An Empirical Research on the Performance of Asset Pricing Models in the Chinese A-Share Market

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Abstract. Asset pricing remains a cornerstone of financial field, providing a framework to understand the anticipated returns of asset portfolios and individual assets. Its widespread application spans academic discourse and practical financial methodologies. This study conducts an empirical analysis of the Chinese A-share Market, utilizing transaction data from the A-share market spanning from 1994 to 2024. It examines the applicability of the traditional asset pricing models within the Chinese stock market. Through classic regression analyses of the CAPM, the Fama and French three-factor model (FF3), the Fama and French five-factor model (FF5), this study verifies that the FF5 provides a superior explanation of stock expectations for the A-share market during this period compared to other traditional asset pricing models. The conclusions of this study indicate that, among the CAPM, FF3, and FF5 models, the number of parameters taken into account by the model and its capacity to explain asset returns are positively correlated.

Keywords: Asset Pricing Models, Chinese Stock Market, Multiple Factors.

1. Introduction

Asset pricing has always been a central issue in the financial field, used to explain the the expected return of a related asset portfolio or a single asset, and is widely used in academic and practical applications. The early asset pricing theory was represented by the Sharpe-Lintner capital asset pricing model (CAPM), which quantified the basic ideas of the asset pricing model [1]. CAPM explains the return on assets through the market risk premium factor (R_M-R_F). The market inapplicability of CAPM and the limitations of single-factor models have been demonstrated in a significant number of practical trials.

In 1993, Fama and French extended the CAPM by incorporating the size and value factors, thereby addressing the observed "size effect" and "value effect" among assets, and introduced a three-factor model. This advancement is critical to enhancing the model's capacity for explanation. In 2015, they further proposed a five-factor model, adding profitability and investment factors, forming an asset pricing model composed of five factors: R_M-R_F, SMB, HML, RMW, and CMA. In previous studies, the global applicability of five-factor model has been confirmed through extensive empirical testing in international markets to better explain the expected return on assets in a cross-section.

Beyond these seminal models, alternative asset pricing models have emerged, such as the Arbitrage Pricing Theory (APT) proposed by Stephen Ross in 1976, and the Carhart four-factor model proposed by Mark Carhart in 1997 (which added momentum based on the FF3 model factors), and the Black-Litterman model (which combines Bayesian statistical methods and the Markowitz mean-variance model) proposed by Fischer Black and Robert Litterman in 1992.

This article aims to study the applicability of three classic models, CAPM, FF3, and FF5, in emerging markets. According to relevant research, FF5 performs better than FF3 and CAPM in the Chinese A-share Market [2]. Through an analysis of classic regression and descriptive statistical results, this paper concludes that the CAPM exhibits relatively weak explanatory power for expected asset returns in Chinese A-share market. In contrast, the three-factor model shows strong applicability, with the SMB and HML are especially critical in bolstering the model's explanatory power. Wu and Xu used early data to conduct research and found that the Chinese stock market exhibits significant effects related to the book-to-market ratio as well as to the scale of companies [3]. While the FF5 model shows a marginal improvement in explanatory power over the FF3 model in the A-share

market, the addition of CMA and RMW does not significantly augment the model's predictive strength.

For the study of asset pricing theory, Chinese stock market has special characteristics compared with international markets. Firstly, the Chinese stock market is generally considered an emerging market with high volatility and uncertainty. This market is notably more vulnerable to the influences of market manipulation and governmental policy interventions when compared to the more established markets found internationally [4]. Secondly, the stock exchanges in the Chinese market differ from those in international markets, leading to slightly distinct investment behaviors among investors. These differences may subsequently impact the weightings of the coefficients and the explanatory power of the factors within the asset pricing models [5]. A case in point is Fama and French noted that the HML is a "redundant factor" in the American stock market and its inclusion does not enhance the model's efficacy [6]. However, within the context of the Chinese stock market, the HML factor has been confirmed not to be "redundant" [7]. Additionally, the reform of Chinese equity structure in 2005 is believed to have led to shifts in market risk and return profiles. Prior research indicates that the market's efficiency may have improved following the reform of the ownership structure. According to previous research, market efficiency may be improved after the ownership structure reform [8]. The above-mentioned various special factors in the Chinese market may exert a significant influence on the relevance and applicability of the asset pricing models within the Chinese market context.

