

The Applicability of Fama-French Three-factor Model to Beijing Stock Market

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ABSTRACT

This paper takes Beijing A-shares as a research focus, divides them into four groups by market value and book-to-market ratio, and uses Fama-French three-factor model to conduct relevant empirical test and regression analysis. The experimental results show that the three factors of the three-factor model have good predictability of the rate of return of Beijing Stock Exchange portfolio, and the volatility of the return rate is the most significant sensitivity to market fluctuations. The ratio of market capitalization and book value has a low explanatory power for the impact of stock risk-return fluctuation.

KEYWORDS

Fama-French three-factor model; Beijing Stock Exchange A shares

1. INTRODUCTION

The establishment of the Beijing Stock Exchange heralds a significant development within China's capital market landscape. Approved by The State Council and under the supervision of the China Securities Regulatory Commission, it represents the nation's inaugural foray into the realm of corporate stock exchanges. For three decades, the Shanghai and Shenzhen Stock Exchanges have dominated China's financial stage, but the emergence of the Beijing Stock Exchange marks a pivotal shift in this narrative. This milestone not only diversifies investment opportunities but also signifies a strategic move towards fostering regional economic growth and innovation. Furthermore, its regulatory oversight ensures market integrity and investor confidence, while its establishment fuels competitive dynamics and the internationalization of China's capital markets.

The establishment of the Beijing Stock Exchange is not only a positive signal of deepening reform released by China's capital market to the world, but also an important measure to actively implement the national innovation-driven development strategy and continuously cultivate new drivers in the context of deepening supply-side structural reform in China's financial industry, providing high-quality smes in China with earlier direct financing and access to the capital market channels. It can revitalize a large amount of capital investment, which in turn drives the real economy. This paper selects the relevant data of Beijing Stock Exchange from July 2021 to February 2024 to analyze the applicability of Fama-French three-factor model to Beijing stock market.

Over time, the multi-factor model has undergone significant historical changes, particularly with the inception of the Capital Asset Pricing Model (CAPM) by William Sharpe et al in 1964. Initially, CAPM focused solely on the market factor, elucidating the relationship between systemic risk and investment excess return, while also delving into the formation of asset equilibrium price, a cornerstone of modern financial market price theory. However, as empirical testing progressed,

limitations of CAPM in explaining abnormal situations became apparent. In 1993, Eugene Fama and Kenneth French augmented the CAPM framework by incorporating two additional factors: size (SMB) and value (HML). This extension provided a more nuanced understanding of portfolio returns, capturing the linear relationship between excess returns and the three factors. The FAMA-French three-factor model thus emerged as a robust tool, offering improved explanatory power for the diverse array of factors influencing security returns.

In 2015, Eugene F. Fama and Kenneth R. French established a five-factor model based on their own three-factor model, that is, two factors were added to the original three-factor model: profit factor (RMW) and investment factor (CMA). Although they have made further improvements to the model, according to the existing research, The efficiency of the five-factor model in explaining China's capital market dynamics remains uncertain. Zhao Shengmin et al. compared the three-factor model with the five-factor model and found that the three-factor model was more suitable for China's A-share market [1]. Guo Zhuxi tested A-share steel enterprises and found that the inclusion of additional profit and investment factors in the five-factor model fails to adequately explain regression outcomes [2]. Zhang Xinyu and Prince Shuang found that the five-factor model has demonstrated improved explanatory power within the A-share market context, but the investment factor CMA is still a redundant factor [3]. Considering the varying conclusions within domestic academic circles regarding the suitability of the five-factor model in the Chinese market, this study opts to employ the Fama-French three-factor model for empirical analysis of the A-share market on the Beijing Stock Exchange.

Domestic scholars have extensively investigated the applicability of the Fama-French three-factor model in China's stock market. Yang Xin and Chen Zhanhui conducted a study on the cross-sectional nature of stock returns in the Shanghai and Shenzhen A-share markets, testing the model's relevance [4]. Liu Hui and Huang Jianshan analyzed listed companies in China's A-share market, providing evidence that the Fama-French three-factor model offers better explanatory power for stock returns compared to the CAPM model [5]. Building upon this research, Shi Haotian further validated the model's suitability in the Chinese stock market, introducing the ST factor and examining its impact on the excess returns of various portfolios [6]. Through literature review, it is found that most domestic scholars take Shanghai stock market and Shenzhen stock market as research objects, while the analysis and research of Beijing stock market is still relatively blank.

