# Is Fama-French five factor model better than the three factor model——Empirical evidence from the US stock market

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**Abstract.** This paper takes the listed companies in the US stock market from July 1993 to October 2021 as a sample to compare the predictive ability of the three-factor model and the five-factor model. The main conclusions are as follows: Firstly, the correlation between the factors of the three factor model and the five factor model is not significant. Second, using the three factor model to test the profitability effect and investment style effect, it is found that there are still significant profitability effect and investment style effect in the US stock market after 1993 after the adjustment of the three factor model. To some extent, this shows that the five factor model is better than the three factor model in predicting the US stock market returns after 1993.Third, through the redundancy test of the factors in the five factor model, it is found that after the adjustment of several other risk factors, the US stock market still has significant market risk, scale effect, profitability effect and investment style effect, but the HML factor is a redundant factor for explaining the stock portfolio yield. Fourth, by comparing the effectiveness of HML, RMW and CMA factors, it is found that the coefficients of CMA factors are not significant, indicating that CMA factors cannot explain the portfolio return rate of the US stock market.

**Keywords:** Three factor model; five factor model; stock return.

## 1. Introduction

What factors determine the return rate of stock portfolio is a long-standing research topic in the market, and the research on this issue is an important topic in the field of asset pricing. The practical experience of stock investment and the analysis of transaction data can enrich and improve the pricing theory. The long-term excess returns of some investment strategies have prompted scholars to constantly improve the theoretical system and modify the pricing model, so as to improve the pricing efficiency of the capital market and form trading strategies. The three-factor model proposed by Fama and French (1993) can well explain the expected rate of return of the stock portfolio on the cross section. The model was quickly accepted by the academic and practical circles. To test whether the investment strategy can obtain excess return, it is usually necessary to control these three factors to test whether the new indicators have the ability to predict the future return of the company in addition to the three factors of market risk, company size and book to market ratio.

The value investment strategy focuses on the analysis of financial statements and profitability, as well as the analysis of enterprise operation and management ability. Its long-term excess return in investment practice has made it highly respected worldwide. The long-term excess return of the value strategy based on company value and growth challenges the effectiveness of the Fama French three factor model. In recent years, relevant evidence shows that the three-factor model cannot explain the changes in the average stock return related to profitability and investment style. Aharoni et al. (2013) found that there was a significant negative correlation between the company's capital investment and the expected rate of return; Novy Marx (2013) pointed out the positive correlation between expected profitability and stock portfolio yield. Fama and French (2015) proposed a five-factor model based on the discussion framework of the dividend discount model, and added profitability and investment style factors to the three-factor model to better describe the expected rate of return of the stock portfolio on the cross section.

This paper is based on Fama French three factor model and five factor model, combined with the transaction data and financial data of the U.S. stock market since 1993, and mainly wants to discuss

two issues: first, for the U.S. stock market after 1993, whether the profit factor RMW and investment factor CMA can explain the stock return rate; Second, whether the RMW and CMA factors contain most of the information of the HML factors, making them redundant variables; Third, whether the five factor model has stronger explanatory power than the three factor model.

## 2. Literature review

The effectiveness of asset pricing models is of great significance for investment decisions. There are numerous theoretical and empirical studies on asset pricing models, ranging from simple single factor models to five factor models, from simple consideration of market risk factors to comprehensive consideration of the company's size, growth, profitability and investment level. Sharpe (1964), Lintner (1965) and Mossin(1966) proposed the CAPM model. On the basis of general equilibrium, the model established the basic idea that the income of assets comes from the risks assumed by assets, and became the pillar of modern financial market price theory. CAPM model uses a single risk factor to describe the return rate of assets, which makes it subject to many challenges. On the one hand, CAPM model cannot explain the size effect, that is, the significant negative correlation between stock return and circulating market value (Banz, 1981; Reinganum, 1981; Keim, 1983). Banz (1981) found that the explanatory power of market risk premium is weak, while the market value of the company has a stronger explanatory power of stock return. This phenomenon is common in many major exchanges in the world. On the other hand, CAPM cannot explain the value effect, that is, the significant positive correlation between book to market ratio and stock return (Chan et al., 1991). Fama and French (1992), Lakonishok et al. (1994) and Davis (1994) found that the company's current share price, book value of owner's equity and earnings per share can explain the future return rate of the company's stock. In order to improve the interpretation and prediction ability of the model, the asset pricing model is gradually developed from a single factor model to a multi factor model.

