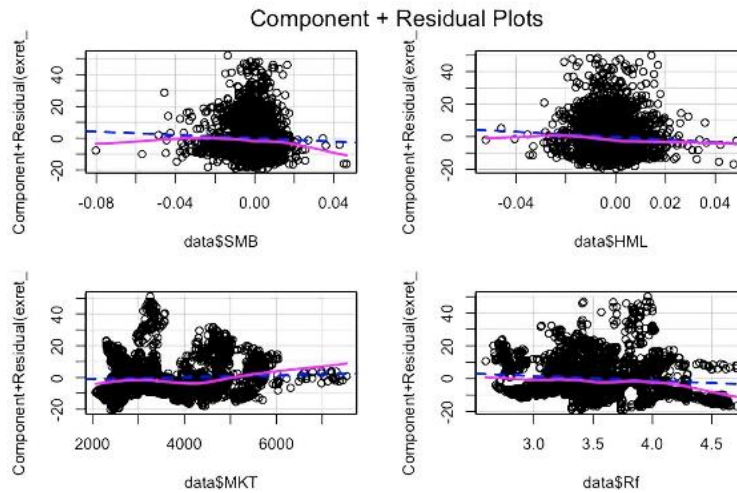


Figure 1 Residual plot of Keda

Figure 1 indicates the linear relationship between candidate factors and stock Keda. We can tell from the picture above those two lines fit almost linearly, which generally means all the factors fit linearly. From this

result, we can conclude that all factors are having a significant impact on stock Keda as the running test models are all fitting quite well.

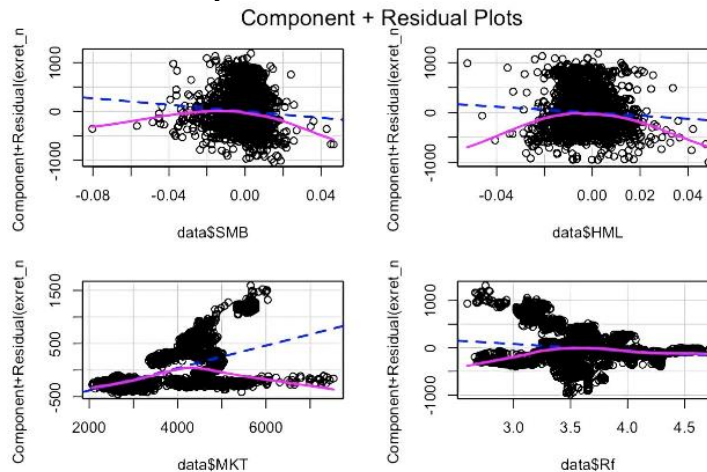


Figure 2 Residual plot of Maotai

Figure 2 indicates the linear relationship between candidate factors and stock Maotai. Remarkably, there's a huge difference between two lines in data\$MKT,

whereas the other three models show the same tendency of fitting linearly.

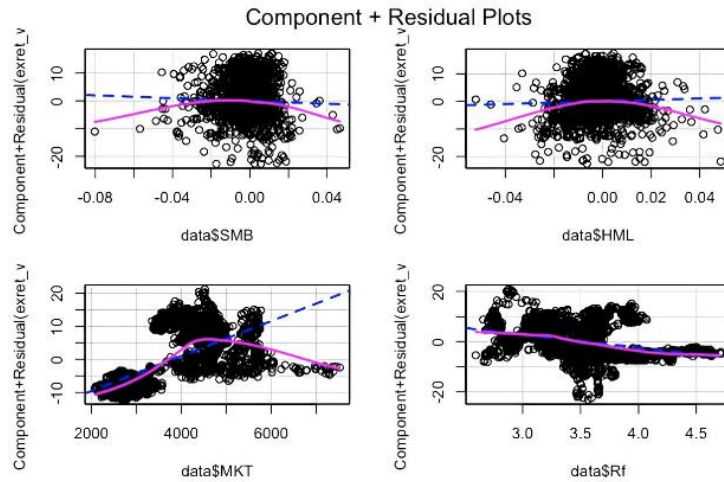


Figure 3 Residual plot of Wanke

Figure 3 indicates the linear relationship between candidate factors and stock Wanke. Just like stock Maotai above, there's a huge difference between two

different lines in data\$MKT which means some candidates' factors are not fitting well with stock Wanke.