Since China's financial market started late, its development path and formation characteristics are not similar to foreign capital markets, on the contrary, there are many differences. Hence, this paper employs the Fama-French three-factor model to assess the efficacy of China's A-share market returns, aiming to ascertain its suitability within the context of the Chinese stock market. Given the recent establishment of the Beijing Stock Exchange, research and analysis pertaining to the Beijing stock market are still in their nascent stages, resulting in limited literature on multi-factor models in this specific market. Therefore, this paper utilizes data from the Beijing Stock Exchange to validate the predictive accuracy of the Fama-French three-factor model for future return projections, which can not only enhance the ability of market price discovery, but also help to monitor the overall systemic risk of the market in real time, which has rich theoretical connotation and practical value.

2. DATA SOURCES

The data for this study comes from the Guotai CSMAR database and selects data from the Beijing stock market from July 2021 to February 2024.

The data analyzed in this document are represented by monthly rates of return, accounting for the reinvestment of cash dividends. The risk-free monthly interest rate in the stock market is sourced from the CSAMR database, while the factor data are obtained from the CSMAR database.

3. EMPIRICAL RESEARCH

3.1. Factor Analysis

Figure 1, Figure 2 and Figure 3 show the changes of the three factors MKT, SMB and HML from July 2021 to February 2024 respectively, reflecting the changes of excess returns brought by the three factors during this period [7].

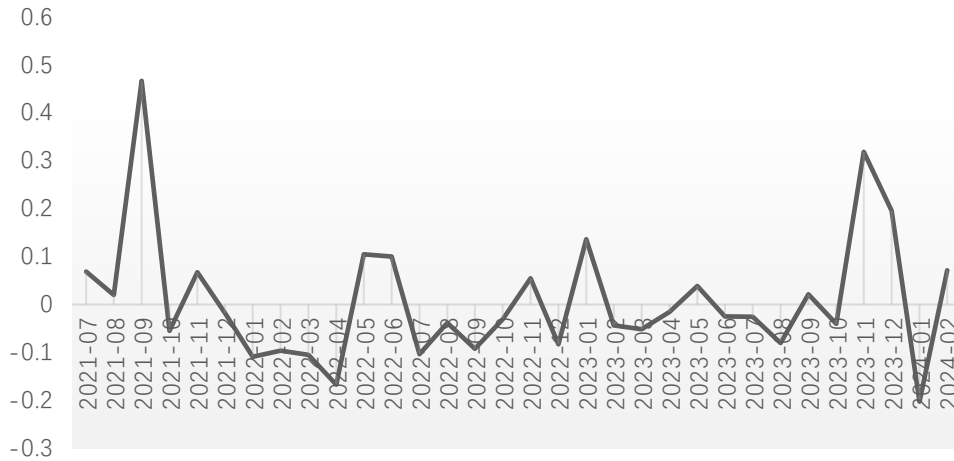


Figure 1. RiskPremium Market risk premium Factor (weighted by total market value)