Fama French (1993,1996) three factor model combines previous research and adds the factor SMB to explain the market value effect and the factor HML to explain the value effect on the basis of CAPM. The important feature of this model is that although SMB and HML represent the factors of the company's market value and the company's book to market ratio, in fact, they represent the difference between the returns of different asset portfolios rather than the company's market value or book to market ratio itself. The construction method of this factor has become the standard method for subsequent research on the construction of factors. Then Fama and French (1998) extended the three-factor model to the global perspective, proposed the global market risk premium, the global market SMB and the global market HML, and compared it with the CAPM model using the global market market risk premium, and found that the three-factor model has stronger explanatory power. The three-factor model has aroused widespread concern in the academic community. Griffin (2002) tested the three-factor model with data from Japan, the United Kingdom and Canada, and found that the model can effectively explain the difference in stock portfolio returns, but the three-factor model calculated with domestic market data is better than the three-factor model of the global market.

In theory, the value of a company depends on the present value of its future equity cash flow. From practical experience, companies with strong profitability tend to have higher returns on their stocks, while companies with high investment levels have lower returns on their stocks. Many scholars consider asset pricing from the perspective of corporate management. Fama and French (2006 and 2008) used the dividend discount model to explain that the expected return, expected investment and book value have the ability to explain and predict the future return of stocks. Cooper et al. Novy Marx (2013) believed that the ROA's ability to explain the company's returns in cross section data was equal to the book to market ratio. Considering ROA when using value investment strategies would improve strategic returns. In addition to profitability, investment level is also an important factor affecting the return on assets. Arharoni et al. Titman et al. (2004) found that investment has a significant negative impact on stock returns, especially for companies with abundant cash flow and

low debt ratio. Liu et al. (2009) found that the return rate of the company's stock is equal to the return rate of leverage investment, and the company's return rate is related to unexpected earnings, book to market ratio and capital investment. Cooper and Priestley (2011) believed that the difference between portfolio returns of companies with high investment level and those with low investment level was due to system risk, which was lower when the investment level was high, and had a good ability to explain portfolio returns. Based on the above research, investment and profitability factors become the factors of the subsequent asset pricing model. At present, the research on the profitability and investment level of the company has become the main development direction of the asset pricing model.

## 3. Empirical Research Design

Fama French three factor model covers the size effect and value effect that cannot be explained by CAPM. The three-factor model is expressed as:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + e_{it} \quad (1)$$

$R_{it}$ represents the yield of portfolio i at time t; $R_{Ft}$ Represents the risk-free interest rate at time t; $R_{Mt}$ Represents the yield of market portfolio weighted by market value; $SMB_t$ refers to the difference between the investment portfolio of companies with low circulating market value and that of companies with high circulating market value in period t; $HML_t$ indicates the difference between the investment portfolio of value companies with high book to market ratio and the investment portfolio of growth companies with low book to market ratio in period t; $e_{it}$ Represents the residual. Table 2 below for the specific method of constructing factors.

Based on the three-factor model, Fama French five factor model adds factors representing the company's profits and investment:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + e_{it} \quad (2)$$

$RMW_t$ refers to the difference between the return rate of the investment portfolio of the company with strong profitability and that of the company with poor profitability in period t. The profitability is measured by the ratio of the operating profit after deducting operating costs, selling expenses, financial expenses and administrative expenses from the operating revenue of the previous period to the book value of the owner's equity of the previous period; $CMA_t$ refers to the difference between the investment portfolio of companies with low investment level and that of companies with high investment level in period t. The investment level is divided by the growth of total assets in period t-1 by total assets in period t-2.

