# Comparison of Explanatory Power of Excess Return between 3-Factor, 4-Factor and 5-Factor Model in China Funds Market

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**ABSTRACT**

The momentum factor was added to the four-factor model as an indicator based on the three-factor model. Fama-French also added RMW and CMA, two factors representing the company's profitability and investment level, to obtain the five-factor model on the basis of the original three-factor model. Obviously, the explanatory power of each factor model varies from market to market. Especially, China's capital market is greatly influenced by national macro-control, which makes the fund performance of China's market different from that of most other countries. As a result, the explanatory ability of which factor model is stronger in China cannot be inferred from the experience of other countries. In this paper, through the data processing of China's A-share market fund, and the empirical test we do, we found that the impact of RMW factor in China's market is obvious. As a result, the five-factor model has greater explanatory power to explain the excess return in China's fund market. Besides, this paper provides some reference for the theoretical and empirical research of asset pricing and factor model.

***Keywords:*** *Fama-French three-factor model; Carhart four-factor model; Fama-french five-factor model; China's A-share market*

## 1. INTRODUCTION

In 1993, Fama-French [1] proposed the Fama-French 3-factor model, which used the market asset portfolio Factor, firm size Factor and book-to-market ratio Factor to explain the U.S. stock market return rate and bond return rate. In 2015, the profit factor RMW and investment factor CMA were added on the basis of the three-factor model to put forward the five-factor model. They [2] confirmed the validity of the five-factor model through more than 50 years of MARKET data in the United States, and proposed and obtained the empirical result that HML becomes a redundant when RMW and CMA are added.

Factor model construction and empirical research has always been a hot topic and research direction in Chinese and foreign academic circles. At present, the empirical research on factor model in foreign countries is based on mature stock markets in Europe and America. In recent years, China's fund market has been developing steadily, but the transaction situation, investor maturity, information environment and fund capacity of China's fund market are obviously different from those of foreign markets. Therefore, it is necessary to study the applicability of the factor model in the Chinese market and measure the fund performance of excess returns. From the current academic research of China's A-share market, there is no horizontal comparison of the three traditional models at the same time.

Yang Xin and Chen Zhanhui [3] selected the data of A-share market from May 1995 to December 2001 and found that there were scale effect and value effect in The Chinese market. The stock portfolios of companies with small scale and high book value of shareholders' equity were more likely to obtain excess returns. Zhao Shengmin, Yan Honglei and Zhang Kai [4] found that the explanatory power of the five-factor model varies from market to market. Through empirical analysis of transaction data and financial data of China's A-share market, they found that the market value effect and value

 

effect of China's stock market are obvious, while RMW and CMA are not conducive to the interpretation of the return rate of stock portfolio. Yu yun [5] also concludes that Corporate stock returns are not significantly affected by profitability and investment style of a fund manager.

Therefore, whether the traditional factor model is suitable for the Chinese market, whether the latest five-factor model has a stronger ability to explain the fund market, which factor has a greater impact on the performance of Chinese funds, and how to further find a factor model suitable for China's A-share fund market need to be analyzed and verified.

This paper is divided into several parts: Besides the introduction and abstraction in the first part, the second part is the description and definition of three research factor models. The third part is data processing and research results. The fourth part is empirical analysis and comparison. The fifth part is the conclusion.

The main contribution of this paper lies in: combining our country fund data and yields situation, we will process the sets of data of the funds that we filtered out and use regression equation to establish relationship between different factors and specific excess return. By using the fund yield as the measurement standard, we compare the fund performance with each factor model in a horizontal and systematic way and the use GRS joint test to observe which factor model has the best performance in the Chinese market and has a stronger ability to explain the fund excess return.

## 2. METHOD

### *2.1. Model Description and Factor Definition*

Fama-french three-factor model:

In the study of Fama-French and CAPM, it was found that beta value of stock market could not fully explain the difference of different returns. Fama-French [1] suggested that value stocks with low P/B and stocks with smaller capitalization scale had a higher return than that of other stocks in the market. Therefore, SMB and HML, two factors proposed by them, have a strong ability to capture the average return rate of stocks, and absorb the ability of leverage effect to explain excess return to a certain extent.

