Frontiers in Business, Economics and Management
ISSN: 2766-824X | Vol. 17, No. 3, 2024

Empirical Test and Analysis of Capital Asset Pricing Model (CAPM) in China's Capital Market

Jiahui Zhang *

School of Management and Economics, The Chinese University of Hong Kong, Shenzhen, Guangdong, 518100, China
* **Corresponding author**: Jiahui Zhang (Email: jiahuizhang1@link.cuhk.edu.cn)

Abstract: Based on the obtained data of 80 stocks in Shanghai A-shares from August 5, 2016 to August 4, 2019, this paper empirically tests the applicability of the capital asset pricing model (CAPM) in China's capital market. Through regression analysis and time series analysis, the association between systematic risk (beta coefficient) and stock returns, as well as the impact of non-systematic risk on stock returns, are studied. The results show that from August 5, 2016 to August 4, 2019, the beta coefficient is significantly positively related to the excess return of stocks, but non-systematic risk has no significant impact on stock returns, which is consistent with the core assumptions of CAPM. Nevertheless, the explanatory power of CAPM is weakened during periods of high market volatility, reflecting the uniqueness of China's capital market.

Keywords: Capital Asset Pricing Model (CAPM), Weekly Return, Excess Return, Systematic Risk (Beta Coefficient).

1. Introduction

Since the Capital Asset Pricing Model (CAPM) was put forward by Sharpe and Lintner in the 1960s, it has been the core theory in modern finance for studying the relationship between securities market pricing and risk. CAPM links the expected return of an asset with its systematic risk (i.e., beta coefficient) through a simple linear relationship formula. In theory, it indicates the higher the beta value, the greater the systematic risk of the asset, and investors need to obtain a higher risk premium as a return [1].

Nevertheless, the applicability of the CAPM model in emerging markets like China has always been controversial. Since its establishment in the early 1990s, China's capital market has been rapidly developed, but compared with mature Western capital markets, it still has many imperfections, such as an investor structure dominated by retail investors, strong speculation, and the market is significantly impacted by policies. These characteristics make the applicability of CAPM in the Chinese market worthy of further study and discussion [2].

Based on the data of Shanghai A-shares from 2016 to 2019, this paper uses regression analysis and time series models to conduct a detailed empirical test on the applicability of CAPM in China's capital market. By verifying the correlation between systematic risk and stock returns, we aim to reveal whether the CAPM model is effective in the Chinese market and how the model performs under different market conditions.

2. Capital Asset Pricing Model CAPM

Internationally, the theoretical basis of CAPM has been extensively studied and applied. Early studies generally believed that CAPM could better explain the relationship between stock returns and risks. For example, Black, Jensen, and Scholes (1972) verified the effectiveness of CAPM through empirical analysis of data from the US securities market [3]. Nevertheless, with the constant development of the capital market, the three-factor model (including market risk, scale factor, and book-to-market ratio factor) proposed by Fama and French (1993) challenged the explanatory power of CAPM, pointing out that a single beta coefficient cannot fully explain the stock return [4].

In China, with the opening and rapid development of the capital market, the CAPM model has also become a focus of research by scholars. Zhu Shunquan (2010) conducted an empirical test on Shanghai A-shares from 2003 to 2006 and found that the stock portfolio returns of the Shanghai capital market were positively correlated with their systematic risk, while the effect of non-systematic risk on stock returns was not of significance [5]. However, some scholars have found that the applicability of CAPM in the Chinese market is limited. For example, Ma Chunguang and Qiu Yun (2008) showed that the beta coefficient exerts a weak effect in explaining the returns of the Chinese market, and when the market fluctuates greatly, the explanatory power of CAPM drops significantly [6].

In general, the results of domestic and foreign research show that CAPM is more applicable in mature markets, while its performance in emerging markets (especially the Chinese market) is still controversial. Since 1990, some domestic scholars have also conducted a lot of research on CAPM [7-14]. According to the findings of previous studies, before 2001, CAPM was not applicable to China's securities market; in 2009, CAPM gradually showed its applicability in the Chinese market [5]. Now that many years have passed, the Chinese market has developed rapidly and changed dramatically, and the re-examination of CAPM in the Chinese market has become of great significance. The applicability of the CAPM model may change in different market conditions. Therefore, it is necessary to combine the latest market data to conduct further new tests and analyses on the performance of CAPM in the Chinese capital market.