This paper wants to study whether the predictive ability of the three-factor model for stock returns has changed since Fama French put forward the three-factor model in 1993. If there is any change, is it strengthened or weakened? At the same time, the three-factor model is compared with the five-factor model proposed by Fama French in 2015. Therefore, this sample selects the monthly return closing price data of all non-financial enterprises in NYSE, AMEX and NASDAQ from July 1993 to October 2021, as well as the total assets, total owner's equity and operating profit data in the consolidated financial statements. The reason why financial enterprises are excluded is that high leverage may be reasonable for financial companies, but it may not be reasonable for other non-financial companies, which may lead to bankruptcy. Therefore, financial companies must be excluded. The data in this paper comes from French Data Library.

This paper constructs pricing factors by referring to Fama and French (2015). Table 1 reports the average monthly excess return of the asset portfolio divided by different dimensions, which intuitively reflects the difference in the explanatory power of different factors. Size refers to the circulating market value calculated by multiplying the total amount of circulating shares disclosed in

the financial statements of the previous year by the closing price of the last trading day of the previous year. B/M represents the book value to market ratio of the book value of owner's equity disclosed in the financial statements of the previous year, excluding the circulating market value on the last trading day of the previous year. OP is the ratio of operating profit to total owner's equity in the financial report of the previous year. Inv refers to the ratio of the change in total assets in the financial report of the previous year to the total assets two years ago.

**Table 1.** Average Monthly Excess Return of Investment Portfolio by Two Dimensions.

| | Low | 2 | 3 | 4 | High |
|---|---|---|---|---|---|
| Size-B/M | | | | | |
| Small | 0.66 | 1.22 | 1.06 | 1.30 | 1.39 |
| 2 | 1.01 | 1.21 | 1.07 | 1.05 | 1.18 |
| 3 | 0.97 | 1.15 | 1.02 | 1.10 | 1.20 |
| 4 | 1.15 | 1.14 | 1.03 | 1.06 | 1.03 |
| Big | 1.08 | 0.97 | 1.02 | 0.68 | 0.93 |
| Size-OP | | | | | |
| Small | 0.98 | 1.31 | 1.22 | 1.40 | 1.13 |
| 2 | 0.89 | 1.06 | 1.16 | 1.23 | 1.30 |
| 3 | 0.92 | 1.03 | 1.08 | 1.15 | 1.23 |
| 4 | 0.94 | 1.09 | 1.07 | 1.17 | 1.20 |
| Big | 0.58 | 0.85 | 0.94 | 1.03 | 1.04 |
| Size-Inv | | | | | |
| Small | 1.44 | 1.32 | 1.33 | 1.15 | 0.74 |
| 2 | 1.16 | 1.11 | 1.21 | 1.21 | 0.86 |
| 3 | 1.17 | 1.09 | 1.10 | 1.12 | 0.95 |
| 4 | 1.12 | 1.10 | 1.14 | 1.19 | 1.05 |
| Big | 1.08 | 0.91 | 0.97 | 1.08 | 1.00 |

From the perspective of the change law of portfolio returns, first, since 1993, the size effect of the U.S. stock market has been very obvious. The returns of the portfolio of companies with small circulating market values are higher than those of the portfolio of companies with large circulating market values, and they are very obvious in each group except for individual groups. Second, since 1993, the value effect of American stock market has been very obvious. The return of value stocks is higher than that of growth stocks, that is, the return of portfolios with high B/M is higher than that of portfolios with low B/M. Third, except for the company portfolio with the minimum circulation market value of 20%, the stock portfolio income increases with the company's profitability, especially for companies with large circulation market value. For the 20% portfolio with the lowest circulating market value, the stock portfolio income decreases with the increase of the company's profitability, which shows that investors in such companies do not pay attention to the performance, but pay more attention to the possibility of asset restructuring caused by poor performance of small market companies, which is more speculative. Fourth, the return of the stock portfolio has a downward trend with the increase of the company's investment scale, but it is not obvious.