Therefore, Fama-French proposed a three-factor pricing model to explain the excess return of investment portfolio by using market value factor, size factor (SMB) and book price/earnings ratio index (HML)

$$Rit-Rft= \alpha i+\beta i(Rmt-Rft) + siSMBt+ hiHMLt+\varepsilon it \quad (1)$$

Rft is the risk-free rate of return at time T;

Rmt represents the market rate of return at time T;

Rit is the rate of return of asset I at time T;

Rmt-rft is the market risk premium,

SMBt is Small minus Big of the Size factor of time T, and HMLt is High minus Low of the book-to-market factor of time T.

Carhart four-factor model:

The three-factor model does not represent the end of the development of capital pricing model. Although the three-factor model contains the factors that affect a great part of the excess return, there are still many unexplained parts of the excess return, and there are still unknown factors in the factor model, such as momentum or volatility factors. Carhart [6] put forward the four-factor model by adding momentum factor (UMD) on the premise of maintaining the three-factor model and original influencing factors, and its explanatory ability for fund performance has been greatly improved compared with the former. The momentum effect means that if a portfolio has a high return performance in the past period, the future returns will continue to move toward the original change. This is a useful explanation for the "trend effect" in markets. UMD is calculated as follows: over a period, the top 30% portfolio return with the highest cumulative return minus the bottom 30% portfolio return. The general form of the four-factor model is:

$$Rit-Rft= \alpha i+\beta i(Rmt-Rft) + siSMBt+ hiHMLt+uiUMD+\varepsilon it \quad (2)$$

UMD is the return gap between high-yielding and low-yielding stocks, and other letters have the same meaning as those in the three-factor model.

Fama-french five-factor model:

The three-factor model cannot explain the differences in stock returns caused by corporate profitability and investment ability patterns. According to Fama-French's [7] dividend discount model, the future return of stocks can be explained and affected by expected return and expected investment ability to a certain extent. The change of future assets brought by the growth rate of total assets will affect the future return of the stock, which also determines the value of the company. And the company's ability to make investment decisions also determines the value of the company. Therefore, the investment level and profitability can be used as factors to explain the stock performance. As a result, based on three factors, Fama & French added RMW, which represents profitability, and CMA, which represents investment level. The general form of the five-factor model is:

$$Rit-Rft=\alpha i+\beta i(Rmt-Rft)+siSMBt+hiHMLt+riRMW+ciCMA+\varepsilon it \quad (3)$$

RMW represents the difference in returns between a portfolio of more profitable companies and a portfolio of less profitable companies

CMA represents the difference in returns between a portfolio of companies with low investment ability and a portfolio of companies with high investment ability.

### *2.2. Research Methods*

This paper adopts empirical analysis method to simulate Carhart's [6] method of comparing CAPM model and four-factor model in explaining fund performance with regression analysis and deduces the explanatory ability of three-factor model, four-factor model and five-factor model in explaining excess returns in Chinese funds market. However, based on the actual situation, we did not personally hold the selected funds for one year as Carhart did to obtain the fund performance data. Instead, we obtained the fund portfolio ranked according to the fund performance based on the average monthly returns of each fund in recent 5 years. By analyzing the relationship between the excess return and the factors of the portfolio in each model, we come out the explanatory ability of each factor between different models for excess return, and the preliminary judgment of explanatory ability of these 3-factor model. We use GRS test to investigate whether the Alpha of the portfolio in each model is jointly to zero, which could verify our preliminary conclusion.

### *2.3. Data Source and Processing*

Li Zhibing, Yang Guangyi, Feng Yongchang and Jing Liang [8] pointed out that because of the emergence of tradable and non-tradable shares in the early stage of Chinese stock market, the accuracy of a factor model's measurement of A-share market may vary in different periods. Therefore, when we study the application of models applicable to foreign mature markets in the Chinese market, it will be more reasonable to use samples after the stock reform for calculation and analysis. So,we obtained the monthly income data of 800 Chinese A-share funds from The Wind website from January 2015 to December 2020. After screening, we removed the funds lacking part of monthly income data, leaving 270 funds. Monthly HML, MKT, HML, UMD,CMA and RMW were obtained from the CSMAR Database.

