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An Empirical Study on Asset Pricing Models Based on The Chinese A-Share Market

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Abstract. Based on the analysis of the A-share markets in Shanghai and Shenzhen Stock Exchange from 2000 to 2023, this paper systematically evaluates the applicability and explanatory power of the Capital Asset Pricing Model (CAPM), the Fama-French Three-Factor Model (FF3) and the Fama-French Five-Factor Model (FF5) in the Chinese market. The study finds that although CAPM has some explanatory power in the early stage, the three-factor and five-factor models can better explain the cross-sectional changes in stock returns as the market develops. In the descriptive statistics, each factor's volatility and correlation reveal the Chinese market's unique characteristics, such as the relative strength of small-cap and growth stocks. In the regression analysis, the results of the Fama-MacBeth regression showed that the significance and explanatory power of the market factor, size factor and value factor were different in different models. Further robustness analysis reveals the COVID-19's impact on the model's performance through the sub-period analysis. This paper provides a new perspective on understanding the asset pricing of China's A-share market and a theoretical basis for investors' investment decisions. It also points out the limitations of existing models in explaining emerging market equity returns. It suggests that future research can deeply explore the performance of more factors in different market environments.

Keywords: Empirical Asset Pricing; Multiple Factor Models; Chinese A-Share Market.

1. Introduction

In modern finance, asset pricing models are a key tool for understanding securities pricing and expected returns. These models are essential for investors to make sound decisions and provide theoretical support for the stability and efficiency of financial markets. As financial markets continue to evolve, especially emerging markets, there is an increasing need for more accurate and applicable asset pricing models.

Since the 60s of the 20th centuries, with the introduction of the Capital Asset Pricing Model (CAPM) by Sharpe and Lintner, the asset pricing theory has ushered in an important breakthrough. CAPM assumes that investors hold a portfolio of markets and that the expected return of a security is a linear function of the market risk premium. This model quickly became a cornerstone of the financial sector due to its simplicity and intuitiveness. However, with the continuous development and change of the financial market, CAPM's limitations have gradually emerged. In 1993, Fama and French proposed a three-factor model that added size and value factors to CAPM, which significantly improved the flexibility to explain cross-sectional changes in stock returns and became a breakthrough in asset pricing. Davis, Fama and French's study of the U.S. market, and Loughran's study of emerging markets support the superiority of the three-factor model [1, 2].

However, with further research, scholars have found that the three-factor model also has shortcomings. Novy-Marx pointed out that profitability and investment models can further improve the explanatory power of the three-factor model. In response to this view, Fama and French launched a five-factor model in 2015 to further refine the asset pricing framework by adding profitability and investment factors [3]. Zhang used the five-factor model to perform regression analysis on Chinese biopharmaceutical stocks [4]. He found that market factors and size factors significantly impact excess returns. Huang's study also shows that the five-factor model outperforms traditional asset pricing models in explaining the return of Chinese individual stocks from 1994-2016 [5]. However,

Mosoeu and Kodongo found that the profitability factor in the five-factor model is most useful for explaining the cross-section of emerging market equity returns [6]. Still, this model underperforms on country-specific portfolios and geographically diversified portfolios.

With China's continuous development in the stock market, the research on the asset pricing model has gradually increased. Liu et al.'s study discussed the applicability of the Fama-French three-factor model (FF3) in the Chinese market, and the results showed that the model had some explanatory power [7]. However, they pointed out that the Chinese market may have unique characteristics, such as higher market volatility and different investor behaviors. These characteristics require further examination of the performance of multi-factor models in the Chinese market. Yang tested the CAPM and the three-factor models by using the daily trading data of the SSE 50 constituents and found that such models only have explanatory power in specific industries in the Chinese market [8].

