# Analysis of Chinese Market Based on Fama and French Five-Factor Model

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**Abstract:** Studies based on the asset pricing model are popular in the academic financial field; many researchers produce mixed results by constructing and improving factor models. However, Fama and French five-factor model (2015) is seldom used in the Chinese stock market. This paper constructs the Fama and French five-factor model, confirming that the size effect strongly influences the Chinese stock market between 1994 and 2021, while the value factor is redundant for the Chinese market. Plus, several analyses in the paper indicate different exchanges where stocks are listed have little influence on monthly returns; A-share and B-share have similar monthly returns in the Chinese stock market. Further analysis also discusses the relationship between the size factor and the monthly return of the SME index.

**Keywords:** Fama and French five-factor model, Chinese stock market, Shenzhen Small Medium Enterprise Board (SME), Exchange Stocks, Markets.

## 1. INTRODUCTION

The Capital Asset Pricing Model is a single-factor model that portrays the relationship between systematic risk and expected return for assets, especially stocks. Sharpe [1] and Lintner [2] developed this model, so the mean-variance model is transformed into a market-clearing asset-pricing model. According to their theory, the only factor that influences the return is the beta. The disadvantage of this model is that it only has one risk factor, but the real market is much more complicated; the return depends on various reasons. The Fama and French three-factor model was firstly proposed in 1993. They found only the value of beta cannot explain the differences in returns between stocks. While market value, book-to-market value ratio, and a price-to-earnings ratio of listed companies can be supplementary for explaining the difference in stock returns. Carhart [3] added a sectional momentum factor in the three-factor model. Novy-Marx [4] proposed another four-factor model, which contains a Profitability-Minus-Unprofitability element. Besides, this model also includes the Market Risk

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factor, High-Minus-Low factor, and Up-Minus-Down factor. Interestingly, Novy-Marx used UMD to represent the momentum factor. Fama and French five-factor model [5] added the profitability factor and the investment factor based on the three-factor model. Currently, the five-factor model is widely used in the financial market forecast. The previous studies proved the significance of the Fama and French five-factor model is greater than the three-factor model.

### 1.1 Literature Review

Chinese stock markets are different from European and American stock markets. They have different investor structures, different trading systems, and different share capital outstanding. Guo et al. [6] tested the Fama and French five-factor model for the Chinese stock market. They find that the Chinese stock market has a strong profitability pattern in average return but a weak investment pattern. Plus, they also realize the investment factor CMA is redundant in the Chinese stock market. Hu, Chen, Shao, Wang [7] explore the size (SMB) and value (HML) factors in the cross-section of returns for the Chinese stock market. They find in both time-series regressions and Fama-MacBeth cross-sectional tests, SMB is the most vital factor in explaining the cross-section of Chinese stock returns.

### 1.2 Objectives

In the early 1990s, state-owned enterprises were successfully converted into joint-stock corporations, and two stock markets were established. To address the issues caused by non-tradable shares, a reform was enacted in 2005 to unwind these shares and make a portion of them tradable.

Since the Fama and French five-factor model has a good performance in the Chinese stock market. Chapter two analyzes Fama and French five factors in the Chinese stock market. In chapter three, mainly focuses on the SME board, comparing the average monthly return of big-size firms and small-size firms. In addition, the paper will discover the impact of A and B shares, also the impact of different Stock Exchanges on the average return of the whole market. The goal is to compare and analyze the Chinese stock market, providing insights and investing recommendations to investors and letting them have a better understanding of the Chinese market.

### 1.3 Data and sample construction

To address the needs of capital market reform, liberalization, and stable development, the Chinese stock market has witnessed several significant changes. The study considers samples that include MKT, SMB, HML, RMW, and CMA of A shares and B shares of both Shenzhen and Shanghai Stock Exchanges from January 1994 to September 2021. All related data are directly or indirectly from databases CSMAR and RESSET. The constructions of SMB and HML are followed by Fama and French [8]. The construction of SMB is to use the circulating market value to sort in June of t year and calculate the (tradable market value-weighted and equal-weighted) income of the small-cap stock portfolio and the large-cap stock portfolio from July to December of year t and January to June of year t+1. The difference in rate. The construction of HML is to use the book-to-market value ratio of t-1 to sort in June of year t and calculate the combination of high book-to-market value ratio and low book-to-market value ratio from July to December of year t and January to June of year t+1. The difference in