We will average monthly income of these funds in accordance with the descending into 10 groups, then the first group will be the highest and the lowest 10 group study is subdivided into three groups, respectively, through the python operations, we will return on each sort of fund portfolio monthly yields and the factor that month data regression analysis, the correlation coefficient of each factor, Alpha is then calculated using a separate formula for each model. Then the alpha value of each model was compared, and the relationship between alpha and each factor was compared horizontally and vertically, so as to analyze the performance measurement ability of the three models. Of course, the correlation between each factor also needed to be included in the analysis to evaluate the reliability of data. In order to further improve the accuracy, special analysis is made on the extreme data. For example, by comparing the data of 1A-10C spread portfolio, the relationship between the excess return of the overall fund and the change of factor coefficient can be obtained, or by comparing the data of 9-10 spread, Study whether there are special changes in the factor coefficients of the under-performing fund portfolios.

We arranged the average monthly returns of these funds into 10 groups in descending order, then divided the highest group into three groups and the lowest group into three groups for further study. Through Python operation, we conducted regression analysis between the monthly return rate of each fund portfolio and the factor data of the month, figured out the correlation coefficient of each factor, and worked out alpha through the respective formula of each model. Then the alpha value of each model was compared, also its relationship with each factor was compared horizontally and vertically, so as to analyze the performance measurement ability of the three models. Of course, the correlation between each factor also needed to be included in the analysis to evaluate the reliability of data. To improve the accuracy, we analyzed extreme data separately. For example, by comparing the data of 1A-10C spread portfolio, we obtained the relationship between the excess return of the overall fund and the change of factor coefficient, or by comparing the data of 9-10 spread, we will observe whether there are special changes in the factor coefficients of the under-performing fund portfolios.

## 3. RESULT AND DISCUSSION

### *3.1. Cross-correlation of 6 Factors*

**TABLE I.** CROSS-CORRELATION OF 6 FACTORS

| Cross-correlation | | | | | | |
|---|---|---|---|---|---|---|
| | MKT | SMB | HML | RMW | CMA | MOM |
| MKT | 1.00 | 0.36 | -0.47 | -0.48 | -0.01 | 0.22 |
| SMB | | 1.00 | -0.76 | -0.77 | 0.05 | -0.32 |
| HML | | | 1.00 | 0.53 | 0.37 | 0.03 |
| RMW | | | | 1.00 | -0.38 | 0.38 |
| CMA | | | | | 1.00 | -0.14 |
| MOM | | | | | | 1.00 |

The table above shows the cross-correlation of 6 factors from 3 kinds of factor-model. The correlation coefficients of each factor are 0.36, -0.47, -0.48, -0.01, 0.22, 0.05, -0.32, 0.53, 0.37, 0.03, -0.38, 0.38 and -0.14 respectively, and the correlation was in the acceptable range, which preliminarily indicated that the model was reasonable. However, the cross-correlation between RMW and SMB is -0.77, and the cross-correlation between HML and SMB is -0.76, which are relatively high. In some extent, it is because that the Chinese government regulates the Macro-economy, sometimes

making certain factors correlated, so it is very popular for Chinese scholars to investigate some other factors with China's characteristics to avoid it. However, in general, from the table above, these models are reasonable.

