Empirical Test of CAPM in Shanghai Securities Market*

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Received: Dec. 24th, 2018; accepted: Jan. 10th, 2019; published: Jan. 17th, 2019

Abstract

In order to empirically analyze the practicality and effectiveness of the CAPM model in the Chinese market, 50 A-shares from the SSE 180 Index are randomly selected, with the investigation period from January 2016 to January 2018. Based on calculation of the beta coefficient of each stock in advance, a cross-sectional analysis for both risks and benefits is performed. The empirical results show that CAPM cannot be fully applied to the current A-share market in China. The limitations of CAPM stem from the limitations of their own conditions and the immaturity of Chinese stock market.

Keywords: CAPM, Empirical Analysis, SSE 180 Index, Beta Coefficient

1 Literature Review

Since 1964, when Sharpe (1964), Linter (1965) and Mossin (1966) introduce the Capital Asset Pricing Model (CAPM), there have been numerous empirical studies on the applicability of the model to mature Western capital markets, represented by the U.S. capital markets. Jensen, Black, and Scholes (1972) and Fama and MacBeth (1973) examine data up to 1969 and found that there is indeed a positive relationship between average stock returns and the beta coefficient as expressed in the CAPM model; Clare, Priestley, and Thomas (1998) examine the CAPM in the U.K. stock market and proved that the hypothesis of a positive correlation between the beta coefficient and its cross-sectional average returns could not be rejected. However, since the 1980s, inconsistent tests have followed, with Reinganum (1981) and Lakonishok and Shapiro (1986) finding no positive relationship between average stock returns and beta coefficients in data tested after the 1970s.

China's securities market started late, and the CAPM model was introduced and applied to various investment decisions and financial theories only at the end of the 20th century. Yang and Xing (1998) study the performance stock prices in Shanghai stock market and obtained the following conclusions from an empirical study of the relationship between average returns and beta coefficients in the traditional CAPM and a cross-sectional test of other factors affecting returns: the relationship between risk and return in Shanghai market is not consistent with the model, and there are factors other than systematic risk that determine returns. Chen and Qu

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(2000) empirically test the CAPM by classifying the stock market into three market patterns: up, down, and sideways, and tested the explanatory power of β in each pattern. The correlation between β coefficient and stock returns is less stable. Zhai (2015) conducts an empirical study on the application of CAPM with a sample of 60 stocks in the first five batches of equity share reform in Shanghai. The results show that:In the context of equity share reform, CAPM has some applicability in Shanghai securities market. Jie (2016) selects 15 representative stocks from 28 stocks in the transportation industry and found that the β coefficient of the transportation industry was poorly fitted, so it can be presumed that China's stock market is not an efficient market. Zhu (2017) summarizes the empirical tests on the applicability of the CAPM model and its extensions in China's stock market and finds that the conclusions obtained are diverse, with few recognized and influential results, and no new theory has been developed to advance the development of this field.

To sum up, most empirical studies show that the applicability of the CAPM model in the China's securities market is low, and the relevant research is still in its infancy. However, after years of development in my country's securities market, the scale of listed companies and market institutional arrangements have also been constantly adjusted. Therefore, it is necessary to re-examine the applicability and effectiveness of CAPM through new data to observe whether the risk factors affecting China's securities market have changed significantly.

2 The CAPM Model

In the 1960s, Sharpe, Lintner and Mossin extend Markowitz's mean-variance theory into the CAPM model. CAPM posits that investors make investment choices based on the mean-variance model. In the mean-variance model, the security market has an efficient frontier that is tangent to a ray from the risk-free rate at a certain point. Markowitz defines this tangent point as the optimal efficient asset portfolio, and defines this line as the capital market line, that is, the effective portfolio corresponding to this point is optimal in all combinations. If a portfolio is replicated proportionally to be identical to the market portfolio, individual investors differ in their proportions of risk-free and market portfolios to their total assets. Therefore, the market portfolio is the basis of CAPM model research. CAPM defines the ratio of the covariance between the asset return and the market portfolio return to the market portfolio return variance as the systematic risk of the asset, and its equation is given by:

$$E(R_i) = R_f + \beta \cdot [E(R_m) - R_f], \tag{1}$$

where $E(R_i)$ is the expected return rate of asset i; R_f refers to the risk-free interest rate; $E(R_m)$ is the expected return rate of the market portfolio, which refers to the investment portfolio composed of all risky assets; β refers to the systematic risk, which is the covariance between asset i's return and the market portfolio return, namely:

$$\beta = \frac{Cov(R_i, R_m)}{\sigma^2 R_m}. \tag{2}$$

According to the method proposed by Fama and MacBeth (1973), the CAPM empirical test is carried out by combining the cross-sectional regression with the time series regression. The specific steps are as follows: (i) Divide the sample period. Divide the sample data into three periods for testing, and each period contains equal weeks. (ii) Use the stock price data of the first period to perform time series regression, and calculate the β coefficient of all individual stocks, denoted as β_i. (iii) Sort firms based on the β_i estimated from in the first period and construct ten portfolios. Then perform time series regression for each portfolio in the second period to obtain the β coefficient of the portfolio, denoted as β_p. (iv) Take the β_p of the portfolio estimated in the second period as an independent variable, and use the mean weekly return of the portfolio in the third period as dependent variable to do a cross-sectional regression with the CAPM model.