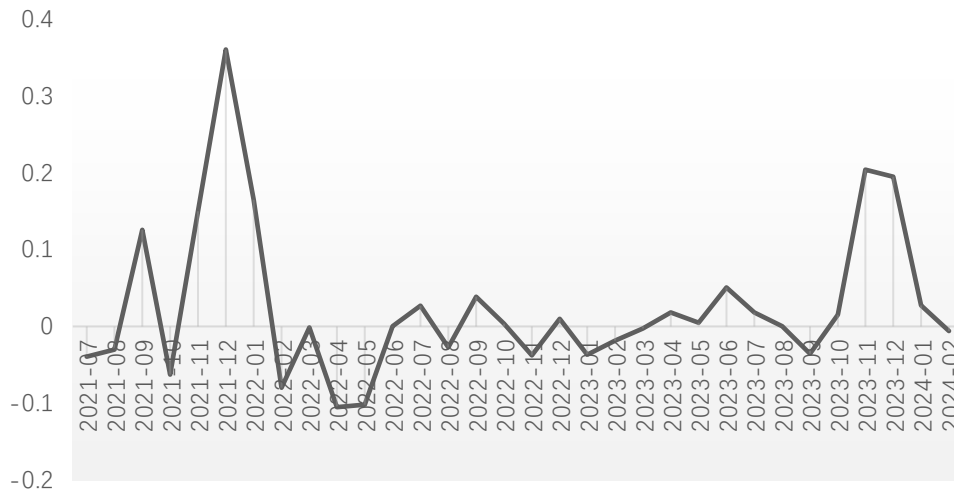


Figure 2. Market value factor of SMB (weighted by total market value)

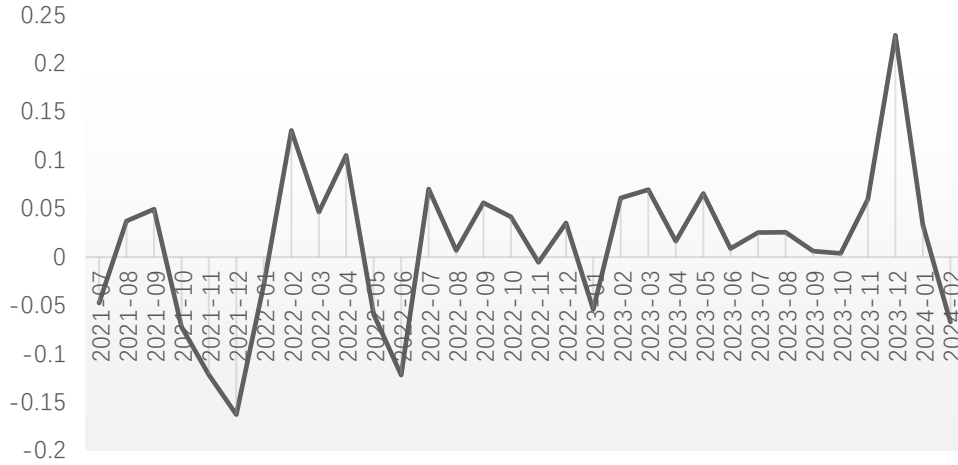


Figure 3. HML book-to-market ratio factor (weighted by total market value)

The images of MKT and SMB are similar, with more positive results on the whole, with more obvious peaks appearing at the end of 2021 and the end of 2023, and small fluctuations around 0 in the rest of the time.

Different from the first two factors, HML images fluctuate greatly, and the changes show a periodicity, which is mirrored by the periodicity of the market. When the market economy is good, investors have good confidence and tend to invest in growth stocks with small market value and large development space, while when the market is not good, they tend to invest in value stocks with large market value and low profits, so HML will become a cyclical change. This also validates the adaptive market hypothesis that speculators and investors change their behavior in response to different market conditions.

3.2. Fama-French Three-Factor Model Analysis

Due to the short survey time and insufficient data, the stock paper excludes missing data and divides the A-shares of BSE into two groups on average based on spreading market value: High market value group (B) and low market value group (S). In terms of data integrity, each share's book value ratio is calculated based on data from the 2022 annual report, and divided into two groups (H) with a high book-to-market value ratio and to (L) a low book-to-market ratio (50%, 50%) respectively. The final sample was divided into 4 combinations of 2×2, namely the low accounting ratio group (SL), the low accounting ratio group (SH), the high accounting ratio group (BH) and the low accounting ratio group (BL). The average monthly rate of return for each group was recorded as BL, BH, SL, SH respectively [7-10].