This paper selected the monthly transaction data of Chinese A-share market from 1994 to 2024 as a sample. The stock exchanges encompassed in this study are the Shanghai Stock Exchange (SSE), Shenzhen Stock Exchange (SZSE), Beijing Stock Exchange (BSE), the Growth Enterprise Market (GEM), and the Science and Technology Innovation Board. The initial approach of the article is to present descriptive statistics for the variables pertinent to the model, including the mean, standard deviation, 25th percentile, median, 75th percentile, along with the minimum and maximum values. This statistical portrayal is followed by an analytical examination of the factor aiming to elucidate the underlying reasons behind the observed market dynamics related to these factors. Secondly, the article employs least squares regression on three distinct models to ascertain the significance of each factor and to evaluate the overall explanatory power of the models, as well as the individual contributions of the factors. In the final stage, this article conducts a robustness test on the optimal five-factor model among the three models: taking the COVID-19 epidemic as a node, by comparing the significance of the factors within the model between the periods of 1994-2019 and 2020-2024, the study aims to affirm the robustness of the five-factor model.

Distinct from traditional inquiries into asset pricing models, this paper presents a focused examination of Chinese A-share market, thereby contributing a novel lens to the study of asset pricing of emerging markets. The exchanges included in the sample data of this article have joined the Beijing Stock Exchange. There are currently relatively few studies on the applicability of the Beijing Stock Exchange's CAPM and other multi-factor models, so this article fills the research gap in this field. This article compares the performance of various asset pricing models, which has important reference value for investors and scholars.

2. Methodology

2.1. Data Selection

This article aims to conduct an empirical analysis of a large sample of the Chinese stock market and explore the explanatory capabilities of three mainstream asset pricing models - CAPM, FF3 and FF5 in the Chinese A-share market. In view of the lack of regulation, high volatility and lack of liquidity in the early Chinese stock market, as well as the incompleteness of market data before 1994, this study has made a deliberate selection of data [9]. This article selects a total of 361 months of monthly data from January 1994 to February 2024 as a sample, covering SSE, SZSE, BSE, GEM, and Science and Technology Innovation Board. The accounting data comes from the China Stock

Market and Accounting Research Database (CSMAR). In order to improve the accuracy of empirical research, the inclusion of stocks follows relevant rules: (1) Exclude company stocks that have incurred losses for two consecutive years, have net assets below the par value of the stock, or that have abnormal circumstances (ST) and company stocks that have been specially transferred and suspended from listing (PT); (2) Exclude the financial industry.

In constructing the expected return rate for stocks in this article, it selected the one-time interest rate of the People's Bank of Chinese one-year fixed deposit as the risk-free rate. Additionally, the monthly return rate for individual stocks was calculated without accounting for the reinvestment of cash dividends. Ultimately, the study compiled a dataset of 688,395 samples."

Based on the model design concepts and methods of Fama and French, this article constructs factors weighted by total market capitalization based on the investment model of the Chinese market and uses investment portfolios (2*3) to divide the sample data into market capitalization and book-to-market ratio divisions [6]; (1) Market value division: The sample data are sorted according to the company's circulating market value on June 30, year t, and the median is taken as the cut-off point. According to the sorted position of a single company's tradable market capitalization, those greater than or equal to the median are classified as large-capitalization companies (B portfolio), and those less than the median are classified as small-capitalization companies (S portfolio); (2) Book-to-market ratio division: The paper calculates the BE/ME ratio for each company for year t-1, with BE adjusted for deferred tax items and the book value of preferred shares, and ME representing the year-end market capitalization. Companies with a non-positive book-to-market ratio are excluded. The remaining companies are then ranked according to their book-to-market ratio as of December 31st of year t-1. The classification thresholds are set at the 30th and 70th percentiles, with the highest 30% classified as high book-to-market ('H' portfolio), the intermediate 40% as medium book-to-market ('M' portfolio), and the final segment as low book-to-market ('L' portfolio) stocks.

2.2. Modeling

Expanding upon the three-factor model, the Fama-French five-factor model takes into account the company's profitability (ROE) and the dynamics of total asset growth. The profitability factor and the investment factor are the two new risk factors that are introduced in this extension. The FF5 is expressed as:

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

In the above formula, R_{it} represents the expected rate of return for stock portfolio i at time; R_{Ft} represents the risk-free rate of return at time t; R_{Mt} represents the market rate of return; SMB_t represents the risk premium caused by differences in listing size; HML_t represents the risk premium attributable to the discrepancies in the book-to-market value ratios of publicly listed companies; RMW_t represents the risk premium due to differences in profitability among publicly listed companies; CMA_trepresents the risk premium due to differences in investment among publicly listed companies (see Table 1). a_i Represents the intercept term; b_i s_i h_i r_i and c_i are factor loadings; e_{it} represents the residual.