According to the Fama-French (2015) factor construction method, this paper adopts the 2×3 grouping method. According to the median market value scale, all stocks are divided into two groups: large market value (B) and small market value (S). According to the 30% and 70% quantiles of the book to market ratio, all stocks are divided into three groups: high (H), medium (N), and low (L); Secondly, by crossing the two indicators of market value and book value to market ratio, all stocks can be divided into six portfolios: SH, SN, SL, BH, BN and BL; Thirdly, replace book to market ratio with operating profit margin and investment style respectively. Repeat the above steps to divide all stocks into 12 portfolios: SR, SN, SW, BR, BN, BW, SC, SN, SA, BC, BN, BA. Among them, R

represents stable profitability, W represents weak profitability, C represents conservative investment style, A represents aggressive investment style, and N represents medium profitability or investment style; Next, calculate the market value weighted average yield of each period of the above portfolios; Finally, four factors are constructed by using the difference of different portfolio returns. The specific calculation method of factors is shown in Table 2:

**Table 2.** Factor construction method.

| | Quantile | Factor algorithm |
|---|---|---|
| FF-3 | Size:50%, B/M:30%,70% | SMB = [ ( SH - BH) + ( SN - BN) + ( SL - BL) ]/3<br>HML = [ ( SH - SL) + ( BH - BL) ]/2 |
| FF-5 | Size:50%, B/M:30%,70% OP:30%,70% Inv:30%,70% | $SMB_{B/M}$=(SH+SN+SL)/3-(BH+BN+BL)/3<br>SMBOP=(SR+SN+SW)/3-(BR+BN+BW)/3<br>SMBInv=(SC+SN+SA)/3-(BC+N+BA)/3<br>SMB = ( $SMB_{B/M}$ + $SMB_{OP}$ + $SMB_{Inv}$ ) /3<br>HML = ( SH + BH) /2 - ( SL + BL) /2<br>RMW = ( SR + BR) /2 - ( SW + BW) /2<br>CMA = ( SC + BC) /2 - ( SA + BA) /2 |

## 4. Comparison between Fama French three factor model and five factor model

### 4.1 Descriptive statistics of factors

According to the data of the U.S. stock market from 1993 to 2021, the mean of $R_M$-$R_F$ factor in the three-factor model and the five-factor model is 0.77, the standard deviation is 4.40, the skewness is -0.66, and the kurtosis is 4.35. The skewness is not much different from the normal distribution, and the kurtosis is slightly higher than the normal distribution. In the three-factor model, the average SMB factor is 0.13, the standard deviation is 3.22, the deviation of skewness is small, and the deviation of kurtosis is large. In the five-factor model, the average SMB factor is 0.15, the standard deviation is 3.11, and the deviation between skewness and kurtosis is smaller than the three-factor model. In the three-factor model, the mean value of HML factor is 0.07, the standard deviation is 3.19, the skewness is close to the normal distribution, and the deviation of kurtosis is large. The HML factor in the five-factor model has little difference compared with the three-factor model. In the five-factor model, the mean RMW factor is 0.33, the standard deviation is 2.71, the skewness is close to the normal distribution, and the deviation of kurtosis is large. The mean value of CMA factor is 0.18, the standard deviation is 2.04, and the skewness and kurtosis are close to normal distribution.

