Effectiveness Analysis of Capital Asset Pricing Model Based on Industry Data

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Abstract. Capital asset pricing model is an economic model that has been used to study and solve asset pricing problems in financial theory in recent decades. This model has become the basic model of investment pricing because of its wide applicability and practical value. However, due to the limitations and limitations of the model itself, it continues to be challenged by various practical tests. This paper takes China's real estate industry as the research object, selects ten companies in the real estate sector of the A-share market, and uses single-factor cross-sectional regression and multi-factor cross-sectional regression to verify the effectiveness of the capital asset pricing model. The results show that the CAPM model is not applicable to China's real estate industry. This may be caused by the low degree of information disclosure, the irrational structure of investors, and the irrational equity structure of listed companies.

Keywords: Effectiveness analysis, Capital Asset Pricing Model, CAPM, industry data

1 Introduction

The real estate industry refers to a comprehensive industry that integrates various economic activities and is engaged in the development, construction, operation, management, maintenance, decoration, and service of real estate with land and buildings as the business objects [1]. Real estate is an important pillar industry in China. Liu He, Vice Premier of the State Council, pointed out in January 2023: “The loans related to the real estate industry account for about 40% of the bank credit; the income related to the real estate industry accounts for 50% of the local comprehensive financial resources, and the real estate assets account for 60% of the assets of urban residents. In the future, China is still in the stage of rapid urbanization, and the huge demand potential will provide strong support for the healthy development of the real estate industry.” In China’s stock market, the real estate sector also occupies a very important position. China's stock market has the characteristics of short development time, immature investment concept, and irregular regulation, which are particularly evident in the real estate sector. In China, houses are not regarded as living places, but

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as investment goods. In recent years, the real estate boom has driven up the price of real estate stocks. In addition, China's real estate sector is also affected by macroeconomic factors such as economic cycle, land policy, monetary policy, etc., so the stock price fluctuates greatly, and investors bear greater risks. In this context, it is of great significance for investors to verify the capital asset pricing model for the establishment of the real estate industry. William Sharp proposed Capital Asset Pricing Model (short for CAPM) is an equilibrium theory on how to price and measure risks and returns in 1964. Its fundamental role is to confirm the relationship between expected returns and risks and reveal whether there are abnormal returns in the market. CAPM requires very strict assumptions. However, due to the special conditions of capital openness and government regulation, China cannot fully meet the above assumptions. Therefore, the feasibility and conformity of the classical model in China need to be studied. Therefore, it has full theoretical and practical significance to study the actual situation of the localization of CAPM in China [2].

2 Capital Asset Pricing Model

CAPM is a prediction model based on the expected return equilibrium of risk assets. In 1964, Sharpe and others developed it into a CAPM, and gave the asset pricing model in theory for the first time. CAPM describes the theoretical relationship between the expected return of assets and the expected risk as a linear relationship. If the portfolio theory mainly studies how investors should choose the optimal portfolio that is suitable for their risk preference, CAPM mainly studies how this collective behaviour will affect the security price when investors choose the portfolio according to the portfolio theory [3]. Thus, revealing the relationship between security returns and risks in an equilibrium state. The capital asset pricing model is based on several assumptions, which can be summarized as follows:

Assumption 1. Investors evaluate the return level and risk level of the portfolio by the expected return rate and variance, and select the optimal portfolio according to the portfolio theory. Assumption 2. Investors have the same expectations on the return, risk, and correlation of assets. Assumption 3. There is no friction in the market. That is, the market does not hinder the free flow of capital and information.

Under the above assumptions, the capital asset pricing theory mainly analyses the following contents:

1. Market Combination. When the market is in equilibrium, the optimal risk portfolio is the market portfolio. Currently, the investment proportion of member securities is consistent with the relative market value of risk securities in the whole market.

2. Capital Market Line (CML). When the market reaches an equilibrium state, the market portfolio M becomes a special effective portfolio. All effective portfolios can be seen as the re-combination of risk-free securities f and market portfolio M. The ray connecting risk-free assets and market portfolio is the capital market line, as shown in Figure 1.