3 Data

The CAPM is established on the premise that the market is efficient and the prices of stocks should be linearly uncorrelated in time series. Since the sample was not suitable for the study during the stock market crash from June 2015 to January 2016, the period chosen for the study was from January 29, 2016 to January 29, 2018, with each time period containing 33 weeks. The target population is the 50 stocks in the SSE 180 Index with the best net return ranking and distributed in different sectors. The SSE 180 Index is selected as the market index. The SSE 180 is a value-weighted index that meets the requirements of the CAPM for market portfolio construction. The weekly closing price is used as the observation value, and the risk free rate is selected as the Shanghai Interbank Offered Rate. All data comes from CSMAR.

3.1 Individual Stock Return

Most of the empirical studies of CAPM use monthly returns. Considering the short time period selected, the use of monthly returns will lead to insufficient sample size, so the following empirical studies use weekly returns of stocks. The weekly returns of stocks are calculated as:

$$r_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}, \tag{3}$$

where $r_{i,t}$ represents the return of stock i in week t, and $P_{i,t}$ and $P_{i,t-1}$ represent the closing price of the stock in week t and week $t-1$, respectively.

3.2 Market Return

The SSE 180 Index is used to replace the market portfolio to calculate the market rate of return. The calculation formula is as follows:

$$r_{m,t} = \frac{WI_t - WI_{t-1}}{WI_{t-1}}, \tag{4}$$

where $r_{m,t}$ represents the market rate of return in week t, and WI_t and WI_{t-1} represent the index in week t and week $t-1$, respectively.

3.3 Risk-free Rate

In the literature, the short-term treasury bond rate or the interbank offered rate is usually used as the risk-free rate. Based on the market environment of the sample stocks, this study uses the Shanghai interbank offered rate as a proxy for the risk-free rate.

4 Empirical Analysis

4.1 Time Series Tests for CAPM

4.1.1 Calculating Individual Stock βs

Firstly, $r_{i,t}$ and $r_{m,t}$ are calculated based on the data of the first period (the first 33 weeks), and the β coefficients of all sample stocks (a total of 50 stocks) are obtained through R language regression, namely β_i. The single factor model used is:

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \epsilon_i \tag{5}$$

Take the expected value of eq. (5), assuming $E(\epsilon_i, t) = 0$, then:

$$E(r_{i,t}) = \alpha_i + \beta_i E(r_{m,t}) \tag{6}$$

Due to space limitations, only the β regression results of 10 representative stocks are listed, as shown in Table 1.

Table 1: Time series regression results of the first period of sample stocks

Stock Code	α_i	t-value	Sign.	β_i	t-statistics	Sign.	R^2
600019	-0.35082	-4.990	2.76e-06	0.82355	23.360	<2e-16	0.8530
600028	-0.02021	-0.729	0.467	0.98996	72.002	<2e-16	0.9701
600029	-0.33588	-5.716	5.17e-08	0.83307	28.579	<2e-16	0.8353
600030	-0.43970	-7.643	1.80e-12	0.78248	27.388	<2e-16	0.8233
600036	-0.43651	-5.807	3.30e-08	0.78278	21.001	<2e-16	0.7326
600050	-1.33991	-17.118	<2e-16	0.33398	8.628	5.70e-15	0.3162
600085	-1.91948	-61.978	<2e-16	0.04769	3.097	0.00231	0.0562
600111	-1.11790	-14.470	<2e-16	0.44426	11.620	<2e-16	0.4560
600177	-0.30671	-5.824	3.03e-08	0.84763	32.445	<2e-16	0.8673
600221	-1.12837	-13.560	<2e-16	0.43897	10.660	<2e-16	0.4137

4.1.2 Construct Stock Portfolios

Due to the large unsystematic risk of a single stock, it is prone to bias the relationship between return and risk. In order to diversify some of the unsystematic risks, the β_i returned by the first period of individual stocks are grouped into 10 groups according to the size of β_i, and the excess return $r_{p,t} - r_{f,t}$ of the combination is calculated according to the simple arithmetic mean method. Then we run the following time series regression for ten portfolios to obtain β_p:

$$r_{p,t} - r_{f,t} = \alpha_p + \beta_p(r_{m,t} - r_{f,t}) + \epsilon_{i,t} \tag{7}$$

Take the expected value of Equation (7), assuming $E(\epsilon_i, t) = 0$, then:

$$E(r_{p,t} - r_{f,t}) = \alpha_i + \beta_p E(r_{m,t} - r_{f,t}), \tag{8}$$

where $r_{p,t}$ denotes the return rate of the portfolio; $r_{m,t}$ and $\epsilon_{i,t}$ represent the return rate of the market portfolio and the residual of the regression, respectively. The time series regression of the second period sample data yields the results shown in Table 2 below.