the return rate of the portfolio (weighted and equal-weighted by the market value of circulation). Plus, to construct RMW and CMA factors, the paper strictly follows the previous study (Fama and French 2015) [9]. RMW construction uses profitability in June of t (calculation method of profitability: operating income in December of t-1 minus operating costs, interest expenses, sales expenses, management expenses, and book value in December of t-1 Calculate the difference between the high-profit stock portfolio and the low-profit portfolio (weighted by market capitalization and equal weight) from July to December of year t and January to June of year t+1. CMA construction uses the investment level in June of t year (calculation of investment level: the total newly added assets in fiscal year t-1 divided by the total assets at the end of fiscal year t-2) for sorting, and calculate from July to December of year t and t+ From January to June of the year, the difference between the return rate of the low investment ratio stock portfolio and the high investment ratio stock portfolio (weighted by market capitalization and equal weight). MKT is all A-shares circulation market value-weighted index.

# 2. FAMA AND FRENCH FIVE-FACTOR MODEL

## 2.1 Fama and French five-factor model

After Fama and French three-factor model, many other researchers found other factor models, adding profitability, investment, and momentum factors. Then Fama and French introduced two new variables RMW and CMA in the original three-factor model. The test results illustrate that the value factor would be superfluous if profitability and investment factors are added to the formula. The mathematical formula for the Fama and French five-factor is :

$$R_{it} - R_{ft} = \beta_i\left(R_{mt} - R_{ft}\right) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t \quad (1)$$

In this formula 1, $R_{ft}$ is the risk-free rate, $R_{it} - R_{ft}$ is the monthly return of a portfolio; their difference refers to the expected return of a portfolio. $SMB_t$ is the return difference between the small-size stocks portfolio and the big-size stocks portfolio. $HML_t$ means the return difference between the portfolio of high-book-to-market ratio stocks and low-book-to-market ratio stocks. $RMW_t$ is the difference between returns of stock portfolios with robust profitability and weak profitability. $CMA_t$ is the difference between returns on a portfolio of stocks with conservative investment and progressive investment. $\beta_i, s_i, h_{i,} r_i, c_i$ are the coefficients of the factors.

## 2.2 Empirical Results

*2.1 Factor returns*

Table 1 is the descriptive statistics for factor returns: 02/1994 – 09/2021, 332 months. It demonstrates the mean, standard deviation, minimum, median, maximum for each variable. As a result, the mean of MKT is 1.0% per month, which is significantly higher than the risk-free rate (0.279%). The excess returns compounded annually are 12.0%, representing that the Chinese stock market has viewed a significant rise in the sample period. However, the standard

deviation is 10.9% per month, which means the trend is fluctuating. The average return of size factor SMB is 0.8%, which is less than the market factor. However, the mean of size factor (SMB) is much bigger than the value factor (HML), the profitability factor (RMW), and the investment factor (CMA). Size effect means that smaller firms have higher returns than larger firms, on average over long horizons. These statistics demonstrate size effect has a strong influence on the Chinese stock market. The value effect refers to the portfolio of value stocks with a high Book-to-Market ratio performing better than the low B/M ratio one. The average value factor – HML is 0.4% per month, which is only half of MKT. Therefore, the HML has less effect on the Chinese stock market. These two results are similar to the conclusion from previous studies.

Table 2 shows the correlation coefficient matrix of the Fama and French five factors. The five factors (MKT, SMB, HML, RMW, and CMA) correlate. I found that correlations among factors did not reach 1.0, which means the correlation structure looks good. The size factor SMB has negative correlations with value factor HML and profitability factor RMW (-0.216 and -0.837) but positively correlates with investment factor CMA and market factor MKT (0.600 and 0.384). Investment factor and profitability factor have a strong correlation with size factor. This can be explained because growth stocks always have lower Book-to-Market ratios and weaker profitability. The positive correlation between HML and RMW (0.071) shows that higher B/M ratio firms tend to invest more actively than lower B/M ones. This also confirms why RMW and CMA have such a strong negative correlation (-0.640). The results are similar to results from Huang, T.-L. [10].