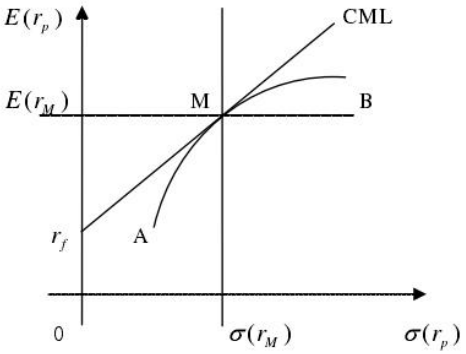

Fig. 1. Figure of Capital Market Line (figure credit: original)

The capital market line reveals the equilibrium relationship between the return and risk of the effective asset portfolio, which can be expressed by the equation

$$E_{r_p} = r_f + [\frac{E(r_M)-r_f}{\sigma_M}]\sigma_p \quad (1)$$

In the formula, E_{r_p} and σ_p represents the expected return and standard deviation of the effective portfolio. r_f means risk-free interest rate; $E(r_M)$ and σ_M represents the expected return and standard deviation of the market portfolio.

3. Security Market Line, SML. The capital market line only reveals the return and risk equilibrium relationship of the effective asset portfolio, while the securities market line gives the return and risk relationship of any securities or portfolio, as shown in Figure 2.

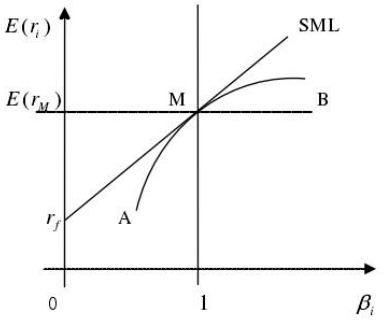

Fig. 2. Figure of Security Market Line (figure credit: original)

Its expression is the famous CAPM:

$$E(r_i) = r_f + [E(r_M) - r_f]\beta_i \quad (2)$$

Among the formula, $\beta_i = \sigma_{iM}/\sigma_M^2$ is called the coefficient of β of security i. $E(r_i)$ represents the expected yield of security i or portfolio i. The securities market line equation fully describes the relationship between the expected return rate and risk of any securities or portfolio.

The model has the following properties: First, the return on assets and β_i is linear. Secondly, β_i is the only significant factor to explain the return on risky assets. Again, β_i passes slope $E(r_M) - r_f$ affects the return of assets and the slope is positive. Finally, the asset return includes a risk-free return representing the time value r_f. To test the effectiveness of CAPM is to verify whether the model conforms to the above four properties. The convenience of CAPM is that it expresses the complicated asset pricing process with simple mathematical formula β the coefficient facilitates investors to classify various assets based on it and realize the optimal allocation of assets β the coefficient reflects the sensitivity of assets to changes in market prices β. Different assets are classified according to different values. The classification method is as follows. When β<1, the asset volatility is less than the market price volatility, and the investment in this asset cannot obtain good returns, but can help investors reduce the probability of loss, which is called defensive assets. When β>1, the price volatility of the asset is greater than that of the market, the asset will face greater losses than the market, which is called offensive asset. When β= 1 indicates that the rate of return obtained by purchasing the asset is the same as the market rate of return.

3 Data Source and Variable Calculation

3.1 Data Source

Since the development of the Shanghai Composite Index and Shenzhen Component Index, a large number of basic data have been provided for calculating market returns. They can accurately reflect the changes of the overall market and the overall development trend of the stock market, and are more in line with the market portfolio described by CAPM. Therefore, the Shanghai Composite Index is selected as the market index of the market portfolio. Considering important factors such as the length of listing time and whether the main real estate business is outstanding, the daily stock data of the top 10 stocks with representative average market value in the real estate sector from January 2020 to December 2022 are selected. We replace the risk-free interest rate with the three-month fixed deposit rate. The data are mainly from the wind information financial terminal database and Ruisi database. The empirical analysis is based on these data [4].