**Table 3.** Descriptive Statistics of Factor Yield.

| FF - 3 | $R_M$-$R_F$ | SMB | HML | | |
|---|---|---|---|---|---|
| Mean | 0.77 | 0.13 | 0.07 | | |
| Median | 1.34 | 0.13 | -0.05 | | |
| Std. Dev. | 4.40 | 3.22 | 3.19 | | |
| Skewness | -0.66 | 0.65 | 0.07 | | |
| Kurtosis | 4.35 | 10.50 | 5.58 | | |
| FF - 5 | $R_M$-$R_F$ | SMB | HML | RMW | CMA |
| Mean | 0.77 | 0.15 | 0.07 | 0.33 | 0.18 |
| Median | 1.34 | 0.09 | -0.05 | 0.38 | -0.01 |
| Std. Dev. | 4.40 | 3.11 | 3.19 | 2.71 | 2.04 |
| Skewness | -0.66 | 0.37 | 0.07 | -0.42 | 0.67 |
| Kurtosis | 4.35 | 7.46 | 5.58 | 13.04 | 4.97 |

### 4.2 Redundancy test of factors

Firstly, the correlation of factors is tested. The FF-3 correlation matrix shows that the correlation coefficients of market premium factor and scale factor, market premium factor and book to market ratio factor, scale factor and book to market ratio factor are 0.23, -0.08 and -0.22 respectively. The probability values corresponding to t-statistics are 0.00, 0.14 and 0.00 respectively, which are significant, non-significant and significant at the 1% confidence level. The largest absolute value of correlation coefficient is 0.23 of market premium factor and scale factor, but it is generally believed that the linear correlation coefficient is only significant when it is above 0.90 or 0.95, so the correlation is not significant, that is, there is no multiple collinearities in FF-3 model. In the same way, this conclusion is also applicable in FF-5 model. See Table 4 below for specific data:

**Table 4.** Correlation Coefficient Inspection Table.

| | Correlation<br>Probability | $R_M$-$R_F$ | SMB | HML | RMW | CMA |
|---|---|---|---|---|---|---|
| FF-3 | $R_M$-$R_F$ | 1.00<br>\ | | | | |
| | SMB | 0.23<br>0.00 | 1.00<br>\ | | | |
| | HML | -0.08<br>0.14 | -0.22<br>0.00 | 1.00<br>\ | | |
| | Correlation<br>Probability | $R_M$-$R_F$ | SMB | HML | RMW | CMA |
| FF-5 | $R_M$-$R_F$ | 1.00<br>\ | | | | |
| | SMB | 0.23<br>0.00 | 1.00<br>\ | | | |
| | HML | -0.08<br>0.14 | -0.01<br>0.79 | 1.00<br>\ | | |
| | RMW | -0.38<br>0.00 | -0.47<br>0.00 | 0.40<br>0.00 | 1.00<br>\ | |
| | CMA | -0.33<br>0.00 | -0.01<br>0.93 | 0.61<br>0.00 | 0.26<br>0.00 | 1.00<br>\ |

Next, the three-factor model is used to test the profitability effect and investment style effect, and the redundancy test is conducted for the factors in the five-factor model. The test of profitability effect and investment style effect uses the three-factor model as the benchmark model of risk adjustment, and then see whether the factor has significant risk premium after risk adjustment. Table 4 The profitability effect and investment style effect test part selects the full sample data of the U.S. stock market since 1993 and regresses the returns of RMW and CMA factors to the three-factor model. The regression intercept item represents the risk premium of this factor after the adjustment of the three-factor model. The risk adjusted premium of RMW and CMA factors is still significantly greater than 0. The results in Table 4 show that there are still significant profitability effects and investment style effects in the US stock market after 1993 after the adjustment of the three-factor model. To some extent, this shows that it is reasonable to add profitability and investment style factors, that is, the five-factor model has higher prediction ability for the US stock market returns after 1993 than the three-factor model.