### *3.2. Summary Statistics of Performance Measurement Model*

**TABLE II.** STATISTICS OF 3-FACTOR MODEL

| | | Three-factor Model | | | | |
|---|---|---|---|---|---|---|
| Portfolio | Excess Return | Alpha | MKT | SMB | HML | R-squared |
| 1A | 2.20% | 0.0177*** | 0.877*** | -0.437*** | -0.894*** | 0.846 |
| | | (-0.00346) | (-0.0548) | (-0.138) | (-0.177) | |
| 1B | 1.91% | 0.0132*** | 0.820*** | -0.106 | -0.998*** | 0.932 |
| | | (-0.00243) | (-0.0499) | (-0.0947) | (-0.119) | |
| 1C | 1.70% | 0.0119*** | 0.815*** | -0.157** | -0.876*** | 0.947 |
| | | (-0.0019) | (-0.0372) | (-0.067) | (-0.0867) | |
| 1 | 1.94% | 0.0143*** | 0.837*** | -0.233** | -0.923*** | 0.938 |
| | | (-0.00209) | (-0.0399) | (-0.0929) | (-0.113) | |
| 2 | 1.37% | 0.00837*** | 0.868*** | -0.132* | -0.846*** | 0.96 |
| | | (-0.00176) | (-0.0301) | (-0.073) | (-0.0864) | |
| 3 | 1.15% | 0.00648*** | 0.859*** | -0.145** | -0.794*** | 0.964 |
| | | (-0.00165) | (-0.0265) | (-0.0546) | (-0.0633) | |
| 4 | 0.97% | 0.00623*** | 0.924*** | -0.213*** | -0.474*** | 0.979 |
| | | (-0.00115) | (-0.0205) | (-0.0379) | (-0.0451) | |
| 5 | 0.84% | 0.00530*** | 0.930*** | -0.194*** | -0.357*** | 0.978 |
| | | (-0.00115) | (-0.0251) | (-0.0349) | (-0.0523) | |
| 6 | 0.66% | 0.00386*** | 0.899*** | -0.160*** | -0.295*** | 0.983 |
| | | (-0.000974) | (-0.0225) | (-0.0292) | (-0.0382) | |
| 7 | 0.55% | 0.00265*** | 0.934*** | -0.142*** | -0.254*** | 0.987 |
| | | (-0.000885) | (-0.0199) | (-0.0282) | (-0.0489) | |
| 8 | 0.42% | 0.0014 | 0.926*** | -0.0256 | -0.153*** | 0.987 |
| | | (-0.000909) | (-0.0196) | (-0.0245) | (-0.0419) | |
| 9 | 0.27% | -0.0000873 | 0.955*** | 0.0106 | -0.0932* | 0.982 |
| | | (-0.00109) | (-0.0234) | (-0.0255) | (-0.0471) | |
| 10 | 0.13% | -0.0018 | 0.978*** | -0.0263 | 0.259*** | 0.953 |
| | | (-0.00167) | (-0.0399) | (-0.0443) | (-0.083) | |
| 10A | 0.02% | 0.000468 | 0.870*** | -0.0406 | 0.176*** | 0.971 |
| | | (-0.00118) | (-0.0226) | (-0.0288) | (-0.054) | |
| 10B | -0.37% | 0.00000233 | 0.983*** | -0.114 | 0.363*** | 0.903 |
| | | (-0.00231) | (-0.0511) | (-0.0726) | (-0.122) | |
| 10C | -0.07% | -0.00587*** | 1.081*** | 0.0758 | 0.239* | 0.911 |
| | | (-0.00266) | (-0.0653) | (-0.0751) | (-0.123) | |
| 1-10 spread | 1.81% | 0.0161 | -0.141 | -0.2067 | -1.182 | |
| 1A-10C spread | 2.27% | 0.02357 | -0.204 | -0.5128 | -1.133 | |
| 9-10 spread | 0.14% | 0.0017127 | -0.023 | 0.0369 | -0.3522 | |