Further studies, such as Wu's research, explored the relationship between corporate excess cash holdings and stock returns [9]. She found that when the market is positive, the quality of information disclosure is good, and the financing constraints are strong, the monthly returns of stocks in the high excess cash holding group are significantly higher than those in the low excess cash holding group. Wang conducted a comprehensive analysis of multi-factor models, quantitative investment, fundamental analysis and event driven. He found that these factors have reference value in investment strategies in the context of China's comprehensive deepening reform of the stock market [10]. Similarly, Yang found in an empirical analysis of 68 real estate companies in China's A-share market that the five-factor model's explanatory power is significantly improved compared with the three-factor model [11].

Researchers have continuously improved and expanded the traditional Fama-French model in recent years by introducing new factors to enhance its applicability and explanatory power in the Chinese market. Ni added the heterogeneous rate of return factor based on the five-factor model. He found that the absolute mean, GRS statistic and t-statistic of the α of the tested assets were greatly reduced, significantly improving the original model's pricing effect [12]. Furthermore, Zhang found that the six-factor model with green factors applies to China's green fund market, and the green factor significantly positively impacts excess return [13]. López-García et al. proposed and discussed a new long-term memory factor used to extend the original models and calculated using the fractal dimension algorithm [14]. The empirical data verified that the model has credible explanatory power.

Although there has been a lot of research on multi-factor models, there are still some gaps in the application of multi-factor models in China's A-share market. Most of the studies focus on the three-factor model, and there are few studies on the applicability of the five-factor model in the Chinese market. In addition, there is limited research on the impact of major events such as the pandemic on model performance. This study aims to comprehensively analyze the effectiveness of the CAPM, three-factor and five-factor models in the A-share markets of Shanghai and Shenzhen Stock Exchange from 2000 to 2023. This paper uses standard regression techniques to estimate the parameters of these three models and compare their explanatory power in the Chinese market. Subsequently, this paper uses multiple models to segment the sample data and compare the model's performance in the two time periods from 2000 to 2019 and 2020 to 2023 to study the impact of the COVID-19 pandemic on the model's explanatory power.

2. Methodology

2.1. Data Selection

The sample period selected for this paper is the stock data of the A-share markets in Shanghai and Shenzhen Stock Exchange from 2000 to 2023, originally derived from the CSMAR database. The data from this period covers sufficient market information to ensure the timeliness and comprehensiveness of this study.

In addition, the risk-free interest rate selected for this study is a one-year time deposit rate, which is relatively stable and representative of the Chinese market. The market capitalization indicator selects the circulating market capitalization, which can more accurately reflect the actual situation of the market. The market return is calculated using the weighted average of the float market capitalization method. It considers the comprehensive monthly market return on which the cash dividend is reinvested to provide more accurate market performance data.

Furthermore, to ensure the validity of the data and the reliability of the research results, the following general processing of the data is carried out in this paper: (1) Exclude data for the first six months after IPO (including listing month); (2) Exclude stocks that have been included in special treatment (ST), stocks that have been in a state of loss for three consecutive years, and stocks that have been alerted (*ST) or specific transfer (PT); (3) Exclude stocks in the financial sector that are significantly different from the financial characteristics of other industries; (4) Exclude stocks with negative book value at risk of bankruptcy.

2.2. Variable Construction

This paper refers to the method introduced on the Ken French website to construct comparable asset pricing factors. The specific variables are constructed as follows.

The dependent variable in this study is the monthly excess return of individual stocks, $R_{it} - R_{ft}$, where R_{it} is the yield of the ith stock in t month, R_{ft} is the risk-free rate in t month.

In order to construct the independent variables required for CAPM, three-factor model and five-factor model, the following factors are introduced in this paper. The independent variables are constructed as shown in Table 1.

Table 1. Variable Definitions.