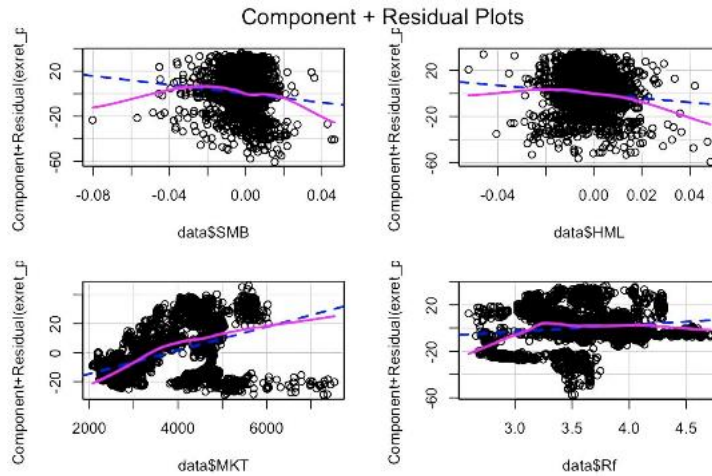


Figure 4 Residual plot of Pingan

Figure 4 indicates the linear relationship between candidate factors and stock Pingan. Just like stock Keda above, we can tell that generally, all the factors fit linearly. And in conclusion, all factors are having a significant impact on stock Pingan as the running test models are all fitting quite well.

### 3. METHOD

In recent decades, several kinds of definitions of the Fama and French Three-Factor Model have been raised [4-6]. To maintain the robustness of the data analysis and conclusions for this essay, the most widely accepted one is used for analyzing the data and shown below:

$$R_{it} - R_{Ft} = \alpha + \beta_1MKT + \beta_2HML + \beta_3SMB \quad (2)$$

In the equation defined above, MKT (abbreviation for 'Market risk'), is de- fined to be:

$$R_{Ft} - R_{Mt} \quad (3)$$

HML(High-Minus-Low) is defined to be:

$$HML = \frac{SH+BH}{2} - \frac{SL+BL}{2} \quad (4)$$

SMB(an acronym for 'Small-Minus-Big'),though a bit complicated, is calculated as:

$$SMB_{B/M} = \frac{SH+SN+SL}{3} - \frac{BH+BN+BL}{3} \quad (5)$$

$$SMB_{OP} = \frac{SR+SW+SN}{3} - \frac{BR+BW+BN}{3} \quad (6)$$

$$SMB_{Inv} = \frac{SC+SN+SA}{3} - \frac{BC+BN+BA}{3} \quad (7)$$

$$SMB = \frac{SMB_{B/M}+SMB_{OP}+SMB_{Inv}}{3} \quad (8)$$

The left-hand side  $R_{it} - R_{Ft}$ , undoubtedly, stands for the average return.And all the parameters are shown in the following Table 1

**Table1.** Names and the algorithm of factors in the 3-factor model.

Factors	Construction of the Algorithm
MKT	$R_{Ft} - R_{Mt}$
HML	$HML = \frac{SH + BH}{2} - \frac{SL + BL}{2}$
SMB	$SMB_{B/M} = \frac{SH + SN + SL}{3} - \frac{BH + BN + BL}{3}$ $SMB_{OP} = \frac{SR + SW + SN}{3} - \frac{BR + BW + BN}{3}$ $SMB_{Inv} = \frac{SC + SN + SA}{3} - \frac{BC + BN + BA}{3}$ $SMB = \frac{SMB_{B/M} + SMB_{OP} + SMB_{Inv}}{3}$

The algorithm uses the ‘2×3 double sorting’ methodology, as described in the essay from Fama and French.

In order to look into the impact of the Fama and French Three-Factor Model on the mainstream Chinese stock market, three stocks with monthly fluctuations from 01.04,2010 to 01.08,2021 are selected. Apart from being representative on the Chinese stock market, they are also, to the maximum extent, chosen to eliminate the possibility of mis-correspondence between mid-to-small firms and the Growth Enterprise Market after the economic crisis took place in 2008.

Additionally, other statistics are being used in the analysis of the data set. Statistics include  $R^2$  and  $Var$ , etc [7]. All the data of each stock is analyzed by the statistic software R. Therefore, there is no need to list the definitions for  $R^2$  and  $Var$  here for verification.

In the next section, we are going to further analyze the impact of the Fama and French Three-Factor Model on the China mainstream stock market based on the results obtained by regressions run on it [8-10].

#### 4. RESULTS ANALYSIS

Through the empirical test, it is found that the Fama-French three-factor model is generally applicable to China's main stock market, in which the market factor (MKT) has the greatest influence, the value factor (HML) has the second, and the scale factor (SMB) shows the smallest influence.

The regression analysis results are shown in Table 2. On further research, we found the following three points:

First: in the four investment portfolios, the intercept of Pingan Bank is not significant, the intercept of Wanke and Keda is very significant, and that of Maotai is relatively significant under the confidence interval of 95%. Moreover, the intercept parameter is negative and significant in the combination large-cap high BM (big

blue chips). The returns of stocks with high expected growth and "Big Blue Chips" can't be explained by the factors Fama-French Model assumed, which led to negative excess returns.

Second: The coefficient regression results of the market factors of the four companies we listed in the mainboard A-shares market show that the factor is highly significant. Since we divided 80% of all A-shares into six groups and the number of stocks in each group is large, it's not surprising to see the coefficient value is very significant. It can be considered that the systemic risks of the six portfolios above are close to the whole market. When analyzing the returns of the six portfolios later, the differences caused by systemic risks can be excluded.