**Table 1:** Descriptive statistics

| Variable | mean | sd | min | p50 | max |
|---|---|---|---|---|---|
| MKT | 0.010 | 0.109 | -0.274 | 0.006 | 1.126 |
| SMB | 0.008 | 0.049 | -0.159 | 0.008 | 0.374 |
| HML | 0.004 | 0.050 | -0.405 | 0.002 | 0.327 |
| RMW | -0.002 | 0.052 | -0.338 | -0.000 | 0.179 |
| CMA | 0.002 | 0.045 | -0.151 | 0.002 | 0.524 |

**Table 2:** Correlation coefficient matrix

| Variable | MKT | SMB | HML | RMW | CMA |
|---|---|---|---|---|---|
| MKT | 1.000 | | | | |
| SMB | 0.384*** | 1.000 | | | |
| HML | -0.164*** | -0.216*** | 1.000 | | |
| RMW | -0.459*** | -0.837*** | 0.071 | 1.000 | |
| CMA | 0.475*** | 0.600*** | 0.003 | -0.640*** | 1.000 |

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

## 3. IMPACT OF EXCHANGE STOCK AND MARKET ON MONTHLY RETURN

Chinese stock can be traded in both Shanghai Stock

Exchange and Shenzhen Stock Exchange. However, there are quite differences between them in which will affect the model performance. Shanghai Stock Exchange is more suitable for large, stable companies, while Shenzhen Stock Exchange is suitable for small and medium-sized, 2developing companies. Any GEM shares with a circulation amount of less than 100 million RMB can be called the SME.

### 3.1 Monthly return across Exchange stock

This section attempts to explore if the Exchange stock is the significant factor that affects the monthly return in the Chinese stock market. The results are shown in Table 3. In table 3, It is obvious to find that the annual return in Shanghai Exchange stock is 18.96%, while in Shenzhen Exchange stock is 16.15%.

Table 4 uses the Kolmogorov-Smirnov test and Shapiro-Wilk test to figure out if the monthly return in Shanghai Exchange stock and Shenzhen Exchange stock is the normal distribution. It clearly shows the significance in both Shanghai and Shenzhen Exchange stocks is 0.000, which is super significant and is not normally distributed.

Since it is an abnormal distribution and there is no way to take the log of negative monthly returns, in table 5, an Independent-Samples Mann-Whitney U Test is done. The Null Hypothesis is the distribution of Monthly return is the same across categories of the Exchange market. The result from table 7 points out the asymptotic significance is 0.798, remaining the null hypothesis. As the Independent-Samples Mann-Whitney U Test figure shows, Shanghai Exchange stock and Shenzhen Exchange stock have no significant difference in monthly return in the Chinese stock market. Results from ANOVA Test also confirm it. The significance between groups is 0.690, which is not significant, meaning the monthly return of two Exchange stocks is similar.

**Table 3: Descriptive**

| Exchange market | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| Monthly return | Shanghai | Mean | | 0.015801 | 0.0044836 |
| | | 95% Confidence Interval for Mean | Lower Bound | 0.007003 | |
| | | | Upper Bound | 0.024598 | |
| | | 5% Trimmed Mean | | 0.006901 | |
| | | Median | | 0.006150 | |
| | | Variance | | 0.022 | |
| | | Std. Deviation | | 0.1476172 | |
| | | Minimum | | -0.3604 | |
| | | Maximum | | 2.0037 | |
| | | Range | | 2.3641 | |
| | | Interquartile Range | | 0.0998 | |
| | | Skewness | | 5.875 | 0.074 |
| | | Kurtosis | | 66.290 | 0.148 |
| | Shenzhen | Mean | | 0.013455 | 0.0038019 |

| | | | | |
|---|---|---|---|---|
| | 95% Confidence Interval for Mean | Lower Bound | 0.005995 | |
| | | Upper Bound | 0.020915 | |
| | 5% Trimmed Mean | | 0.005967 | |
| | Median | | 0.005700 | |
| | Variance | | 0.016 | |
| | Std. Deviation | | 0.1250591 | |
| | Minimum | | -0.3061 | |
| | Maximum | | 1.5176 | |
| | Range | | 1.8237 | |
| | Interquartile Range | | 0.1093 | |
| | Skewness | | 3.056 | 0.074 |
| | Kurtosis | | 25.355 | 0.149 |