Symbol	Variable	Definition
MKT	Risk factor	The value-weighted return of all A-shares (including Shanghai and Shenzhen Stock Exchange) minus the risk-free rate.
SMB	Size factor	Stocks are sorted by the mid-year market to calculate the average value of the portfolio with small-cap and large-cap.
HML	Value factor	Stocks are sorted by book-to-market ratio to calculate the difference in monthly returns between stocks with high and low book-to-market ratios.
RMF	Profitability factor	Stocks are sorted by profitability to calculate the difference in monthly returns for high- and low-profitability stocks.
CMA	Investment factor	Stocks are sorted by investment level to calculate the difference in monthly returns for low-to-high-investment stocks.

2.3. Modelling

This study mainly analyzes the capital pricing model (CAPM), the Fama-French three-factor model and the five-factor model to comprehensively evaluate the applicability and effectiveness of different asset pricing models in China's A-share market.

CAPM is the most basic asset pricing model that predicts an asset's expected rate of return through the market risk premium and the asset's beta. Three-factor model includes a size factor (SMB) and a value factor (HML) to CAPM, significantly improving the explanatory power of stock returns. Five-factor model includes a profitability factor (RMW) and an investment factor (CMA) to the three-factor model. The formula for the five-factor model is as follows.

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) + s_i\text{SMB} + h_i\text{HML} + r_i\text{RMW} + c_i\text{CMA} \quad (1)$$

$E(R_i)$ is the expected rate of return of asset i, R_f is the risk-free interest rate, β_i is the beta coefficient of asset i, which measures the systemic risk of the asset relative to the market portfolio, $E(R_m)$ is the expected rate of return of the market portfolio. $s_i,\ h_i,\ r_i,\ c_i$ is the sensitivity of asset i to each factor.

2.4. Robustness Check

Robustness analysis is a key step in the empirical test of the asset pricing model to ensure the reliability and applicability of the model results. This study will use a sub-period analysis method to divide the sample data into two sub-periods: pre-pandemic (2000-2019) and intra-epidemic (2020-2023). This approach helps identify models' performance differences in different market environments, especially in response to unexpected events like the COVID-19 pandemic. The COVID-19 pandemic has profoundly impacted global financial markets, with markets experiencing unprecedented volatility and significant changes in investor confidence and expectations. With this analysis, it is possible to identify how the model performs under stable market conditions and assess its adaptability during a crisis.

3. Empirical Results

3.1. Descriptive Statistics

Table 2 shows the descriptive statistics of five factors, showing the statistics of a total of 620,018 data after the elimination of the original data, including the mean, standard deviation, minimum, median and maximum of each factor.

Table 2. Descriptive Statistics

	mean	sd	min	p50	max
MKT	0.442	6.767	-26.835	0.203	29.604
SMB	0.263	3.733	-16.603	0.229	15.008
HML	-0.315	4.677	-28.874	-0.443	18.296
RMW	-0.007	2.929	-15.273	0.075	13.570
CMA	0.062	2.511	-10.576	0.023	8.615

In Table 2, the standard deviation of the market factor is 6.767, indicating high volatility in market returns over the sample period. The minimum value of this factor is -26.835 and the maximum value is 29.604. These extremes reflect the extreme volatility of the market over a specific period. Specifically, China's stock market has experienced several important stages of development and market volatility from 2000 to 2023, including the 2008 financial crisis, the abnormal stock market volatility in 2015, and the Covid-19 epidemic in 2020.

The minimum value of the size factor is -16.603 and the maximum value is 15.008, which indicates that small-cap companies have significantly outperformed or underperformed large-cap companies in certain periods. Small-cap companies are more volatile due to their lower market share and liquidity, which are more affected by changes in market sentiment and the economic environment. In addition, there are more policy interventions and economic restructuring in the Chinese market, which also lead to fluctuations in the returns of small-capitalization companies.

In terms of value factor, the median value factor was -0.443, indicating that the value factor performed negatively most of the time during the sample period. The Chinese market has experienced rapid

economic growth during the sample period. With the rapid rise of emerging industries and high-tech companies, many investors have attracted them due to their high growth potential.