Table 2 shows that the β_p values of the portfolios are similar, mostly around 1, and their significance levels are basically small, which indicates that stock returns are significantly influenced by stock market returns. In addition, 60% of the portfolios have significant α_p, so the null hypothesis is rejected; meanwhile, the coefficient of determination R^2 does not increase with the increase of β_p, which indicates that stock returns are affected by other factors besides systematic risk.

4.2 CAPM Cross-sectional Regression

The average of the weekly excess returns of the 10 portfolios grouped in the second period over the observation period is calculated based on the data of the third period (last 33 weeks):

$$\overline{r_{p,t} - r_{f,t}} = \frac{1}{T}\sum_{t=1}^{33}(r_{p,t} - r_{f,t}) \tag{9}$$

Table 2: Time series regression results of the first period of sample stocks

Stock Code	α_p	t-value	Sign.	β_p	t-statistics	Sign.	R^2
Portfolio 1	0.01969	0.221	0.826	1.00468	26.876	<2e-16	0.964
Portfolio 2	-0.03657	-2.034	0.0519	0.9839	129.822	<2e-16	0.9984
Portfolio 3	0.27969	3.796	0.0008	1.1243	35.964	<2e-16	0.9796
Portfolio 4	1.2147	3.42	0.0023	1.5569	10.1	6.38e-10	0.8159
Portfolio 5	0.16745	1.281	0.213	1.06992	18.964	4.04e-15	0.9424
Portfolio 6	0.27447	2.574	0.0161	1.12462	24.759	<2e-16	0.9593
Portfolio 7	-0.00215	-0.171	0.865	0.99959	188.99	<2e-16	0.9992
Portfolio 8	0.04006	2.253	0.0326	1.0182	135.612	<2e-16	0.9985
Portfolio 9	0.03557	1.842	0.0765	1.01648	124.583	<2e-16	0.9983
Portfolio 10	0.2933	0.838	0.411	1.1498	7.66	8.95e-08	0.7184

Combined with the β_p of the second period, the following model is used:

$$\overline{r_{p,t} - r_{f,t}} = \gamma_0 + \gamma_1 \beta_p + \epsilon_p \tag{10}$$

Conduct cross-sectional regression analysis to test whether the regression coefficient γ_1 is significantly zero and whether high systematic risk can bring high expected return rate, namely:

$$E(\gamma_1) = E(r_{m,t}) - E(r_{f,t}) > 0 \tag{11}$$

The regression analysis results are shown in Table 3 and Figure 1:

Table 3: Cross-sectional regression results of the third period of stock portfolio

	γ_0	γ_1	R^2	F-statistics	P-value
Coefficient	1.0989	0.0374	0.4728	7.176	0.02798
t-statistics	30.0510	2.6790			

From Table 3, the R^2 is only 0.4728, which is an average fit while $\gamma_1 = 0.0374$. The t-statistics of γ_1 shows that the return is significantly positively correlated with the systematic risk, indicating that the return increases with the risk, which is consistent with the CAPM model; the constant γ_0 is significantly different from zero, indicating that there are factors other than the systematic risk.

5 Conclusion

The empirical test results show that there is a certain positive linear correlation between returns and risks, which is basically consistent with the conclusions of the CAPM model. However, systematic risk is not the only determinant in the pricing model, so it is not ruled out that non-systematic risk will also affect pricing. to a certain effect. China's securities market started relatively late, the scale of the stock market is small, and the degree of information disclosure in the securities market is relatively low. Compared with the securities markets in developed countries, there is a big gap. In the investor structure, the number of individual investors has an absolute advantage, and investors' immature investment concepts are also the main reasons for the deviation of the model. After experiencing the baptism of the stock market crash, the growing institutional investors have gradually become the main body of my country's securities market. With the establishment and improvement of a multi-level market system and the deepening of the reform of the new share issuance system, my country's securities market is gradually becoming mature, and the balanced relationship between risks and returns in securities investment will be increasingly reflected.

References

Chen, Y., Sun, J., Xu, W., & Jin, H. (2019). *Empirical test of capm in shanghai securities market.* Finance.

Clare, A. D., Priestley, R., & Thomas, S. (1998). Reports of beta's death are premature: Evidence from the uk. *Journal of Banking & Finance*, *22*(9), 1207–1229.

Fama, E. F., & MacBeth, J. D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of political economy*, *81*(3), 607–636.

Jensen, M. C., Black, F., & Scholes, M. S. (1972). The capital asset pricing model: Some empirical tests.

Lakonishok, J., & Shapiro, A. C. (1986). Systematic risk, total risk and size as determinants of stock market returns. *Journal of Banking & Finance*, *10*(1), 115–132.

Linter, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, *47*(1), 13–37.

Mossin, J. (1966). Equilibrium in a capital asset market. *Econometrica: Journal of the econometric society*, 768–783.

Reinganum, M. R. (1981). A new empirical perspective on the capm. *Journal of financial and quantitative analysis*, *16*(4), 439–462.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *The journal of finance*, *19*(3), 425–442.