Table 1. Cross-generated portfolios from the two grouping methods

Market cap size book-to-market	B(50%)	S(50%)
L(50%)	BL	SL
H(50%)	BH	SH

Based on the monthly average return data of the four portfolios presented in Table 1, the construction methods for the size factor (SMB) and the book-to-market ratio (HML) can be determined:

$$SMB = \frac{SL+SH}{2} - \frac{BL+BH}{2} \quad (1)$$

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

Table 1 illustrates that the "size factor" (SMB) is calculated by subtracting the average return of the two portfolios with relatively small market capitalization (SL, SH) from the average return of the two portfolios with relatively large market capitalization (BL, BH). This difference represents the risk premium associated with small businesses compared to large firms. Similarly, the "value factor" (HML) is derived by subtracting the average return of the two portfolios with the highest book-to-market ratio (SH, BH) from the average return of the two portfolios with the lowest book-to-market ratio (SL, BL). This difference indicates the risk premium for value-oriented businesses relative to growth-oriented businesses.

After the groups are obtained, the average monthly return rate of each group is calculated with the stock market value of each group as the weight, and finally the market-weighted average monthly return rate of each group from July 2021 to February 2024 is obtained.

Table 2. Descriptive statistics

Variable	Mean	Std. dev.	Min	Max
BH	-0.00086	0.110202	-0.16474	0.339878
SH	0.019056	0.142438	-0.16931	0.462187
BL	0.013857	0.155708	-0.21183	0.619137
SL	0.053305	0.289476	-0.17423	1.496365

Analyzing from the perspective of monthly return rates, it's observed that $BH < BL$ and $SH < SL$, indicating that companies with lower book market values tend to exhibit higher average monthly return rates. Additionally, $BH < SH$ and $BL < SL$ suggest that small-cap companies tend to yield higher average monthly returns. From the standpoint of standard deviation, $BH < BL$ and $SH < SL$, signifying that companies with lower book market values generally entail greater risk. Similarly, $BH < SH$ and $BL < SL$ imply that small-cap companies are associated with higher levels of risk compared to large-cap counterparts. This suggests that high returns often come with higher risks. To sum up, it can be concluded that the mean value of SH is relatively high and the standard deviation is small in this sample interval, which is the optimal choice for rational investors. SL has a high average yield but a larger standard deviation and greater risk, so it is not recommended to invest [10].

Fama-French three-factor model is expressed as:

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{Mt} - R_{ft}) + s_i SMB_t + h_i HML_t + e_i \quad (3)$$

In the provided model, R_{it} denotes the return rate of stock i at time t , while R_{ft} represents the risk-free rate at time t . The intercept term α_i accounts for the inherent characteristics of stock i . The term $(R_{Mt} - R_{ft})$ represents the market risk premium (MKT), capturing the excess return of the market over the risk-free rate. The Size factor, denoted as SMB_t , signifies the simulated portfolio return associated with the market value (Size) factor at time t . Similarly, the book-to-market ratio factor, HML_t , represents the simulated portfolio return rate of the book-to-market factor at time t . The coefficients β_i , s_i , and h_i denote the sensitivities corresponding to the three factors, capturing the respective influence of market risk premium, Size factor, and book-to-market ratio factor on stock i 's return rate.

Table 3. Regression analysis

	(1)	(2)	(3)	(4)
Portfolio	BH	SH	BL	SL
MKT	0.722***	1.089***	1.089***	0.722***
	(9.99)	(19.99)	(19.99)	(9.99)
SMB	0.131	0.559***	-0.441***	1.131***
	(1.53)	(17.04)	(-13.45)	(13.23)
HML	0.038	0.654***	-0.346***	-0.962***
	(0.27)	(17.09)	(-9.03)	(-6.78)
Constant	-0.010	0.009*	0.009*	-0.010
	(-1.24)	(2.05)	(2.05)	(-1.24)
Observations	32	32	32	32
R-squared	0.853	0.975	0.979	0.979
F test	0	0	0	0
r2_a	0.838	0.972	0.977	0.976
F	65.94	505.3	213.9	357.6
Robust t-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1				

From the perspective of the fit degree of the model, the goodness of fit of the model adjustment is 85% ~ 98%, which is a high goodness of fit, indicating that MKT, SMB and HML are important factors affecting the volatility of stock returns in the Beijing stock market.