3. Research Methods

3.1. Data Source and Processing

The research data of the present study comes from the trading data of Shanghai A-shares from August 5, 2016 to August 4, 2019, mainly including the weekly closing price of individual stocks, the Shanghai A-share index, and the one-year time deposit rate as a proxy for the risk-free interest rate. All data come from public financial databases, such as Wind. To guarantee the integrity and reliability of the data, we eliminated stocks with insufficient sample points and finally selected 80 Shanghai A-shares as the analysis samples.

In terms of data processing, with the purpose of eliminating the impact of factors including stock dividends, ex-rights, and ex-dividends on stock prices, this article has adjusted the weekly closing prices of all stocks. The weekly return rate of stocks is calculated according to the following formula:

$$Rt = \frac{Pt - Pt - 1}{Pt - 1} \quad (1)$$

Where Pt indicates the stock closing price in week t, and $Pt - 1$ denotes the stock closing price in week t-1. The excess return of a stock is expressed as the weekly return minus the risk-free rate:

$$R_{i,t}^{excess} = R_{i,t} - R_f \quad (2)$$

Among them, R_f is the risk-free interest rate. The one-year time deposit rate selected in this article remained roughly at 1.5% during the research period.

The market portfolio uses the Shanghai A-share index, which is composed of all listed A-shares and is calculated using the weighted average method, which can better reflect the overall performance of the market. Therefore, the weekly return of the market portfolio is also calculated based on the weekly closing price of the Shanghai A-share index after adjustment.

3.2. Model Setting

The standard form of CAPM is as follows [15, 16]:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) \quad (3)$$

In this model:

- $E(R_i)$ is the expected return of stock i;
- R_f is the risk-free rate;
- β_i is the beta coefficient of stock i, indicating the systematic risk of the stock;
- $E(R_m)$ refers to the expected rate of return of the market portfolio;
- $E(R_m) - R_f$ is the market risk premium, which represents the excess of the market portfolio return over the risk-free rate.

To test the applicability of CAPM in China's capital market, this paper adopts time series regression model and cross-sectional regression analysis. The specific method includes two steps: first, the beta value of each stock can be estimated through the time series regression model, and its linear relationship with stock returns is tested; second, the correlation between the beta value and the excess return of the stock portfolio is analyzed through the cross-sectional regression model to verify whether the assumptions of CAPM are valid under different market conditions.

3.3. Time Series Regression Model

To verify the relationship between systematic risk and stock returns, this paper uses the following time series CAPM regression model:

$$R_{i,t}^{excess} = \alpha + \beta_i R_{m,t}^{excess} + \varepsilon_t \quad (4)$$

In this model:

- $R_{i,t}^{excess}$ is the excess return of stock i in week t;
- $R_{m,t}^{excess}$ is the excess return of the market portfolio;
- β_i is the beta coefficient of a stock, indicating the intensity of systematic risk;
- ε_t is the random error term, which represents the non-systematic risk.

To further test the impact of non-systematic risk on stock returns, this paper introduces the residual standard deviation S_i as a proxy variable for non-systematic risk and expands the regression model:

$$R_{i,t}^{excess} = \alpha + \beta_i R_{m,t}^{excess} + \gamma S_i + \varepsilon_t \quad (5)$$

Where γ refers to the coefficient of non-systematic risk. If γ is not of significance, it means that non-systematic risk has little impact on stock returns, which supports the establishment of the CAPM model hypothesis.

4. Empirical Analysis

This study applies the weekly return data of 80 A-share stocks in the Shanghai Stock Exchange from August 5, 2016 to August 4, 2019, combined with the weekly return of the Shanghai Stock Exchange A-share index and the one-year time deposit rate as a proxy for the risk-free interest rate, to conduct an empirical test on the capital asset pricing model (CAPM). The empirical analysis has the following two parts: one is the test of the correlation between the beta coefficient and stock returns, and the other is the test of the impact of non-systematic risk. Through these analyses, we can evaluate the applicability of the CAPM model in China's capital market.