Table 1: Variable construction.

Variable Symbol	Variable Description
SMB_t	The variation in return rate over time t between a portfolio of low market capitalization companies and another portfolio of high market capitalization companies.
HML_t	The variation in the return rate over time between a portfolio of growth companies with a low book-to-market ratio and a portfolio of value companies with a high ratio.
RMW_t	The following profitability formula is the foundation for calculating the difference in return rate between a portfolio of companies with good profitability and a portfolio of with poor profitability during period t. This calculation involves taking the operating profit from the previous period and subtracting operating costs, sales expenses, financial expenses, and administrative expenses. The profitability is then measured by the ratio of the owner's equity to the book value from the previous period.
CMA_t	It refers to the disparity in returns between a portfolio of companies characterized by a low level of investment and one with a high level of investment during period t. The investment level is determined by the ratio of the growth in total assets during period t-1to the total assets in period t-2.

This article will conduct an empirical comparison of three classic asset pricing models and also provide the CAPM and FF3. The CAPM is expressed as:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + e_{it} \quad (2)$$

The FF3 is expressed as:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + s_i SMB_t + h_i HML_t + e_{it} \quad (3)$$

In the models represented by equations (2) and (3), the variables and the coefficients have the same meanings as in equation (1).

2.3. Robustness Check

This paper conducts a robustness test on the model with the most robust explanatory power for Chinese A-share market to confirm the stability of the model and the accuracy of the results. Since the end of 2019, COVID-19 has spread rapidly, exerting profound impacts on the economy, financial markets, and various sectors of society. Research has confirmed that COVID-19 has had a significant impact on international stock markets, both in the short and long term [10]. Restrictions on economic activities, rising unemployment and instability in financial markets caused by the epidemic have all tested the performance of chinese stock market and the applicability of the asset pricing models in China. Previous research has shown that the COVID-19 epidemic caused significant short-term fluctuations in chinese stock market and changes in stock investor sentiment [11, 12]. This part aims to verify whether the applicability of the five-factor model is affected within the scope of Chinese A-share market before and after the epidemic. To this end, this study conducts regression analysis on the data from two distinct periods, 1994-2019 and 2020-2024, to verify the significance of each factor within the FF5 during these timeframes.

3. Empirical Results

3.1. Descriptive Statistics

Table 2: Summary statistics.

Variables	mean	S.D.	p25	p50	p75	min	max
R_M-R_F	0.39%	7.10%	-3.13%	0.35%	3.97%	-28.00%	116.50%
SMB	0.55%	4.65%	-2.16%	0.56%	3.03%	-22.20%	22.80%
HML	0.09%	3.39%	-1.81%	0.20%	1.91%	-14.00%	15.80%
CMA	0.19%	2.87%	-1.37%	0.27%	1.71%	-16.10%	74.60%
RMW	-0.08%	3.00%	-1.93%	-0.22%	1.63%	-18.00%	12.20%

Table 3: Correlation matrix.

	R_M-R_F	SMB	HML	CMA	RMW
R_M-R_F	1.0000				
SMB	0.1512	1.0000			
HML	-0.2344	-0.5149	1.0000		
CMA	0.1778	0.2561	0.2587	1.0000	
RMW	-0.2475	-0.6402	0.1433	-0.5991	1.0000

Table 2 provides a descriptive statistical analysis of the five explanatory variables in the five-factor model, displaying the mean, standard deviation, p25, median, p75, min, and max for each variable. Table 3 shows the correlation matrix for the five explanatory variables in the FF5, analyzing the intercorrelations among the factors.

Table 2 shows that the mean value of R_M-R_F is 0.39%. Risky assets in the market have extra returns relative to risk-free assets, that is, there is a risk premium in the market. Based on this, it is inferred from this that investors need a higher rate of return to bear risky assets in the market, which confirms the higher risk premium requirements for high-risk assets. Additionally, the results indicate that the standard deviation of R_M-R_F is 7.10%, and the range between the maximum and minimum values is 144.50%, which signifies a large variance. The high degree of data dispersion suggests that certain investment portfolios in the A-share market are quite sensitive to this factor. It also implies that the market environment during this period has significant volatility and a certain degree of uncertainty. The mean value of the SMB factor is 0.55%, which is relatively high, confirming that stocks of small-cap companies outperform those of large-cap companies. This suggests to a certain extent that under the market structure of Chinese A-share market, the size effect has a strong explanatory power for asset expected returns. The RMW factor represents the stock return difference between high-profit companies and low-profit companies. In Table 2, the mean value of the RWM factor is negative, indicating that high-profitability companies in the A-share market have relatively poor performance. The reasons for this may be due to investor preferences on one hand, and on the other hand, holding stocks of high-profitability companies usually carries relatively higher risk, and investors demand a higher risk premium for this.