The average value of the profitability factor is -0.007, which is close to zero. This indicates a smaller return difference between companies with strong and weak profitability over the sample period. This reflects that market participants in the Chinese market are more focused on the company's growth potential and policy support than just looking at current profitability.

The investment factor's standard deviation is 2.511, indicating that the difference in returns between low- and high-investment companies is insignificant. This reflects that in the Chinese market, companies' investment decisions are more influenced by macroeconomic policies and market expectations than by the level of investment alone.

3.2. Correlation Analysis

When performing multivariate model analysis, it is important to understand the correlation between factors for the effectiveness and explanatory power of the model. Table 3 shows the correlation coefficients between the factors in the five-factor model.

Table 3. Correlation Matrix

	MKT	SMB	HML	RMW	CMA
MKT	1.000				
SMB	0.174***	1.000			
HML	-0.109***	-0.291***	1.000		
RMW	-0.260***	-0.561***	-0.024***	1.000	
CMA	-0.103***	0.055***	0.640***	-0.493***	1.000

Note: *** indicates significance at a significance level of 1%.

MKT is positively correlated with SMB (0.174), indicating that when market returns increase, so do small-cap stock returns. This is because China's stock market is dominated by retail investors with a higher risk appetite and a preference for investing in small-capitalization stocks when the market is rising. MKT negatively correlates with RMW (-0.260), indicating that when market returns are high, highly profitable companies do not perform as expected, as investors focus more on growth potential than current earnings.

SMB is positively correlated with the market factor (MKT) (0.174) but negatively correlated with other factors, especially RMW and HML (-0.561 and -0.291, respectively). Small-cap companies tend to be fast-growing, and investors prefer to see them as growth rather than value in Chinese market. In addition, many small-capitalization companies in the Chinese market belong to emerging industries. Although the growth potential is high, the profit model is not yet mature, resulting in fewer companies with high profitability.

There is a strong positive correlation between HML and CMA (0.640). Companies with a high book-to-market ratio are usually also low-investment companies. In the Chinese market, most of these companies are mature in traditional industries, with conservative expansion capital expenditures and low investment levels. There companies focus more on stable returns and avoid the risks associated with large-scale investments.

The negative correlation between RMW and CMA is strong (-0.493), suggesting that companies with high profitability are generally high-investment companies. In the Chinese market, companies with strong profitability tend to be in emerging industries, which require continuous investment to maintain their competitive advantage. Meanwhile, they have stronger profitability and financial resources to make more investments.

3.3. Regression Results

Regression analysis is a key step in studying asset pricing models for the Chinese stock market. This paper tests each factor's significance and explanatory power by the Fama-MacBeth regression method and the CAPM, FF3 and FF5 models.

3.3.1. Fama-MacBeth Benchmark Regression Results

Table 4 shows the results of the Fama-MacBeth benchmark regression based on the CAPM, FF3, and FF5 models. MKT is significantly positive in all models, indicating that the market factor has significant explanatory power on individual stock returns. In both the FF3 and FF5 models, SMB and HML are significant, indicating that these two factors are equally important in explaining individual stock returns. In the FF5 model, RMW is significantly negative, while CMA is not, but the five-factor model generally provides a more comprehensive explanatory power.

Table 4. Fama-MacBeth Benchmark Regression Results

	CAPM	FF3	FF5
MKT	1.003***	0.597***	0.561***
	(15.644)	(16.749)	(15.942)
SMB		0.162***	0.120***
		(6.244)	(5.348)
HML		-0.075***	-0.062***
		(-3.349)	(-2.872)
RMW			-0.060***
			(-3.746)
CMA			-0.001
			(-0.213)
Constant	0.025	0.007	0.005
	(0.452)	(0.758)	(1.000)
N	620018	620018	620018
F	244.736	178.851	99.847