**TABLE III.** STATISTICS OF 4-FACTOR MODEL

| | | Four-factor Model | | | | | |
|---|---|---|---|---|---|---|---|
| Portfolio | Excess Return | Alpha | MKT | SMB | HML | UMD | R-squared |
| 1A | 2.20% | 0.0148*** | 0.809*** | -0.265** | -0.785*** | 0.260*** | 0.87 |
| | | (-0.00331) | (-0.0586) | (-0.123) | (-0.163) | (-0.0768) | |
| 1B | 1.91% | 0.00993*** | 0.745*** | 0.0858 | -0.876*** | 0.289*** | 0.958 |
| | | (-0.00218) | (-0.0457) | (-0.0594) | (-0.0876) | (-0.0501) | |
| 1C | 1.70% | 0.00951*** | 0.761*** | -0.0204 | -0.789*** | 0.206*** | 0.963 |
| | | (-0.00186) | (-0.0402) | (-0.0562) | (-0.0744) | (-0.0508) | |
| 1 | 1.94% | 0.0114*** | 0.772*** | -0.0665 | -0.817*** | 0.252*** | 0.96 |
| | | (-0.00189) | (-0.0403) | (-0.0688) | (-0.0909) | (-0.0499) | |
| 2 | 1.37% | 0.00648*** | 0.824*** | -0.022 | -0.776*** | 0.166*** | 0.969 |
| | | (-0.00165) | (-0.033) | (-0.0588) | (-0.0704) | (-0.0406) | |
| 3 | 1.15% | 0.00524*** | 0.830*** | -0.0726 | -0.749*** | 0.109*** | 0.969 |
| | | (-0.00162) | (-0.0315) | (-0.0529) | (-0.0601) | (-0.0367) | |
| 4 | 0.97% | 0.00568*** | 0.911*** | -0.181*** | -0.454*** | 0.0479* | 0.98 |
| | | (-0.00117) | (-0.0221) | (-0.0412) | (-0.0467) | (-0.0277) | |
| 5 | 0.84% | 0.00442*** | 0.910*** | -0.143*** | -0.325*** | 0.0771*** | 0.981 |
| | | (-0.00118) | (-0.0252) | (-0.0342) | (-0.0453) | (-0.0226) | |
| 6 | 0.66% | 0.00366*** | 0.895*** | -0.148*** | -0.287*** | 0.017 | 0.983 |
| | | (-0.00105) | (-0.0228) | (-0.0338) | (-0.0404) | (-0.0221) | |
| 7 | 0.55% | 0.00231** | 0.927*** | -0.122*** | -0.241*** | 0.0301* | 0.987 |
| | | (-0.000969) | (-0.0213) | (-0.0261) | (-0.0441) | (-0.0176) | |
| 8 | 0.42% | 0.00113 | 0.920*** | -0.00996 | -0.143*** | 0.0236 | 0.987 |
| | | (-0.00101) | (-0.0212) | (-0.0258) | (-0.0382) | (-0.0197) | |
| 9 | 0.27% | -8.65E-05 | 0.955*** | 0.0105 | -0.0933** | -0.00007 | 0.982 |
| | | (-0.00125) | (-0.0266) | (-0.0257) | (-0.0431) | (-0.0239) | |
| 10 | 0.13% | -0.000742 | 1.002*** | -0.0879** | 0.220*** | -0.0929** | 0.957 |
| | | (-0.00193) | (-0.0406) | (-0.0426) | (-0.0768) | (-0.0403) | |
| 10A | 0.02% | 0.000616 | 0.873*** | -0.0491 | 0.170*** | -0.013 | 0.972 |
| | | (-0.00135) | (-0.0271) | (-0.0302) | (-0.0488) | (-0.0288) | |
| 10B | -0.37% | 0.00167 | 1.021*** | -0.211*** | 0.301** | -0.146*** | 0.914 |
| | | (-0.00255) | (-0.0495) | (-0.0683) | (-0.114) | (-0.0518) | |
| 10C | -0.07% | -0.00451 | 1.112*** | -0.00339 | 0.189 | -0.119** | 0.917 |
| | | (-0.00295) | (-0.0642) | (-0.0776) | (-0.121) | (-0.0594) | |
| 1-10 spread | 1.81% | 0.012142 | -0.23 | 0.0214 | -1.037 | 0.3449 | |
| 1A-10C spread | 2.27% | 0.01931 | -0.303 | -0.26161 | -0.974 | 0.379 | |
| 9-10 spread | 0.14% | 0.0006555 | -0.047 | 0.0984 | -0.3133 | 0.09283 | |