The five-factor model redundancy test uses the returns of four factors for regression to explain the returns of the fifth factor. The regression intercept item represents the risk premium of the factor after risk adjustment of the other four factors. The regression results from 1993 to 2021 show that after the adjustment of other risk factors, the US stock market still has significant market risk, scale effect,

profitability effect and investment style effect. The regression intercept of HML factor to the other four factors is -0.40, and it is significant at the 1% confidence level. This shows that according to the data of the US stock market since 1993, the HML factor in the five-factor model is a redundant factor for explaining the stock portfolio return. This paper does not make a further test on this, but I suspect that this result may be because HML, RMW and CMA are both related to the company's value and financial data. HML factor is measured by net assets per share and stock price, while RMW is measured by specific financial data such as the company's operating income, costs and three expenses, and CMA is measured by the company's investment scale and total assets, which has overlapping information. The explanatory power of the newly introduced RMW and CMA factors to the US stock market has included the explanatory power of the HML factor, which leads to redundancy of the HML factor. In fact, Fama and French (2015) added the profit factor RMW and investment factor CMA on the basis of the three-factor model and proposed a five-factor model. The effectiveness of the five-factor model was confirmed by more than 50 years of market data in the United States. The empirical results found that the value factor HML became redundant after adding the profit factor RMW and investment factor CMA. Fama and French explained on the forum that the profit factor RMW and the investment factor CMA contain most of the information of the value factor HML. These three factors are three aspects of measuring the company's value and growth, and are important considerations of the value strategy.

**Table 5.** Profitability effect, investment style effect test and redundancy test.

| | **Profitability and investment style Effect test** | | **Redundancy test of five factor model** | | | | |
|---|---|---|---|---|---|---|---|
| | RMW | CMA | RM-RF | SMB | HML | RMW | CMA |
| α | $0.49^{***}$ | $0.26^{***}$ | $1.10^{***}$ | $0.30^{*}$ | $-0.40^{***}$ | $0.52^{***}$ | $0.29^{***}$ |
| | (-4.44) | (3.08) | (5.28) | (1.92) | (-3.09) | (4.58) | (3.41) |

Note: t statistic value and intercept term are in brackets α the unit is the percent sign; *, *, * * They are significant at 10%, 5% and 1% significance levels respectively.

### 4.3 Comparison of Fama French three factor and five factor models

In order to compare the effectiveness of HML, RMW and CMA factors and the applicability of three factor model and five factor model, 2 × 3 The method is to calculate the factors. According to the order of Size from small to large and B/M from low to high, each dimension is divided into five equal parts on average. The two models are compared through the regression results of 25 Size-B/M portfolios, with the return rate of 25 portfolios as the explained variable. Table 5 reports the regression coefficients of different factors of the three-factor model and the five-factor model and the t statistics of the regression coefficients. SMB is significant in both models and a large number of research results have confirmed the significance of SMB factors. Due to the limited space, this paper omits the estimation results of SMB factors.

HML, RMW and CMA have no correlation, so there is no adverse effect caused by collinearity in the five-factor model. Through comparison, it is found that the coefficients of HML factor and RMW factor are significantly positive in the three factor model and the five factor model, except for the company with the lowest book to market value ratio of 20%, while the coefficients of CMA factor in the five factor model are not significant, indicating that the company's investment level has no impact on the stock return of American companies, and CMA factor cannot explain the portfolio return rate of American stock market. From the results of empirical analysis, American investors' value investment strategies mainly focus on the valuation level of stocks, looking for undervalued stocks rather than analyzing the company's development prospects and future investment value, and the investment level of listed companies is ignored.