3.3.2. Model Comparison

Table 5, Table 6 and Table 7 show the regression results of the CAPM, FF3 and FF5 model, respectively. In the CAPM model, the average value of the α is 0.009, indicating that the abnormal returns of most individual stocks are small. The market factors explain the returns of individual stocks well. The mean value of adj. R^2 is 0.2193, indicating that the explanatory power of market factors is limited. In the FF3 model, the average value of α decreased to 0.0056, which was slightly lower than that of the CAPM model. The mean value of adj. R^2 increased to 0.3309, indicating that the introduction of scale and value factors significantly enhanced the explanatory power. In the FF5 model, the average value of α further decreased to 0.0007 and adj. R^2 increased to 0.3382, indicating that the introduction of profit factors and investment factors further enhanced the explanatory power. However, the CMA factor was not significant in this data set.

Based on the comprehensive evaluation of the above three models, MKT is significantly positive, indicating that the market factor has a strong explanatory power on the return of individual stocks. This is consistent with the market-driven nature of China's stock market, where changes in investor sentiment and macroeconomic policies have a greater impact on the market. Meanwhile, China's stock market has a strong policy orientation, and the government's macroeconomic control measures, monetary policy and fiscal policy changes significantly impact market fluctuations.

Table 5. CAPM Model Regression Results

	mean	sd	min	p50	max
α	0.009	0.043	-0.1131	0.0042	0.9206
Aα	0.0143	0.0415	0	0.0068	0.9206
se	0.0177	0.0256	0.0033	0.0121	0.8348
t-stat	0.3448	0.9023	-10.5589	0.3945	28.9509
p-value	0.5595	0.2631	0.0001	0.5696	0.9998
adj_R^2	0.2193	0.175	-1	0.2274	0.9933

Table 6. FF3 Model Regression Results

	mean	sd	min	p50	max
α	0.0056	0.047	-0.6827	0.0017	1.0487
Aα	0.0135	0.0454	0	0.0056	1.0487
se	0.0168	0.0273	0.0031	0.0109	0.8489
t-stat	0.1312	0.9354	-5.6443	0.1789	27.1711
p-value	0.5861	0.2678	0	0.6112	1
adj_R^2	0.3309	0.2123	-1.9961	0.364	0.9941

Table 7. FF5 Model Regression Results

	mean	sd	min	p50	max
α	0.0007	0.0269	-0.9869	0.0011	0.4547
Aα	0.0115	0.0244	0	0.0059	0.9869
se	0.0175	0.0301	0.0012	0.011	0.9585
t-stat	0.0592	1.0303	-32.8835	0.114	3.7619
p-value	0.5748	0.2754	0	0.6044	0.9999
adj_R^2	0.3382	0.2565	-2.5534	0.3763	0.999

In both the FF3 and FF5 models, SMB is significant and positive, indicating that small-capitalization stocks have higher alpha in the Chinese market. This may be due to the rapid growth of China's economy and innovation-driven strategy, which has led to the outperformance of many small-capitalization companies, especially technology-based companies. In addition, small-cap companies are more likely to be favored by market sentiment and speculative funds, resulting in higher volatility in their stock prices.

HML is significantly negative in both the FF3 and FF5 models, reflecting the outperformance of growth stocks relative to value stocks in the Chinese stock market. This aligns with the Chinese market's recent preference for emerging industries and high-tech companies. Chinese stock market investors pay more attention to emerging industries such as technology, pharmaceuticals, and new energy, and companies in these industries usually have high growth and market expectations.

In the FF5 model, the newly introduced RMW is significantly negative, indicating that high-profit companies are underperforming in the Chinese market, related to higher expectations of high-growth companies and a highly competitive industry environment. However, CMA is not significant, indicating that the impact of investment activities on individual stock returns is weak or complex in the Chinese market.

The five-factor model provides a more comprehensive explanatory power of individual stock returns by introducing profit and investment factors. Although the investment factors are insignificant, the five-factor model performs best overall, better capturing the characteristics and changes of the Chinese stock market.