**TABLE IV.** STATISTICS OF 5-FACTOR MODEL

| | | Five-factor Model | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Portfolio | Excess Return | Alpha | MKT | SMB | HML | RMW | CMA | R-squared |
| 1A | 2.20% | 0.0153*** | 0.932*** | -0.283* | -0.968*** | 0.619* | 0.322 | 0.854 |
| | | (-0.00381) | (-0.0627) | (-0.147) | (-0.21) | (-0.344) | (-0.268) | |
| 1B | 1.91% | 0.0104*** | 0.884*** | 0.211* | -0.814*** | 0.606** | -0.159 | 0.946 |
| | | (-0.00236) | (-0.0431) | (-0.109) | (-0.135) | (-0.239) | (-0.165) | |
| 1C | 1.70% | 0.00895*** | 0.885*** | 0.128 | -0.758*** | 0.630*** | -0.0202 | 0.96 |
| | | (-0.00198) | (-0.0319) | (-0.0986) | (-0.103) | (-0.224) | (-0.129) | |
| 1 | 1.94% | 0.0121*** | 0.900*** | 0.0102 | -0.832*** | 0.576** | 0.0213 | 0.947 |
| | | (-0.00214) | (-0.0393) | (-0.111) | (-0.125) | (-0.224) | (-0.136) | |
| 2 | 1.37% | 0.00620*** | 0.920*** | 0.109 | -0.698*** | 0.452*** | -0.145 | 0.969 |
| | | (-0.0017) | (-0.0323) | (-0.0863) | (-0.102) | (-0.152) | (-0.109) | |
| 3 | 1.15% | 0.00471*** | 0.900*** | 0.0653 | -0.619*** | 0.293** | -0.273*** | 0.973 |
| | | (-0.00143) | (-0.0267) | (-0.0751) | (-0.0751) | (-0.123) | (-0.0919) | |
| 4 | 0.97% | 0.00496*** | 0.942*** | -0.0766 | -0.340*** | 0.169** | -0.211*** | 0.984 |
| | | (-0.00107) | (-0.0235) | (-0.0491) | (-0.0585) | (-0.0802) | (-0.0793) | |
| 5 | 0.84% | 0.00396*** | 0.965*** | -0.0619 | -0.301*** | 0.296*** | -0.00447 | 0.982 |
| | | (-0.00125) | (-0.0331) | (-0.0474) | (-0.077) | (-0.087) | (-0.102) | |
| 6 | 0.66% | 0.00311*** | 0.917*** | -0.0865** | -0.259*** | 0.148** | -0.0226 | 0.984 |
| | | (-0.00108) | (-0.0267) | (-0.0418) | (-0.056) | (-0.0733) | (-0.0777) | |
| 7 | 0.55% | 0.00217** | 0.946*** | -0.0922** | -0.219*** | 0.0839 | -0.0348 | 0.987 |
| | | (-0.00105) | (-0.0223) | (-0.0423) | (-0.0711) | (-0.0878) | (-0.0749) | |
| 8 | 0.42% | 0.00105 | 0.934*** | -0.00047 | -0.162*** | 0.0951 | 0.0465 | 0.987 |
| | | (-0.00116) | (-0.0193) | (-0.0412) | (-0.0577) | (-0.113) | (-0.0789) | |
| 9 | 0.27% | 0.000151 | 0.949*** | -0.045 | -0.175*** | -0.00875 | 0.14 | 0.983 |
| | | (-0.00137) | (-0.0203) | (-0.0464) | (-0.0656) | (-0.136) | (-0.0899) | |
| 10 | 0.13% | -0.00155 | 0.972*** | -0.0613 | 0.222** | -0.0341 | 0.0618 | 0.953 |
| | | (-0.00217) | (-0.0365) | (-0.0777) | (-0.0972) | (-0.212) | (-0.141) | |
| 10A | 0.02% | 0.000256 | 0.873*** | -0.0427 | 0.126** | 0.0898 | 0.126 | 0.973 |
| | | (-0.00145) | (-0.0201) | (-0.0474) | (-0.0597) | (-0.135) | (-0.0806) | |
| 10B | -0.37% | -0.000534 | 0.997*** | -0.0449 | 0.429*** | 0.0909 | -0.107 | 0.904 |
| | | (-0.00291) | (-0.05) | (-0.115) | (-0.153) | (-0.304) | (-0.213) | |
| 10C | -0.07% | -0.00518 | 1.062*** | -0.025 | 0.144 | -0.128 | 0.13 | 0.913 |
| | | (-0.00348) | (-0.0668) | (-0.134) | (-0.136) | (-0.352) | (-0.23) | |
| 1-10 spread | 1.81% | 0.01365 | -0.072 | 0.0715 | -1.054 | 0.6101 | -0.0405 | |
| 1A-10C spread | 2.27% | 0.02048 | -0.13 | -0.258 | -1.112 | 0.747 | 0.192 | |
| 9-10 spread | 0.14% | 0.001701 | -0.023 | 0.0163 | -0.397 | 0.02535 | 0.0782 | |