**Table 6.** Comparison of Fama French three factor and five factor models.

| Three factor model: $R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + e_{it}$ | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| B/M | Low | 2 | 3 | 4 | High | Low | 2 | 3 | 4 | High |
| | | | a | | | | | t(a) | | |
| S | -0.41 | 0.28 | 0.19 | 0.46 | 0.49 | -2.61 | 2.24 | 2.45 | 5.69 | 3.71 |
| 2 | 0.01 | 0.32 | 0.21 | 0.19 | 0.16 | 0.08 | 3.84 | 2.44 | 2.73 | 1.95 |
| 3 | 0.02 | 0.28 | 0.20 | 0.23 | 0.24 | 0.27 | 2.95 | 2.11 | 2.43 | 2.08 |
| 4 | 0.28 | 0.31 | 0.21 | 0.20 | 0.07 | 3.05 | 3.30 | 2.03 | 1.91 | 0.53 |
| B | 0.38 | 0.28 | 0.32 | -0.14 | -0.03 | 7.59 | 3.64 | 3.46 | -1.41 | -0.19 |
| | | | b | | | | | t(b) | | |
| S | 1.17 | 0.99 | 0.92 | 0.86 | 0.92 | 32.92 | 33.85 | 49.99 | 46.16 | 30.11 |
| 2 | 1.15 | 0.98 | 0.94 | 0.92 | 1.08 | 48.70 | 50.74 | 47.07 | 56.07 | 57.39 |
| 3 | 1.12 | 1.01 | 0.96 | 0.99 | 1.07 | 52.42 | 45.51 | 43.17 | 45.47 | 39.95 |
| 4 | 1.08 | 1.01 | 1.00 | 1.02 | 1.13 | 51.87 | 45.96 | 41.53 | 41.52 | 40.02 |
| B | 0.98 | 0.91 | 0.91 | 1.03 | 1.21 | 84.28 | 51.61 | 42.91 | 46.01 | 32.83 |
| | | | s | | | | | t(s) | | |
| S | 1.36 | 1.35 | 1.03 | 1.06 | 1.03 | 27.40 | 33.34 | 40.29 | 40.71 | 24.11 |
| 2 | 1.03 | 0.90 | 0.68 | 0.77 | 0.92 | 31.26 | 33.46 | 24.26 | 33.47 | 35.12 |
| 3 | 0.77 | 0.55 | 0.35 | 0.43 | 0.52 | 25.85 | 17.89 | 11.48 | 14.20 | 13.75 |
| 4 | 0.47 | 0.19 | 0.12 | 0.22 | 0.23 | 16.24 | 6.23 | 3.72 | 6.48 | 5.93 |
| B | -0.26 | -0.18 | -0.17 | -0.22 | -0.21 | -16.29 | -7.32 | -5.87 | -6.93 | -4.12 |
| | | | h | | | | | t(h) | | |
| S | -0.28 | -0.02 | 0.33 | 0.54 | 0.73 | -5.82 | -0.60 | 13.21 | 21.13 | 17.35 |
| 2 | -0.28 | 0.20 | 0.50 | 0.65 | 0.85 | -8.56 | 7.51 | 18.25 | 28.52 | 32.83 |
| 3 | -0.36 | 0.21 | 0.48 | 0.69 | 0.90 | -12.17 | 6.87 | 15.63 | 22.94 | 24.26 |
| 4 | -0.36 | 0.29 | 0.50 | 0.62 | 0.87 | -12.53 | 9.72 | 15.14 | 18.38 | 22.43 |
| B | -0.29 | 0.15 | 0.37 | 0.73 | 0.86 | -18.49 | 6.20 | 12.59 | 23.85 | 16.94 |
| B/M | Low | 2 | 3 | 4 | High | Low | 2 | 3 | 4 | High |
| Five factor model: $R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_iSMB_t + h_iHML_t + r_iRMW_t + c_iCMA_t + e_{it}$ | | | | | | | | | | |
| | | | a | | | | | t(a) | | |
| S | -0.06 | 0.50 | 0.23 | 0.50 | 0.45 | -0.43 | 4.10 | 2.82 | 5.78 | 3.20 |
| 2 | 0.19 | 0.28 | 0.09 | 0.14 | 0.12 | 1.96 | 3.60 | 1.05 | 1.86 | 1.41 |
| 3 | 0.20 | 0.20 | 0.07 | 0.09 | 0.11 | 2.27 | 2.10 | 0.72 | 0.99 | 0.94 |
| 4 | 0.41 | 0.16 | 0.02 | 0.09 | 0.06 | 4.59 | 1.69 | 0.24 | 0.85 | 0.44 |