The factors in FF5 exhibit some degree of association, as seen in Table 3. The negative correlation between R_M-R_F and HML means that value stocks may outperform growth stocks when the market is relatively poor, indicating that investors choose more stable value stocks in a poor market environment. The positive relationship between R_M-R_F and CMA suggests that when the market performs well, companies with stronger profitability quality perform relatively better, implying that investors prefer stable profitability in a good market environment. However, the negative correlation between RMW and R_M-R_F is just the opposite, indicating that in a good market environment, companies with stronger profitability quality (good capital structure) and weaker profitability ability are more favored by the market. The negative correlation between CMA and RMW further supports this view. The correlation between SMB and HML, CMA, and RMW is similar to the correlation between R_M-R_F and HML, CMA, and RMW, but in terms of numerical value, the correlation between R_M-R_F and HML, CMA, and RMW is weaker because the R_M-R_F factor mainly considers the overall market, while HML, CMA, and RMW mainly consider specific internal factors of the company. In summary, through the correlation matrix analysis, the relationships between the five factors of the FF5 in the Chinese A-share market are relatively reasonable, indirectly verifying the applicability of FF5 in the Chinese market.

3.2. Regression Results

Table 4: Regression results of asset pricing models.

Variables	(1)	(2)	(3)
	CAPM	FF3	FF5
R_M-R_F	1.060***	0.950***	0.957***

	(0.00301)	(0.00305)	(0.00319)
SMB		0.537***	0.446***
		(0.00481)	(0.00717)
HML		-0.328***	-0.320***
		(0.00736)	(0.00856)
RMW			-0.403***
			(0.0114)
CMA			-0.265***
			(0.0103)
Constant	-0.176***	-0.178***	-0.177***
	(0.000214)	(0.000212)	(0.000214)
Observations	688,395	688,395	688,395
R-squared	0.153	0.183	0.184

Note: The figure in parentheses represents the standard errors; *** p<0.01, ** p<0.05, * p<0.1.

This study conducted least squares regression analysis on three classic asset pricing models: CAPM, FF3, and FF5. Table 4 shows the results of the regression analysis of the three asset pricing models. The coefficient of determination(R-squared) indicates the degree of variance in the dependent variable that can be predicted by the independent variables. The regression analysis results show that compared with FF3 and FF5, the R-squared of CAPM is lower, indicating that the market risk premium factor (R_M-R_F) has relatively limited explanatory power for asset returns. The introduction of the size factor (SMB) and the value factor (HML) in the three-factor model significantly improves the model's explanatory power. Comparing results (2) and (3), since five-factor model further considers the investment factor (CMA) and the profitability factor (RMW), the R-squared is slightly higher, indicating that five-factor model fits the data better. This confirms that in Chinese A-share market, five-factor model has stronger explanatory and predictive power for variable relationships and models compared with CAPM and FF3. It is worth noting that the R-squared of FF3 has significantly improved compared with CAPM, but compared with FF3, the R-squared of FF5 only slightly increases, suggesting that the five-factor model has reached a certain level of saturation in explaining the existing factors, and the explanatory power of the new factors added for asset returns is not very significant. The results in Table 4 clearly show that as the number of factors considered in the model increases, the model's explanatory power for asset returns also increases, which is consistent with the expected results.

Comparing results (1) and (2), the significant improvement in the fit of CAPM compared with three-factor model indicates that a single RM-RF market risk premium factor is not sufficient to offer precise forecasting ability for anticipated returns in the Chinese A-share market, while the SMB and HML factors significantly optimize the performance of the model. SMB is a measure of the return differential between portfolios of low- and high-market value companies. Result (1) shows that SMB has a strong positive relationship with low market value stocks, indicating that low market value stocks perform better in terms of returns compared to high market value stocks. This effect is partly due to the fact that low market value stocks are more susceptible to market fluctuations, resulting in higher risk premiums for the stocks, which increases their expected returns. In addition, some studies have shown that there are certain flaws in the market efficiency hypothesis, and low market value stocks may be undervalued, which also provides a basis for the relatively higher returns of low market value stocks [13]. The HML is the differential in returns between companies with high and low book-to-market ratios. The strong negative relationship between HML and high book-to-market ratio stocks in result (2) indicates that high book-to-market ratio stocks perform better in terms of returns compared to low book-to-market ratio stocks. This effect is partly due to the fact that high book-to-market ratio stocks are usually value stocks, and value stocks have a relatively higher probability of obtaining higher returns.