3.4. Robustness Check

To further verify the robustness of the five-factor model, this paper performs regression analysis on data from two different periods, 2020-2023, and 2000-2019. Table 8 below shows the 2000-2019 and 2020-2023 regression results.

Table 8. Robustness Analysis of FF5

	FF5 (2000-2019)	FF5 (2020-2023)
MKT	0.630***	0.213***
	(16.253)	(3.368)
SMB	0.115***	0.146**
	(4.682)	(2.603)
HML	-0.056**	-0.094
	(-2.523)	(-1.369)
RMW	-0.065***	-0.032
	(-3.549)	(-1.214)
CMA	0.001	-0.012
	(0.259)	(-1.000)
Constant	0.006	0.000
	(1.000)	(.)
N	421642	198376
F	104.095	6.531

The regression analysis of the two periods shows that the market and size factors are significant in FF5 models. They are both positive in both periods, and there is no significant difference. In addition, the investment factor was insignificant in both periods, indicating that the impact of investment activities on individual stock returns is weaker or more complex in the Chinese market. Lu's study also found that the outbreak of the epidemic in 2020 did not affect the change in the relationship between investor sentiment and stock indexes [15].

However, the profitability factor was significantly negative in the period 2000-2019 and not significantly in the period 2020-2023, reflecting the differences in the performance of highly profitable companies in different market cycles. During the period from 2000 to 2019, highly profitable companies performed poorly as the Chinese stock market underwent multiple policy changes and market reforms, leading the market to focus more on the company's future growth potential than on current profitability. Traditional companies with high profitability may be seen as having limited growth potential and, therefore, underperforming. This period also included China's rapid economic growth after China acceded to the WTO, the 2008 global financial crisis, and the unusual volatility of the stock market in 2015, all of which had a profound impact on the preferences of market investors.

In the shorter period of 2020-2023, the profitability factor becomes insignificant. This may be due to the uncertainty of the global economy caused by the pandemic, which has led to a change in the market's criteria for evaluating profitability. High-profitability companies may be more favored during the pandemic due to their stable cash flow and ability to resist risks, which will weaken the

significance of the profitability factor. In addition, government stimulus policies and industry restructuring have also changed investors' preferences for different types of companies.

4. Conclusion

This study mainly explores the applicability and effectiveness of the CAPM, FF3 model and FF5 model in China's A-share market. Using the monthly data of the A-share markets in Shanghai and Shenzhen Stock Exchange from 2000 to 2023, this paper estimates the parameters of each model by standard regression technology and performs various diagnostic tests and analyses. The results show that the five-factor model has the best-fitting effect. In particular, through the sub-period analysis of the sample data, this paper studies the impact of the new crown epidemic on the model's explanatory power and finds that the five-factor model still has strong explanatory power during the epidemic.

In terms of descriptive statistics, the study found that the Chinese market had large volatility during the sample period, and the market characteristics were obvious. Correlation analysis showed a significant correlation between different factors, further explaining the interaction of various factors in the model. In the regression analysis, the five-factor model shows the strongest explanatory power, especially in the case of large market volatility.

Although this study validates the model's effectiveness through a large amount of data and various analysis methods, there are still some limitations. First, the data sample in this paper does not consider data from other markets (such as the Beijing Stock Exchange), which may affect the full applicability of the model. Additionally, this paper mainly uses the traditional regression technique, which may not fully capture the financial market's nonlinear relationships and complex dynamic changes.

Future research can explore the following aspects in depth. First, the scope of the study can be expanded to include a wider range of market data to verify the applicability and effectiveness of the model. Second, more sophisticated machine learning and nonlinear regression techniques can be used to capture potentially complex dynamic relationships in the market. Finally, more variables reflecting market behavior and sentiment, such as investor sentiment index and market liquidity indicators, can be considered further to enhance the explanatory power and applicability of the model. Through these further studies, it is hoped that it can provide more accurate and valuable references for investors and policymakers.

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