Third: For the coefficient of scale factor (SMB), the companies we listed all show a significantly positive value, and the significance is increasing with the rise of the ratio of book value, suggesting that the mainboard stock market in China exists "big company effect". Investors prefer to choose large-scale companies for they are more mature, and the future gains from these companies far outweigh the loss of not choosing smaller companies. The coefficient in the large-scale companies are all significantly negative, and the absolute values are increasing with the increase of the book values, suggesting that investors tend to invest in companies with high book values; because mature companies are lack growth, they can only rely on high book value. That is, the high shareholder's equity gets more profit distribution of the company, and this kind of investment belongs to value investment [11].

The above analyses show that with investors' different preferences for the size of the company in the market, their choices for the value of the company are also different. The performance of the stock with a high book value ratio is completely different from that of the stock with a low book value ratio.

The intercept term of the four portfolios is significantly not zero, which is inconsistent with the

initial assumption. Under the ideal model, the intercept term should be zero. Based on the results we got, this paper makes the following assumption: in China's main board stock market, there may be other factors that cannot be explained by these three factors affecting the stock return rate. That is, the existence of the

international economic situation and other reasons also affect the A-share mainboard market. During the economic downturn period (2008 financial crisis), the ROE of most enterprises was low or maintained a downward trend [12].

**Table2.** Fama-french three model regression results

	Ex-return of Pingan	Ex-return of wanke	Ex-return of Maotai	Ex-return of keda
SMB	-196.104*** (42.825)	-25.186 (15.673)	-3,353.888*** (892.608)	-52.076* (28.990)
HML	-184.411*** (44.403)	25.466 (16.251)	-3,024.629*** (925.509)	-79.684*** (30.058)
MKT	0.008*** (0.0003)	0.005*** (0.0001)	0.211*** (0.007)	0.001*** (0.0002)
Rf	5.693*** (0.872)	-5.197*** (0.319)	-145.547*** (18.179)	-2.862*** (0.590)
Constant	-0.998 (3.888)	12.392*** (1.423)	164.186** (81.031)	42.584*** (2.632)
Observations	2,679	2,679	2,679	2,679
R <sup>2</sup>	0.186	0.556	0.357	0.023
Adjusted R <sup>2</sup>	0.185	0.555	0.356	0.022
Residual Std. Error	16.699	6.112	348.073	11.305
F Statistic	152.919***	836.324***	371.038***	15.813***

*Note:*

\*p<0.1; \*\*p<0.05; \*\*\*p<0.01

## 5. CONCLUSION

In this article, we chose the CNI A-SHARE INDEX as the risk-free return rate and chose stocks from 2010 to 2021 of four leading companies in their corresponding industry, PingAn, Wanke, Maotai and Keda, to test the effectiveness of the Fama and French 3-factor model in the Chinese stock market. Our empirical results show that in the decades after the financial crisis in 2008, the Fama and French Three-Factor Model still can't fit the development of the Chinese stock market well.

The market risk takes the winning side of determining the price of a piece of stock. However, we also found that the expected returns of "Big Blue Chips" stocks with high expected growth can't be explained by the factors assumed by Fama and French. Second, it's found that the 'big company effect' also exists. This kind of company gains more external investments from investors due to their long-term, robust, and stable states. As a consequence, there will be more capital to be put in risk management, and thus leading to a non-malignant circle. Finally, it's the case that this model constructed as before cannot thoroughly explain all the elements affecting the price of a stock. From the four portfolios, we listed, the

obtained intercept doesn't match the initial setting. It, therefore, reveals the existence of other potential factors with impacts on the stock price. For example, international political and economic circumstances and speculative behaviour also have an influence on the stock price.

Since Fama and French Three-Factor Model has been verified by stock markets in many countries, it is of great significance to analyze whether the implication of the Three-Factor Model is suitable for such an emerging stock market in China and make the optimized three-factor model accord Chinese stock market characteristics is undoubted of great practical significance for investors to make the best investment decision and for governments to make macroeconomic policies. Considering that China's stock market development has its particularities, we suggest that the governments should give full play to their supervisory and guiding roles. Objectively, fiscal and monetary policies are required to coordinate with each other in order to maintain economic stability. Optimizing the industrial structure is also essential to improve the quality of economic growth.

By testing the effectiveness of the Fama and French Three-Factor Model on four representative stock portfolios in China's capital market, we have enriched the experience of the research into the Chinese stock market as well as, to some extent, compensating the usefulness of this model in academia. By analyzing how factors impact the final price of a stock, we further revealed the logic behind the capital pricing law and offered a practical strategy of finding a more appropriate factor model for China's capital market from a different point of view.

As we only consider the market risk, the business scale, and the financial circumstance of a company when constructing the factors, there must be an error term that cannot be interpreted by either of these factors, which has been proved by the Fama and French [14]. Therefore, it's firmly believed that exploring and finding a more well-interpreted model for pricing a portfolio in China's capital market is, without controversy, imperative, which is beneficial to getting familiarity with the dynamic change of China's capital market, buttressing the decision-making of regulation, and assisting the practice of investments.

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