3.2 Variable Calculation

Among many capital asset pricing model validity tests, the most popular one is the test conducted by Fama and French on CAPM. This paper selects four explanatory

variables that affect the expected rate of return to verify whether CAPM is applicable to China's real estate industry. These variables are company size, total stock risk, risk coefficient and return price ratio E/P. The four main data in this paper are the weekly and monthly returns of the market; the weekly rate of return and monthly rate of return of the selected sample. The time span of these data is from January 2020 to December 2022. These data are calculated as follows:

(1) Company size. Different from the equity structure of foreign listed companies, Chinese listed companies differ in the price and liquidity of shares with different equity before and after listing. Because the data required in this paper is the expected rate of return of the market, this paper focuses on the current market value of the company. The size of a company can be expressed by the following formula: Size= LN (number of shares in circulation* market price) The way to obtain the number of shares in circulation of each company is simple and direct, and the market price needs to take the natural logarithm of the market value of the company, and the reason to take the logarithm is to reduce the error.

(2) Income price ratio E/P. It can obtain the earnings per share E at the end of the accounting year from the company's annual report and the share price P from the database, where E= diluted after-tax profit/total equity. The reciprocal of the P/E ratio is the ratio of earnings to price, E/P, which can be used to explain investors' prediction of whether the company will increase in value in the future. E/P is equal to earnings per share divided by the closing price at the end of each month [5].

(3) Market yield. The market yield represents the yield of the market portfolio. The change of market yield determines the issue price of bonds. The coupon rate is determined before the issuance. The interest rate of the capital market is constantly changing, and the market yield is also changing. This will make the difference between the predetermined coupon rate and the market yield when the bonds are issued. If the bonds are still issued at par, the actual yield obtained by investors will not be equal to the market yield. Therefore, it is necessary to adjust the issuance price of bonds [6]. In order to make the actual yield obtained by investors equal to or slightly higher than the market yield, when the market yield is higher than the coupon rate, the bonds should be issued at a price lower than the coupon rate; when the market yield is lower than the coupon rate, the bonds should be issued at a price higher than the par value. The market rate of return used in CAPM empirical research is usually replaced by the return of stock index. To a certain extent, the stock index can reflect the changes of the entire stock market because of the construction method of the stock index: first select a representative stock sample, and then use the average method to construct. This paper uses the Shanghai Composite Index to calculate.

$$Index\ yield = \frac{Current\ closing\ index - Last\ closing\ index}{Last\ closing\ index} \tag{3}$$

$$Comprehensive\ market\ yield = \frac{Shanghai\ Stock\ Exchange\ Index\ Yield + Shenzhen\ component\ index\ yield}{2} \tag{4}$$

(4) Stock yield. Stock income refers to the stock dividend and the income that exceeds the actual purchase price of the stock due to the ownership of the stock. Investors are most concerned about how much income they can get when buying stocks [7]. Specifically, it is the appreciation of dividend and stock market price. The definition of stock return is as follows:

$$R_{i,t} = \frac{P_{i,t+1} - P_{i,t} + D_{i,t}}{P_{i,t}} \quad (5)$$

In the formula, R represents the yield of the ith stock; $R_{i,t}$ means in t period; P represents the closing price of the ith stock. $P_{i,t+1}$ and $P_{i,t}$ means in t period and t+1 period respectively; D represents the dividend and other income obtained by the ith stock. $D_{i,t}$ means in period t. In addition to the closing price and dividend, we also need to consider the time interval of the yield and the treatment of the closing price. Before calculating the stock yield, the first step is to determine the time interval between the two closing prices. In order to use regression analysis to calculate β Coefficient and CAPM validity test, therefore, a large amount of historical data is required. When the historical data are less, that is, the time interval is longer, the sample data is less, and the effect of linear regression is worse, so a large amount of historical data is required. However, if the time interval between the two closing prices is very short, the impact of fluctuations in the stock trading on the trading history data cannot be avoided and eliminated, and then it is easy to cause errors in the results [8]. Therefore, to determine the value of t, we must consider the effects of linear regression and the stability of historical transaction data. The 10 stocks selected in this paper have data loss during the period from January 2020 to December 2022 due to suspension of trading. The processing method of smoothing and adding value to the yield data can not only eliminate the error of non-inevitable factors, but also increase the data.