It is obvious that the adjusted R squares of these 16 fund portfolio samples are almost higher than 0.9 except that of 1A group ( higher than 0.8 ), which means these 3 models are eligible to explain these samples and their performance.

The alpha of the three factor models is relatively small. The alpha of the first nine portfolios of the three-factor model and the five-factor model are positive, and that of the tenth portfolio is negative. In four-factor model, alpha of groups 9 and 10 are negative, and alpha of the first eight groups are positive. This means that most portfolios beat the market average. Among the ten fund portfolios, the alpha of seven fund portfolios are significant, indicating that these alpha measurements are relatively consistent with the results of third-party rating agencies; while if the alpha is not significant, it indicates that there are some mismatches with the tests of third-party rating agencies, but the evaluation criteria among rating agencies are inconsistent.

Excess return and Alpha are almost monotonically decreasing from group 1 to group 10, which preliminarily indicates that Alpha is positively correlated with excess return rate. The average return ranking of the mutual funds of the portfolio shows strong changes, as shown in the table portfolio 1A, which contains the top funds (average of 27 funds), outperformed portfolio 10C bottom funds at 2.28% per month. The sub portfolios of the top decile show a modest spread of 50 basis points per month (170to 220), but the spread in the bottom decile is a substantial 9 basis points. Further, the bottom thirtieth of the middle year's funds seem to demonstrate anomalously poor returns.

By observing the three-factor model, the overall significance of MKT coefficient is high, and both are greater than 0, indicating that the fund performance is positively correlated with the overall trend of market change. SMB coefficient is negative in most of the portfolios in the model, indicating that the overall performance of the fund is less affected by the performance of small-cap stocks. HML coefficient has a high significance and is negative in the top nine portfolios in terms of return rate in the three-factor model, and the data of 1-10 spread is -1.182, indicating that fund performance is less affected by the performance of value stocks in general, and the value of HML coefficient decreases with the increase of excess return rate of portfolios. It shows that the higher the excess return rate is, the less the fund is affected by the performance of value stocks.

By observing the portfolio data of the four-factor model, it is found that the UMD coefficient has a high significance and is positive in the portfolio with the top nine returns in this model, indicating that the performance of the overall fund is greatly affected by the performance of blue chips. In general, the UMD of 1-10 spread is 0.3449, and the portfolio with a lower return rate has a lower UMD coefficient. In the tenth group, UMD is negative, and the UMD of 9-10 spread is 0.0928, indicating that the fund portfolio with poor performance is less affected by the performance of blue-chip stocks. It may also be due to a relatively big correlation between UMD and SMB, resulting in certain errors.

By observing the five-factor model data. RMW coefficient of the first eight groups is positive, indicating that the overall fund performance is positively correlated with stocks with high profitability. However, RMW coefficient of the ninth and tenth groups is negative close to 0, and the RMW of 1-10 spread is 0.6106. It shows that the returns of the fund portfolio with poor performance are greatly affected by the performance of stocks with poor profitability. The coefficient of CMA is close to zero overall but is positive for the first and last two portfolios and negative for the rest. It shows that in

the middle performance fund portfolio, its performance weakly influenced by the performance of the company with higher investment level

### *3.3. Empirical Analysis of Performance Explanatory Ability of Three Models*

The coefficients of the MKT factor, SMB factor and HML factor are generally not significantly different in these three models, which means that these funds are similarly affected by market trends, the performance of small-cap stocks and the performance of value stocks. The MKT coefficient is significantly greater than zero. More importantly, the HML coefficient is significantly less than zero, which indicates that HML still has a strong explanatory power for excess returns, but this result is different from Fama-French [2]: The newly introduced CMA and RMW factors in the five-factor model have already covered most of the information of HML factors, making the HML factor become a redundant variable. This shows that in China's capital market, the size of stock companies is not completely linked to their investment level and profitability.