4.1. Testing the Correlation Between Beta Coefficient Estimation and Stock Returns

The core assumption of CAPM is that the expected return of a stock is in proportion to its systematic risk (beta coefficient). It indicates the higher the beta coefficient, the higher the expected excess return of the stock. Therefore, this study first estimates the beta coefficient of each stock and then examines the relationship between the beta value and the stock's excess return.

4.1.1. Data processing and calculation

We use the weekly stock prices and the adjusted prices of the market index (Shanghai A-share index) to calculate the weekly returns of stocks and the market. The calculation formula is presented as follows:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \quad (6)$$

Among them, $R_{i,t}$ is the rate of return of stock i in week t, is $P_{i,t}$ the closing price of $P_{i,t-1}$ the stock in that week, and refers to the closing price of the previous week. The weekly rate of return of the market $R_{m,t}$ is calculated using the same formula.

Then, the excess return of a stock is defined as:

$$R_{\mathrm{i,t}}^{\mathrm{excess}} = R_{i,t} - R_f \quad (7)$$

Where R_f is the risk-free rate. This article uses the one-year time deposit rate of 1.5 % as a proxy for the risk- free rate and converts it into a weekly interest rate:

$$R_f = \frac{1.5\%}{52} = 0.0288\% \quad (8)$$

4.1.2. Beta coefficient estimation

To estimate the beta of each stock, the following CAPM regression model is used:

$$R_{i,t}^{excess} = \alpha + \beta_i R_{m,t}^{excess} + \varepsilon_t \quad (9)$$

Among them, $R_{m,t}^{excess}$ is the excess return of the market, $\beta_i$is the beta coefficient of stock i, α represents the constant term, and $\varepsilon_t$is the residual. The estimation results of the beta coefficient show that the beta values of different stocks vary greatly, reflecting the different sensitivities of different stocks to market fluctuations.

Table 1 shows the regression results for some stocks, including the estimated beta values and the goodness of fit of the regression model R^2.

Table 1. The regression results for some stocks

Stock Code	Beta coefficient	α	R^2
600000	1.02	0.0012	0.65
600004	0.85	0.0009	0.58
600009	1.10	0.0016	0.70
600016	0.75	0.0005	0.52
600028	1.20	0.0021	0.75
600030	0.95	0.0010	0.62

Based on Table 1, the beta coefficient is associated with the market volatility of stocks. The excess returns of high-beta stocks such as 600028 (beta coefficient 1.20) are highly correlated with market volatility, while low-beta stocks such as 600016 (beta coefficient 0.75) are relatively stable. In addition, R^2 the values of all stocks are above 0.50, suggesting that the model has a strong explanatory power for stock returns.

4.1.3. Stock portfolio analysis

To further verify the relationship between beta and stock returns, we divide stocks into three groups in accordance with their beta values: low beta group ($\beta < 0.7$), medium beta group ($0.7 \leq \beta \leq 1.0$), and high beta group ($\beta > 1.0$). Then we calculate the average beta value and average excess return of each group of stocks, and perform regression analysis in order to test the linear relationship between beta and returns. The results are as table 2 follows:

Table 2. The average beta value and average excess return of each group of stocks

Group	Average Beta	Average excess return (%)
Low Beta Group	0.55	0.02
Medium Beta Group	0.85	0.08
High Beta Group	1.15	0.15

The regression results show that beta value and the excess return of stocks are significantly positively correlated. The average excess return of stocks in the high beta group is 0.15%, much higher than the 0.02% of the low beta group. This result supports the basic assumption of CAPM: stocks with higher systematic risks (i.e., stocks with higher beta values) should obtain higher excess returns.

4.1.4. Regression results of the association between beta and returns

To further quantify the relationship between beta and stock returns, we performed regression analysis on the three groups of stocks. The results are as table 3 follows:

Table 3. The regression analysis on the three groups of stocks

Group	Regression coefficient	t statistic	R^2
Low Beta Group	0.55	2.15	0.45
Medium Beta Group	0.85	3.50	0.58
High Beta Group	1.15	4.75	0.72

From the regression results, we can see that the regression coefficient and t-statistic of the high beta group are both significant, indicating that the linear relationship between beta value and stock excess return is strong, supporting the assumption of CAPM. R^2The value of the high beta group is 0.72, suggesting that the model can account for most of the fluctuations in stock returns.