(5) β Coefficient. We carry out univariate linear regression and get β Estimated value of coefficient βi. Represents the measure of the system risk of the stock. Β coefficient is used to measure and express the sensitivity of a stock to market changes. Β coefficient can also be used to represent the system risk of a stock. The ith share β coefficient can be expressed by the following formula:

$$\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)} \quad (6)$$

In the formula, R_i and R_m represents the return of the ith stock and market index respectively, and $\mathrm{Cov}(R_i, R_m)$ represents the covariance of the return of the ith stock and market. $\mathrm{Var}(R_m)$ represents the variance of market index yield. It is the same as the time interval selected when calculating the rate of return. This paper selects the weekly rate of return for calculation β. The reason is that the daily rate of return cannot exclude the influence of non-inevitable factors, and the sample number of monthly rate of return is too small [9].

4 Effectiveness Analysis

4.1 Single Factor Cross Section Regression

This paper introduces four single-factor regression models, which are β Coefficient, total risk σ2. Size and ratio of return to price E/P We can use the following four formulas to analyse the impact of stock expected return on β Coefficient, total risk σ2. The sensitivity of the size and the ratio of income to price (E/P). Through regression analysis of the equation, we can see that the β value are mostly concentrated between 0.5 and 0.7. β value reflects the stock system risk, which indicates that β value has some explanatory power to the stock return of Shanghai stock market, but its explanatory power is not significant. On the whole, it can only reflect the positive correlation between return and system risk to a certain extent [10]. At the significance level of 0.05, the constant term is the same as βcoefficients of are all significantly zero. The constant c is significantly zero, indicating that with the development and improvement of China's securities market, it has approached the minimum standard required by CAPM, indicating that there is no large amount of speculative behaviour in the market. However, β coefficient of is significantly zero but contradicts it, that is, the market does not give any reward to risk, which cannot be explained in theory and practice. βcoefficient of is significantly zero, which also shows that β Low-valued stocks have higher returns than CAPM predicted, stocks with high value are lower than the theoretical value, which is similar to the securities markets of western developed countries. There is no strict linear relationship between stock returns and market returns in the Shanghai stock market, and the system risk has a poor ability to explain stock returns, which can negate the effectiveness of CAPM in the Shanghai stock market. The results of single-factor cross-section regression are shown in Table 1.

Table 1. Results of single factor cross section regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
c	-0.00221	0.00487	-0.3201	0.7527
β	0.01361	0.01054	1.3561	0.2351

4.2 Multi-Factors Cross Section Regression

In the single-factor model regression, the three factors that have significant explanatory power for expected return are company size, E/P and E/PNEG. In order to further study the explanatory power of these three variables, we conducted multiple regression on company size, E/P and E/PNEG, and established the following multiple regression model:

$$\mathrm{R_i} = \alpha_i + I_1(Size)_i + I_2(E/P)_i + I_3(E/PNEG)_i + c_i \quad (7)$$

We refer to the parameters in the single-factor regression model for the meaning of the sub-parameters of this multiple regression model. The cross-section regression process of multiple factors need not be described too much, because its process is only an extension of the single-factor regression model. Table 2 shows the regression results of multiple basic variables to expected return.

Table 2. Results of multi-factors cross section regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
c	0.00155	0.00854	0.35114	0.91545
β	0.01951	0.01837	1.03522	0.33547
$Var(\varepsilon_i)$	-0.4872	0.7241	-0.61742	0.52464

According to β coefficient, it is tested at the significance level of 5%. If coefficient b can pass the significance test, then CAPM model is effective; on the contrary, the CAPM model is invalid. Here, β coefficient is greater than 1 and the sign is positive. It can be seen that the return rate of stocks is positively correlated with the return rate of market portfolio, and the systematic risk is greater than the risk of market portfolio, which also indicates that stocks are aggressive stocks. When the market rises, the increase of the stock is greater than the increase of the market. Add the non-system risk Var of the stock in the regression equation $Var(\varepsilon_i)$. The coefficients of are significantly zero, where c is zero, which indicates that the non-system risk of individual stocks has no significant explanation for its return rate. This, to some extent, indicates that the stock market is still immature and cannot completely distinguish the impact of systematic risk and non-systematic risk on stock returns.