**Table 4:** Tests of Normality

| | | Kolmogorov-Smirnov[a] | | Shapiro-Wilk | | | |
|---|---|---|---|---|---|---|---|
| Exchange market | | Statistic | df | Sig. | Statistic | df | Sig. |
| Monthly return | Shanghai | 0.167 | 1084 | 0.000 | 0.649 | 1084 | 0.000 |
| | Shenzhen | 0.115 | 1082 | 0.000 | 0.817 | 1082 | 0.000 |

a. Lilliefors Significance Correction

**Table 5: Independent-Samples Mann-Whitney U Test Summary**

| | |
|---|---|
| Total N | 2166 |
| Mann-Whitney U | 582719.500 |
| Wilcoxon W | 1168622.500 |
| Test Statistic | 582719.500 |
| Standard Error | 14553.483 |
| Standardized Test Statistic | -0.256 |
| Asymptotic Sig. (2-sided test) | 0.798 |

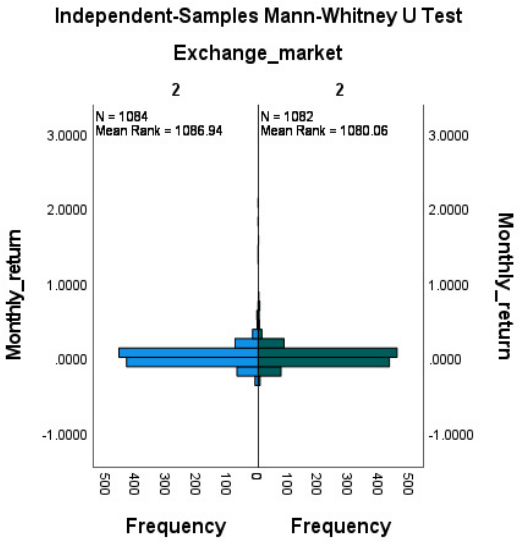


**Figure 1** Independent-Samples Mann-Whitney U Test Exchange market

**Table 6:** ANOVA Test

| Monthly return | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 0.003 | 1 | 0.003 | 0.159 | 0.690 |
| Within Groups | 40.506 | 2164 | 0.019 | | |
| Total | 40.509 | 2165 | | | |

### 3.2 Monthly return across the market

To see if A-share and B-share have a dramatic difference in monthly return in the Chinese stock market, the section does descriptive statistics and several other tests to figure out the result.

Table 7 indicates the annual return of A-share is 18.66%, while the annual return of B-share is 13.75%, which is relatively lower than A-share. Table 8 shows the results of the Shapiro-Wilk test and Kolmogorov-Smirnov test. Similarly, the significance of both tests is 0.000. Plus, table 9 describes asymptotic significance is 0.329 of Independent-Samples Mann-Whitney U Test. It remains the null hypothesis - The distribution of Monthly return is the same across categories of the market.Table 6 shows that the significance from ANOVA Test is 0.471, which also verifies that – The monthly return of A-share and B-share are very close.

**Table 7: Descriptive**

| Market | | | Statistic | Std. Error |
|---|---|---|---|---|
| Monthly return | A | Mean | 0.015547 | 0.0041245 |
| | | 95% Confidence Interval for Mean | Lower Bound 0.007454 | |
| | | | Upper Bound 0.023640 | |
| | | 5% Trimmed Mean | 0.007648 | |
| | | Median | 0.006700 | |
| | | Variance | 0.019 | |
| | | Std. Deviation | 0.1366080 | |
| | | Minimum | -0.3203 | |
| | | Maximum | 2.0037 | |
| | | Range | 2.3240 | |
| | | Interquartile Range | 0.1025 | |
| | | Skewness | 5.109 | 0.074 |
| | | Kurtosis | 58.159 | 0.148 |
| | B | Mean | 0.011459 | 0.0038828 |
| | | 95% Confidence Interval for Mean | Lower Bound 0.003840 | |
| | | | Upper Bound 0.019077 | |
| | | 5% Trimmed Mean | 0.003667 | |
| | | Median | 0.003750 | |
| | | Variance | 0.016 | |
| | | Std. Deviation | 0.1261753 | |
| | | Minimum | -0.3604 | |
| | | Maximum | 1.5176 | |
| | | Range | 1.8780 | |
| | | Interquartile Range | 0.1033 | |
| | | Skewness | 3.144 | 0.075 |
| | | Kurtosis | 27.063 | 0.150 |