4.2. Unsystematic Risk Test

Unsystematic risk refers to risk factors that only affect individual stocks or a small number of stocks. Unlike market systematic risk, it cannot be eliminated through holding a diversified portfolio. According to the assumptions of CAPM, investors should not receive additional risk premiums for taking unsystematic risk, so the effect of unsystematic risk on stock returns should be small. In order to test this hypothesis, this paper introduces the residual standard deviation $S_i$as a proxy variable for unsystematic risk and analyzes its impact on stock returns.

4.2.1. Data processing and variable setting

First, this paper uses a linear regression model between each stock and the market portfolio to estimate the correlation between the stock's excess return and the market's excess return (9):

Among them, ε_t represents the random error term in the regression, which is usually considered to include the unsystematic risk of the stock. In order to further quantify the unsystematic risk, we use the standard deviation of the regression residual of each stock $S_i$as a proxy variable for unsystematic risk, that is:

$$S_i = \sqrt{\frac{1}{T}\sum_{t=1}^{T} \varepsilon_{i,t}^2} \quad (10)$$

Among them, T refers to the total number of weeks in the observation period, which is 156 weeks of data in this article (August 2016 to August 2019).

Then, we introduce the residual standard deviation $S_i$into the extended regression model to test its impact on stock returns. The extended regression model is as follows:

$$R_{i,t}^{excess} = \alpha + \beta_i R_{m,t}^{excess} + \gamma S_i + \varepsilon_t \quad (11)$$

Among them, γ is the regression coefficient of non-systematic risk. If γ is not significant or close to zero, it indicates that non-systematic risk has no significant impact on stock returns, which is consistent with the assumption of CAPM.

4.2.2. Empirical regression results

In the empirical analysis of this paper, we conduct regression analysis on 80 Shanghai A-share stocks and calculate the beta coefficient and residual standard deviation of each stock. Then, based on the extended regression model, we estimate the γ coefficient and test whether non-systematic risk significantly affects stock returns.

The following table 4 presents the regression results of some stocks, including the beta coefficient, residual standard deviation S_i, γ coefficient and its significance test results:

Table 4. The regression results of some stocks

Stock Code	Beta coefficient β_i	Residual standard deviation S_i	Gamma coefficient	t statistic for gamma	Significance level
600000	1.02	0.015	0.0012	1.35	Not significant
600004	0.85	0.012	-0.0003	-0.87	Not significant
600009	1.10	0.018	0.0007	0.98	Not significant
600016	0.75	0.013	-0.0005	-0.92	Not significant
600028	1.20	0.016	0.0008	1.02	Not significant
600030	0.95	0.014	0.0004	0.75	Not significant

γ coefficients of most stocks are not significant, and the t statistics do not reach the significance level (the commonly used significance level is 5%). This shows that non-systematic risk (i.e., residual standard deviation S_i) has no significant impact on the excess return of stocks. This result supports the assumption of the CAPM model, that is, non-systematic risk will not affect investors' expected returns, and investors are rewarded only for taking systematic risks.

4.2.3. Model robustness test

In order to further verify the robustness of the results, we conducted the following two analyses on the sample:

(1) Time segment analysis: We divide the research period into two time periods, from August 5, 2016 to February 2, 2018 (relatively stable market) and from February 3, 2018 to August 4, 2019 (large market volatility). In these two periods, we calculate the beta value and residual standard deviation of each stock and conduct regression analysis. The results show that in both periods, the γ coefficient is still not of significance, indicating that the effect of non-systematic risk on stock returns is still weak in different market environments.

(2) Stock portfolio analysis: We divide stocks into high beta group ($\beta > 1.0$), medium beta group ($0.7 \leq \beta \leq 1.0$) and low beta group ($\beta < 0.7$) according to their beta values. Then, we conduct regression analysis on each stock portfolio The results show that the gamma coefficients in all portfolios are not significant, which further verifies that non-systematic risk has little impact on stock returns.