From the regression coefficient β_{MKT} of market factors, according to the data in the table, $P < 0.01$ of BL, BH, SL and SH groups, market factors have a good explanatory power to the monthly return rate of each portfolio, and market factors are important factors to promote the change of the return rate of Beijing Stock A shares. Simultaneously, all four portfolios exhibit positive regression coefficients for market factors (β_{MKT}), suggesting a positive correlation between market performance and the Beijing Stock Exchange's performance. Notably, BH and SL portfolios demonstrate significantly stronger fluctuations in excess return rates compared to the overall market. During economic booms, the overall market tends to trend upwards, with large portfolios boasting high book-to-market ratios and small portfolios with low ratios performing particularly well. But at the same time, the investment risk of the portfolio also exceeds the market risk.

From the regression coefficient of scale factor β_{SMB} , the P value of BL, SL and SH is < 0.01 , but the P value of BH is more than 10%, indicating that SMB has no significant influence on BH. The addition of factor SMB has a certain explanatory power to the sample combination. From the perspective of the positive and negative regression coefficient of this factor, the β_{SMB} of SH and SL combinations is positive, and the scale factor coefficient of BL is negative, which means that the combination of small market value of SH and SL types will increase the risk return rate. In general, there is scale effect in the A-shares of Beijing Stock Exchange, but the benefits of small companies are not obvious [11].

From the regression coefficient β_{HML} of book-to-market ratio, the P-value is similar to the size factor, and HML has no significant effect on BH. For BL and SL portfolios, β_{HML} is negative, and SH's β_{HML} is positive. The findings reveal a distinct book value effect and a favorable risk-return ratio for stocks with high book value ratios, with the small-scale portfolio exhibiting the most pronounced effect, indicating promising investment prospects for companies within this portfolio. Conversely, portfolios with low book-to-market ratios exhibit a lower risk-to-return ratio, suggesting a less significant relationship between portfolio return and the book-to-market ratio factor. Therefore, it is necessary to keep alert to changes in portfolio returns and make reasonable investment decisions in a timely manner.

From the perspective that the regression result of the constant term is not 0, it indicates that other factors besides the three factors affect the change of the return rate of Beijing Stock Exchange, which provides a reference direction for further research in the future.

4. CONCLUSION

This paper selects the relevant data of Beijing Stock A shares from July 2021 to February 2024 to empirically examine the suitability of the Fama-French three-factor model. In summary, we can obtain:

In the regression analysis of the four portfolios, it is found that market factor (MKT) has the most significant impact on the return rate of BSE A shares, and there is a highly positive relationship between factor and return rate.

According to the analysis of regression results, the small-scale effect of the A-shares of Beijing Stock Exchange is not obvious. Small-scale effect: small-market companies have good growth, large future income space for investors, and the same amount of money for companies has greater development space and future compared with large-market companies. China's stock market has a large number of retail investors, most of them pursue speculative trading, affected by the herd effect, some large orders can easily push up the stock price of small companies, so as to obtain high returns. In addition, the risk premium of small market cap companies is higher than that of large market cap companies, and investors will demand higher risk compensation. Economies of scale are a reflection of this risk premium. However, the small company effect exists but is not obvious in the sample interval of the paper, indicating that this factor (SMB) has a low explanatory power for the Beijing Stock Exchange.

In addition, the factor analysis of the book-to-market ratio finds that, compared to stock market returns, the high book value reflects the effect of a particular book value and a higher risk-return ratio. Among them, the portfolio with a high book value ratio is the most obvious, indicating that the notes in the portfolio have good investment prospects. But the risk of the equity investment group returning to a low account-to-market ratio is lower, and there is no clear relationship between the investment group's return and accountable factor to market (HML).

To sum up, market factor (MKT) has the highest explanatory power in Beijing stock market. When choosing an investment strategy, investors must first consider the impact of investment risk and market rate of return, as well as the impact of the market value factor and the book value ratio factor. It should be noted that investors should pay attention to China's macroeconomic policy and the overall economic environment and take into account the general stock market trend when building the investment portfolio. This paper uses the highly explanatory asset valuation theory to improve the valuation ability of risky assets and gives investors effective and achievable investment recommendations.

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