**Table 8:** Tests of Normality

| Market | | Kolmogorov-Smirnov[a] | | | Shapiro-Wilk | | |
|---|---|---|---|---|---|---|---|
| | | Statistic | df | Sig. | Statistic | df | Sig. |
| Monthly return | A | 0.149 | 1097 | 0.000 | 0.705 | 1097 | 0.000 |
| | B | 0.122 | 1056 | 0.000 | 0.813 | 1056 | 0.000 |

a. Lilliefors Significance Correction

**Table 9:** Independent-Samples Mann-Whitney U Test Summary

| | |
|---|---|
| Total N | 2153 |
| Mann-Whitney U | 565128.500 |
| Wilcoxon W | 1123224.500 |
| Test Statistic | 565128.500 |
| Standard Error | 14420.070 |
| Standardized Test Statistic | -0.977 |
| Asymptotic Sig.(2-sided test) | 0.329 |

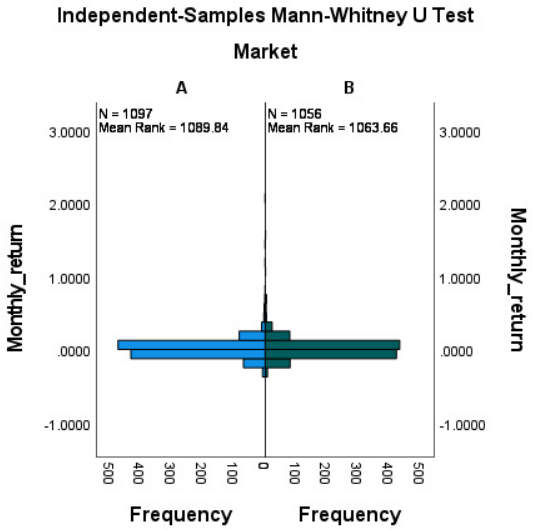


**Figure 2** Independent-Samples Mann-Whitney U Test market

**Table 10: ANOVA Test**

Monthly return

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 0.009 | 1 | 0.009 | 0.519 | 0.471 |
| Within Groups | 37.249 | 2151 | 0.017 | | |
| Total | 37.258 | 2152 | | | |

## *1.* SME

The SME index of monthly market value from 2004.7 to 2021.6 is arranged in ascending order to distinguish the size of firms. The first 30% of all is called small, while the last 30% is called big.

According to table 11, the annual return of small size firms is 26%, Which is more than three times as much as that of big size firms. This result is the same as the previous studies.

Table 12 illustrates the results of the Shapiro-Wilk test. It is easy to get the significance of the monthly return of small size firms is 0.582, while the significance of the monthly return of big size firms is only 0.001, which means the monthly return of small size companies can be considered as normal distribution. Figure 4 and figure 5 show both of them are exactly normal distributions. Figure 3 is the boxplot of big-size firms. It explains why the significance of big-size firms indicates not an abnormal distribution because there are too many abnormal values. The T-Test is done to figure out whether or not the monthly return of big-size firms is normally distributed. As a result, after eliminating outliers of both big and small size firms, as table 13 shows - they can both be considered as the normal distribution (0.1168 and 0.0721, respectively). Table 14 uses Levene's Test for Equality of Variances to show that significance is 0.00 less than 0.05, which means the variances of small-size firms and big-size firms are different.