The FF5 model additionally considers the company's profitability (RMW) and investment ability (CMA). The coefficients in the regression results indicate that a 1% change in profitability leads to a

reverse change of 0.403% in RMW and 0.265% in CMA, respectively. Although these two newly added factors are highly significant, the model's explanatory power does not significantly improve compared with three-factor model. The RMW measures the difference in returns between companies with different profitability levels, that is, the impact of the profitability factor on stock returns. Result (2) shows that the slope of RMW is negative, indicating that the market is more willing to invest in companies with lower profitability, or allocates a higher risk premium to companies with higher profitability. CMA represents the impact of the company's investment factor on stock returns. The negative slope of CMA in result (3) indicates that companies with lower capital investment efficiency have higher expected returns, reflecting that investors prefer to invest in factors with lower capital investment efficiency, or allocate a higher capital risk premium to companies with higher capital investment efficiency.

In addition, Fama and French have demonstrated that the HML factor in the American stock market is "redundant" through empirical analysis [6], that is, the introduction of HML does not change the effectiveness of the model. The results in Table 4, results (2) and (3), indicate that the regression results of the HML factor in the FF3 and FF5 are very significant and have a very high level of confidence. This demonstrates that the HML factor is not redundant in the Chinese stock market. The size of the company's market value has a certain degree of impact on expected returns.

The above regression analysis basically coincides with the descriptive statistical results of the five factors, but the performance of the factors is affected by the special structure of the emerging market, investor preferences, market environment, and various factors such as data selection and processing methods. Further comprehensive consideration of various factors is needed to explore the performance of the factors.

3.3. Robustness Check

This article has verified the applicability of FF5 in the Chinese market. To further verify the reliability of the results and test the robustness of the model, this article will conduct regression analysis on the data before and after the COVID-19. Table 5 presents the least squares regression results of FF5 in the Chinese market for the periods of 1994-2019 and 2020-2024. In the results (1) and (2), it can clearly see that the results for RM-RF, SMB, HML, RMW, and CMA are all significant at the 1% level during the period of 1994-2019. Taking the COVID-19 as a node, the significance remains unchanged from 2020 to 2024, which is consistent with the main regression results. Therefore, the results are robust.

Table 5: Robustness testing results.

Variables	(1)	(2)
	1994-2019	2020-2024
RM -RF	0.990***	0.957***
	(0.00367)	(0.00319)
SMB	0.387***	0.446***
	(0.00979)	(0.00717)
HML	-0.457***	-0.320***
	(0.0107)	(0.00856)
RMW	-0.347***	-0.265***
	(0.0113)	(0.0103)
CMA	-0.343***	-0.403***
	(0.0143)	(0.0114)
Constant	-0.204***	-0.177***
	(0.000278)	(0.000214)
Observations	468,950	688,395
R-squared	0.204	0.184

Note: The figure in parentheses represents the standard errors; *** p<0.01, ** p<0.05, * p<0.1.

4. Conclusion

This paper compares the performance of the traditional asset pricing models CAPM, FF3, and FF5 in the A-share market, revealing that the CAPM model has insufficient explanatory power in the Chinese A-share market. The FF5 model has stronger explanatory power than other traditional models, but its performance is not significantly improved compared to the three-factor model. In terms of factor explanatory power, it is confirmed that the HML is not a "redundant factor" and has considerable explanatory power in the Chinese stock market. The addition of SMB and HML greatly enhances the performance of the model, while the addition of CMA and RMW only slightly improves the model's performance. The robustness analysis of FF5 also verifies the stability of the five-factor model's predictive power in the Chinese stock market. Nevertheless, this study still has certain limitations. The research in this article did not propose an innovative research method, and due to different sources of data and the scope of sample data selection, the analysis of the Chinese stock market cannot draw comprehensive conclusions. Given the particularities of the Chinese stock market as an emerging market and the relevant characteristics of Chinese financial market, the asset pricing models urgently need further optimization. Whether there are other important pricing factors also requires further research.

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