| B | 0.31 | 0.17 | 0.25 | -0.13 | 0.25 | 6.14 | 2.17 | 2.60 | -1.31 | 1.56 |
| | | | h | | | | | t(h) | | |
| S | -0.32 | -0.17 | 0.14 | 0.34 | 0.42 | -5.34 | -3.48 | 4.16 | 9.54 | 7.22 |
| 2 | -0.33 | 0.00 | 0.27 | 0.44 | 0.63 | -8.44 | 0.03 | 8.05 | 14.42 | 17.78 |
| 3 | -0.33 | 0.04 | 0.31 | 0.49 | 0.70 | -9.02 | 1.12 | 7.95 | 12.80 | 14.42 |
| 4 | -0.33 | 0.13 | 0.32 | 0.48 | 0.81 | -8.92 | 3.38 | 7.61 | 10.72 | 15.31 |
| B | -0.30 | 0.08 | 0.34 | 0.78 | 1.19 | -14.33 | 2.56 | 8.57 | 18.35 | 17.96 |
| | | | r | | | | | t(r) | | |
| S | -0.65 | -0.48 | -0.09 | -0.11 | -0.10 | -9.84 | -8.56 | -2.50 | -2.65 | -1.54 |
| 2 | -0.27 | 0.09 | 0.23 | 0.08 | 0.06 | -6.11 | 2.59 | 6.03 | 2.35 | 1.53 |
| 3 | -0.18 | 0.17 | 0.26 | 0.23 | 0.25 | -4.48 | 3.96 | 5.90 | 5.40 | 4.63 |
| 4 | -0.21 | 0.26 | 0.30 | 0.17 | -0.01 | -4.91 | 6.02 | 6.39 | 3.38 | -0.15 |
| B | 0.14 | 0.14 | 0.10 | 0.01 | -0.31 | 5.99 | 3.75 | 2.17 | 0.21 | -4.15 |
| | | | c | | | | | t(c) | | |
| S | -0.10 | 0.08 | 0.03 | 0.05 | 0.35 | -1.11 | 1.00 | 0.67 | 1.02 | 3.99 |
| 2 | -0.19 | -0.04 | 0.04 | 0.07 | 0.02 | -3.20 | -0.87 | 0.87 | 1.59 | 0.46 |
| 3 | -0.34 | -0.01 | 0.04 | 0.09 | 0.03 | -6.16 | -0.13 | 0.62 | 1.56 | 0.46 |
| 4 | -0.15 | 0.11 | 0.15 | 0.10 | 0.05 | -2.63 | 1.79 | 2.35 | 1.53 | 0.59 |
| B | 0.03 | 0.16 | 0.07 | -0.03 | -0.50 | 0.96 | 3.26 | 1.18 | -0.41 | -5.04 |

## 5. Conclusions

The practical experience of the stock market has promoted the continuous enrichment and improvement of the asset pricing theoretical system, which has evolved from the original CAPM single factor model to the multi factor model. Fama French five factor model covers the RMW factor reflecting the profitability of the company and the CMA factor reflecting the investment level under the existing research results. This paper finds that HML becomes redundant variable through the correlation test and redundancy test of factors. Fama and French explained that the profit factor RMW and the investment factor CMA contain most of the information about the value factor HML. Finally, in order to verify whether the five-factor model is better than the three-factor model after 1993, this paper uses the monthly return rate data and financial data of the U.S. stock market from July 1993 to October 2021 for empirical analysis. The empirical results show that the profitability and investment style effects are significant, that is, the five-factor model is superior to the three-factor model.

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