4.3 Reasons Analysis

The capital asset pricing model is based on strict assumptions. The necessary condition is that the securities market is effective. China's securities market is at an initial stage of development and is still in a weak and effective state. The main reasons are as follows. The degree of information disclosure is relatively low. In an effective market, every investor can get all valuable information for free, and the disclosure of market information will have an impact on the price of securities, which will be reflected quickly through the price of securities. In China's securities market, information disclosure is incomplete, and sometimes there is fraud. Incomplete information and false information will mislead the market and make the price of securities deviate. The structure of investors is unreasonable. The capital asset pricing model assumes that all investors use portfolio theory to analyse and deal with problems, so they have the same investment direction. Therefore, the scientific of

investors' decision-making has limited the application of the model [11]. However, there are many individual investors in China's securities market, which generally lack experience and professional knowledge. A large part of investors have great blindness in investment, which reduces the effectiveness of the market. The irrational ownership structure of listed companies and the inability of China's state-owned shares and corporate shares to be listed and circulated limit the high liquidity of securities and reduce the degree of competition in the securities market. On the other hand, this ownership structure has exacerbated the information asymmetry in China's securities market. This seriously distorted equity structure has caused serious impact [12].

5 Conclusions

During the research period of the sample selected in this paper, from January 2020 to December 2022, the capital asset pricing model is not valid for listed companies in China's real estate industry, the assumption that it is the risk pricing factor of the expected rate of return is overturned. That is, from January 2020 to December 2022, CAPM is not applicable to China's real estate industry. B value basically does not reflect the risk of the stock, and the non-system risk cannot well explain the change of its earnings. We have reason to believe that China's stock market is still immature and imperfect. Compared with the mature securities market in western countries, there is still a long way to go.

References

1. Zerbib O D. A Sustainable Capital Asset Pricing Model (S-CAPM): Evidence from Environmental Integration and Sin Stock Exclusion[J]. Review of Finance, 2022, 26(6): 1345-1388.
2. Grillini S, Ozkan A, Sharma A, et al. Pricing of time-varying illiquidity within the Eurozone: Evidence using a Markov switching liquidity-adjusted capital asset pricing model[J]. International Review of Financial Analysis, 2019, 64(1): 145-158.
3. Jegadeesh N, Noh J, Pukthuanthong K, et al. Empirical tests of asset pricing models with individual assets: Resolving the errors-in-variables bias in risk premium estimation[J]. Journal of Financial Economics, 2019, 133(2): 273-298.
4. Kleibergen F, Zhan Z. Robust inference for consumption‐based asset pricing[J]. The Journal of Finance, 2020, 75(1): 507-550.
5. Ben‐Rephael A, Carlin B I, Da Z, et al. Information consumption and asset pricing[J]. The Journal of Finance, 2021, 76(1): 357-394.
6. Chu Y, Hirshleifer D, Ma L. The causal effect of limits to arbitrage on asset pricing anomalies[J]. The Journal of Finance, 2020, 75(5): 2631-2672.
7. Evans R B, Sun Y. Models or stars: The role of asset pricing models and heuristics in investor risk adjustment[J]. The Review of Financial Studies, 2021, 34(1): 67-107.
8. Zhang M B. Labor‐technology substitution: Implications for asset pricing[J]. The Journal of Finance, 2019, 74(4): 1793-1839.
9. Belo F, Lin X, Yang F. External equity financing shocks, financial flows, and asset prices[J]. The Review of Financial Studies, 2019, 32(9): 3500-3543.

10. Crockett S, Duffy J, Izhakian Y. An experimental test of the Lucas asset pricing model[J]. The Review of Economic Studies, 2019, 86(2): 627-667.
11. Shafron E. Investor tastes: Implications for asset pricing in the public debt market[J]. Journal of Corporate Finance, 2019, 55(1): 6-27.
12. Pramono E S, Rudianto D, Siboro F, et al. Analysis investor index Indonesia with capital asset pricing model (CAPM)[J]. Aptisi Transactions on Technopreneurship (ATT), 2022, 4(1): 35-46.