**Table 11:** Table Descriptive

| size | | | | Statistic | Std. Error |
|---|---|---|---|---|---|
| Monthly return | small | Mean | | 0.021680 | 0.0149606 |
| | | 95% Confidence Interval for Mean | Lower Bound | -0.008245 | |
| | | | Upper Bound | 0.051606 | |
| | | 5% Trimmed Mean | | 0.023172 | |
| | | Median | | 0.029100 | |
| | | Variance | | 0.014 | |
| | | Std. Deviation | | 0.1168460 | |
| | | Minimum | | -0.2284 | |
| | | Maximum | | 0.2518 | |
| | | Range | | 0.4802 | |
| | | Interquartile Range | | 0.1688 | |

| | | | | |
|---|---|---|---|---|
| | Skewness | | -0.183 | 0.306 |
| | Kurtosis | | -0.478 | 0.604 |
| big | Mean | | 0.006213 | 0.0093135 |
| | 95% Confidence Interval for Mean | Lower Bound | -0.012423 | |
| | | Upper Bound | 0.024850 | |
| | 5% Trimmed Mean | | 0.005098 | |
| | Median | | 0.010050 | |
| | Variance | | 0.005 | |
| | Std. Deviation | | 0.0721422 | |
| | Minimum | | -0.1816 | |
| | Maximum | | 0.2936 | |
| | Range | | 0.4752 | |
| | Interquartile Range | | 0.0595 | |
| | Skewness | | 0.675 | 0.309 |
| | Kurtosis | | 4.095 | 0.608 |

**Table 12:** Tests of Normality

| size | | Shapiro-Wilk | | |
|---|---|---|---|---|
| | | Statistic | df | Sig. |
| Monthly return | small | 0.984 | 61 | 0.582 |
| | big | 0.922 | 60 | 0.001 |

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

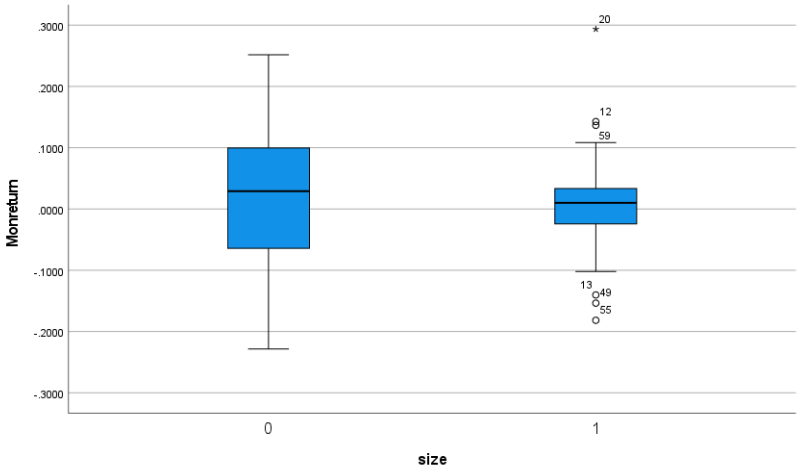


**Figure 3** Boxplot of big and small size firms

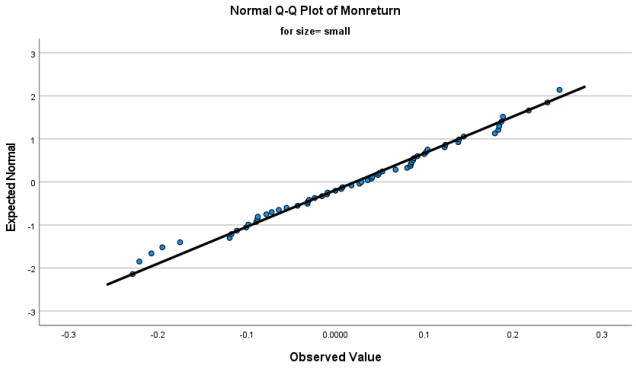


**Figure 4** Normal Q-Q Plot of Monreturn for size= small

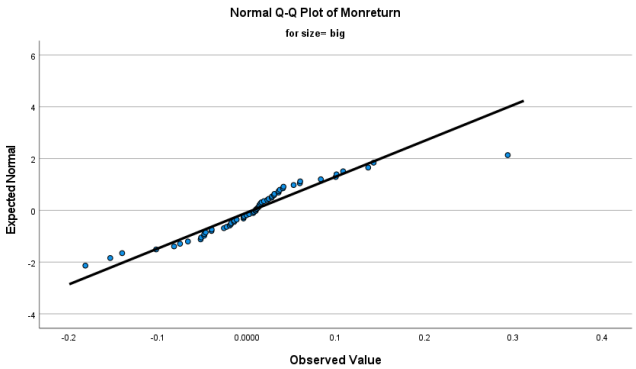


**Figure 5** Normal Q-Q Plot of Monreturn for size= big

**Table 13:** Group Statistics

| ize | | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Monthly return | small | 61 | 0.021680 | 0.1168460 | 0.0149606 |
| | big | 60 | 0.006213 | 0.0721422 | 0.0093135 |