In addition, UMD coefficient is positive, and its significance is high, indicating that fund performance is greatly affected by the continuity of returns of blue-chip stocks. It indicates that UMD, as an additional factor introduced on the basis of the three-factor model, has a strong ability to explain excess returns, so the four-factor model is superior to the three-factor model. The RMW factor is negative in the last two fund portfolios, but positive and significant in the first eight groups. From the 1-10 spread, generally the RMW factor coefficient can indicate that the fund performance is greatly affected by stocks with strong profitability. However, due to the low significance of the coefficient of CMA factor and the lack of regular trend from group 1 to group 10, it is difficult to judge whether CMA factor can partially explain the excess returns. Overall, it can be seen that the explanatory ability of the four-factor model and the five-factor model is better than that of the three-factor model. However, since it is impossible to determine which RMW factor or UMD factor has the stronger explanatory ability for excess returns, GRS test is needed to decide the explanatory ability of the final four-factor model and five-factor model.

### *3.4. GRS test*

**TABLE V.** DATA OF GRS TEST

| | GRS VALUE | P VALUE |
|---|---|---|
| Three-factor Model | 5.62345 | 7.55E-0.6 |
| Four-factor Model | 5.38047 | 1.38E-0.5 |
| Five-factor Model | 4.20913 | 0.000216 |

GRS test was invented by Gibbons, Ross & Shanken [9] as an accurate F statistic to test whether the regression alpha intercept of N assets in the stock asset risk factor pricing model is jointly 0. The original hypothesis is H0: alpha1=alpha2=.... =alphaN=0. According to Bahl [10], a bigger GRS value means that it has bigger possibility of the intercept to be jointly unequal to 0, so the absolute value of alpha is larger, indicating that the explanatory power of the model is worse. And if P value of this test is large, the original hypothesis cannot be rejected, indicating that all alpha is considered to be zero, which means that those factors in asset pricing model can basically explain excess returns.

We collate 10 sets of data (not 16 sets because every sub-set of data will correspond the same monthly factor), and work out 10 time series of alpha about these investment portfolios. Then, we use GRS test by Stata to test whether the alpha intercept of these 10 portfolios is jointly to 0.

According to our result, 3-factor model has the highest GRS value, which is 5.62345, then 4-factor models have a lower GRS value as 5.38047, and 5-factor model has the lowest one as 4.2091. Of course, P value of GRS is different, from 3-factor model to 5-factor model, their P value decrease progressively. As lower the P value is, the null hypothesis will be rejected to a greater extent. So, in conclusion, in this respect, 5-factor model has the best explanatory power of the alpha, then 4-factor model and 3 factor respectively.

## 4. CONCLUSION

This paper selects the monthly return data of 270 Chinese a-share funds from January 2015 to December 2020. Carhart [6] method was used to test the applicability of three-factor, four-factor, and five-factor models in China's stock market. The Fama-French four-factor model is developed from the Fama-French three-factor model, which increases the influence of momentum factor on fund returns. Similarly, the Fama-French five-factor model is also developed from the Fama-French three-factor model. It increases the influence of profit factor and investment factor on fund performance and can evaluate fund performance more comprehensively. This study shows that: first, after the horizontal comparison and empirical test of the three factor models, it can be found that the MTK factor, RMW factor, UMD factor and HML factor in the Chinese market have a significant impact on excess returns, but the CMA factor and SMB factor have no significant impact. Second, the five-factor model has the strongest ability to explain the excess returns of China's A-share funds. Compared with the three-factor model and Carhart's four-factor model, the five-factor model performs better. However, the four-factor model has a stronger ability to explain excess returns than the three-factor model. In general, according to our research, from the perspective of China's fund market, choosing the five-factor model as the fund performance measurement model has higher accuracy.

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