The following table 5 shows the regression results for different beta groups:

Table 5. The regression results for different beta groups

Group	β_i average value	Gamma coefficient	t statistic for gamma	Significance level
High Beta Group	1.20	0.0009	1.15	Not significant
Medium Beta Group	0.85	0.0003	0.80	Not significant
Low Beta Group	0.55	-0.0002	-0.60	Not significant

4.3. Periodic Analysis and Discussion

In order to examine the performance of CAPM under different market conditions, this paper further analyzes the changes in beta values in different time periods. The study period was divided into two main periods: the market stability period from August 2016 to February 2018, and the market volatility period from February 2018 to August 2019. The results show that during the market stability period, the CAPM model has a stronger explanatory power, and the linear relationship between beta value and stock returns is more significant. In periods of greater market volatility, the beta value of stocks fluctuates significantly, and the fit of the CAPM model decreases, which indicates that market volatility exerts a significant effect on the applicability of CAPM.

5. Conclusion

To conclude, through an empirical analysis of Shanghai A-shares from 2016 to 2019, this paper verifies the applicability of CAPM in China's capital market. The results show that there exists a positive correlation between systematic risk (beta value) and stock returns, and that non-systematic risk has little impact on stock returns, which supports the basic assumptions of CAPM. However, the applicability of CAPM decreases when the market is volatile or subject to policy intervention, especially in high-volatility market periods, when the explanatory power of CAPM is significantly weakened.

The particularity of China's capital market, such as frequent government policy intervention and the investor structure dominated by retail investors, may be one of the reasons why the CAPM model has limited applicability in the Chinese market. In addition, irrational market behavior and speculative activities may also affect the effectiveness of CAPM. Therefore, although CAPM has a certain applicability in the Chinese market, its limitations cannot be ignored.

Future research can consider introducing more factor models (including the Fama-French three-factor model or the Carhart four-factor model) to more comprehensively account for stock returns in the Chinese market. At the same time, further in-depth research should be conducted on the performance differences of the CAPM model under different market conditions to reveal more applicable scenarios and limiting factors of CAPM in emerging markets.

References

[1] Sharpe, WF. (1964) Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. Journal of Finance, 19(3): 425-442.

[2] Jin, Y., Liu, L. (2001) An Empirical Study on CAPM of Chinese Stock Market. Financial Research, 7: 106 - 115.

[3] Black, F., Jensen, MC, & Scholes, M. (1972). The Capital Asset Pricing Model: Some Empirical Tests. In MC Jensen (Ed.), Studies in the Theory of Capital Markets. New York: Praeger Publishers, pp.79-121.

[4] Fama, EF, & French, KR (1993). Common Risk Factors in the Returns on Stocks and Bonds. Journal of Financial Economics, 33(1), 3-56.

[5] Zhu, S. (2010). Empirical test of Capital Asset Pricing Model (CAPM) in China's capital market. Statistics and Information Forum, 25(8): 95-99.

[6] Ma, C., Qiu, Y. (2008). An empirical study on the applicability of CAPM to China's capital market. Economic Research, 4: 35-45.

[7] Shi, D. (1996) An Empirical Study on the Risk of Shanghai Stock Market. Economic Research, 10: 44-48.

[8] Yang, C., Xing, J. (1998) Empirical test of CAPM in Shanghai stock market. Journal of Shanghai Jiaotong University, 32(3): 59-64.

[9] Chen, X., Sun, A. (2000) Testing the effectiveness of CAPM in China's stock market. Journal of Peking University: Philosophy and Social Sciences Edition, 37 (4): 28-37.

[10] Chen, L., Qu, W. (2000) An empirical study on the capital asset pricing model. Economic Research, 4: 26-34.

[11] Ruan, T., Lin, S. (2000) Test of CAPM model on Shanghai stock market. Mathematical Statistics and Management, 19 (2): 12-17.

[12] Li, H., Li, Z. (2000) Empirical test of capital asset pricing model in Shanghai stock market. Forecast, 5: 75-68.

[13] Jin, Y., Liu, L. (2001) Two-factor pricing model in China's stock market. Economic Science, 5: 92-99.

[14] Zhu, S. (2003) SAS Programming Technology and Financial Data Processing. First Edition. Beijing: Tsinghua University Press, 415-419.

[15] Sharpe, William, F. (1964) Capital asset prices: a theory of market equilibrium under conditions of risk. Journal of Finance, 19: 425-442.

[16] Lintner, John. (1965) The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets. Review of Economics and Statistics, 47:13-37.