**Table 14:** Levene's Test for Equality of Variances

| | | F | Sig. |
|---|---|---|---|
| Monthly return | Equal variances assumed | 18.136 | 0.000 |
| | Equal variances not assumed | | |

## 4. CONCLUSION

After thoroughly studying some previous literature that uses multi-factor models in the Chinese stock market, this paper proposes that current Chinese financial academia is deficient in Fama and French five-factor model research. Most of the previous studies are based on Fama and French three-factor model, and researchers doubt the applicability of the five-factor model in the Chinese market. In this work, the construction of the Fama and French five-factor model (2015) tests the validity of the factor model in the Chinese stock market. Furthermore, the paper uses several other tests to discover the effects of exchanges and shares on monthly returns; it also tested the relationship between SMB and the SME board's returns. The main conclusions are:

a) Fama and French five-factor model is Applicable to The Chinese market. Among all five factors, the size and market factors are the two most vital factors related to the return. The value factor is the least; it has a minimal influence on returns in Chinese stock markets.

b) Exchanges, where stocks are listed, have little influence on monthly returns; A-share and B-share have similar returns in the Chinese stock market.

c) Both returns of big-size and small-size firms are considered as the normal distribution. However, the annual return of small-size firms is more than three times as much as that of big-size firms.

Chinese stock market's special features will affect the capability of the model. Differences in market microstructure cause this difference. Moreover, significant events such as the reform of non-tradable shares in 2005 and COVID-19 in 2019 will also affect the model's performance.

This paper holds a rigorous attitude to complete the above research. However, there are still multiple deficiencies and potential future research directions below:

a) The sample in this paper is monthly, which may lack more detail than weekly and daily data. If more specific data are used, the research results will be more in line with the actual market, and the paper will be more convincing

b) It is proved that the value factor is redundant. Future studies can use new factors to substitute the value factor to get more good results.

## REFERENCES


[1] Sharpe, W.F. (1964), CAPITAL ASSET PRICES: A THEORY OF MARKET EQUILIBRIUM UNDER CONDITIONS OF RISK*. The Journal of Finance, 19: 425-442.

[2] Lintner, J. (1965), SECURITY PRICES, RISK, AND MAXIMAL GAINS FROM DIVERSIFICATION*. The Journal of Finance, 20:
587-615.

[3] Carhart, M. M. (1997). On persistence in mutual fund performance. The Journal of Finance, 52(1), 57-82.

[4] Novy-Marx, R. 2013. The other side of value: The gross profitability premium. Journal of Financial Economics 108:1–28.

[5] Fama, E. F., & French, K. R. (2015). A five-factor asset pricing model. Journal of Financial Economics, 116(1), 1-22.
[6] Guo, Bin & Zhang, Wei & Zhang, Yongjie & Zhang, Han, 2017. "The five-factor asset pricing model tests for the Chinese stock market," Pacific-Basin Finance Journal, Elsevier, vol. 43(C), pages 84-106.
[7] Hu, G.X., Chen, C., Shao, Y. and Wang, J. (2019), Fama–French in China: Size and Value Factors in Chinese Stock Returns. International Review of Finance, 19: 3-44.
[8] Fama, E.F., & Fama, K.R. FrenchIndustry costs of equity
J. Financ. Econ., 43 (2) (1997), p. 153-193
[9] Huang, T.-L. (2018, November 10). Is the fama and French five-factor model robust in the Chinese stock market? Asia Pacific Management Review.
[10] Fama, E. F., & French, K. R. (2015). A five-factor asset pricing model. Journal of Financial Economics, 116(1), 1-22.