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Empirical study on CAPM model on China stock market

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Title: Empirical study on CAPM model of China stock market
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Abstract

Background: The capital asset pricing model (CAPM) describes the interrelationship between the expected return of risk assets and risk in the equilibrium of investment market and gives the equilibrium price of risky assets (Banz, 1981). CAPM plays a very important role in the process of establishing a portfolio (Bodie, 2009). As Chinese stock market continues to grow and expand, the scope and degree of attention of CAPM models in China will also increase day by day. Therefore, in China, such an emerging market, it is greatly necessary to test the applicability and validity of the CAPM model in the capital market.

Purpose: Through the monthly data of 100 stocks from January 1, 2007 to February 1, 2018, the time series and cross-sectional data of the capital asset pricing model on Chinese stock market are tested. The main objectives are: (1) Empirical study of the relationship between risk and return using the data of Chinese stock market in recent years to test whether the CAPM model established in the developed western market is suitable for the Chinese market. (2) Through the empirical analysis of the results to analyse the characteristics and existing problems of Chinese capital market.

Method: First of all, we calculate the $\beta_i, i = 1, 2, \dots, 100$ coefficients of each stock. Then 100 stocks are divided into 20 groups based on the size of the β_i coefficient. Furthermore, we calculate $\beta_{pi}, 1 = 1, 2, \dots, 20$ coefficients of each portfolio. Then, we test whether there is a positive linear correlation between the average return r_{pi} of each portfolio and the β_{pi} coefficient during the sample period. Therefore, according to the empirical method of this article, we would draw the conclusion.

Conclusion: From the results of empirical research, China's securities market does not satisfy the capital asset pricing model, and asset portfolios with high systematic risks have low excess returns. In Chapter 5, this article will explain in detail the problems in the Chinese securities market.

Table of Contents

1 Introduction

1.1 Background

American economist Sharpe (1964) first proposed a capital asset pricing model (CAPM) in 1964. This model describes the relationship between the expected rate of return on risky assets and risk in the equilibrium of the investment market. Later, it was further improved and improved by American economists such as John Linter, Mossin (1966). Since the 1970s, European and American scholars have conducted a large number of empirical tests on the CAPM model. The early test results show that the stock pricing in the mature western stock market basically conforms to the CAPM model. In 1976, Roll questioned the empirical test at that time. It was because of Roll's criticism that the test of CAPM turned from risk-return test to multi-variable test, and became the mainstream of CAPM model test. Since the 1980s, some studies have criticized and challenged the CAPM model. Some of them questioned the model itself, such as the well-known Fama and French (1992) three-factor model, and some challenged the mainstream of financial theory, such as behavioral finance. At present, the test of the validity of the beta and the factors influencing the return on assets is still one of the academic focuses in the field of theory and application.

Since the CAPM model plays a very important role in establishing the investment portfolio, as China's stock market continues to develop, the CAPM model will also be increasingly used in China. Therefore, it is necessary to test the applicability and effectiveness of CAPM in an emerging capital market like China. After 20 years of development, the Chinese stock market has made great achievements. As an important part of Chinese securities market, the stock market plays an important role in economic development and social stability. As of 2017, China had a total of 3452 listed companies, 13.11% increase compared to the same period of last year, 131 securities companies, 62 fund companies and 163 futures companies[1], with the second largest stock market capitalization in the world and the first volume in the commodity futures market in the world. At present, China's stock market is undergoing a difficult recovery phase after the short-lived prosperity in 2015. The ordinary people are very concerned about whether or not the Chinese stock market can reproduce prosperity. The most concerned issue for rational investors is whether the market price has been effectively priced and whether the change in the stock price is regular. As for the applicability of CAPM model in China's stock market, many scholars have done some research in recent ten years and concluded that the Chinese stock market before 1999 is not suitable for the CAPM model. However, with the continuous development of China's stock market, whether the above conclusion has changed or not needs further study and evidence collection. The solution to this problem not only has important reference value for the establishment of investment decisions and investment portfolios in the micro-economy, but also provides answers to the effectiveness of resource allocation in macroeconomic operations. Based on the latest ten years of recent data CAPM empirical test, hoping to get further conclusions.

[1] Source: China National Bureau of Statistics

1.2 Purpose

We select the stock data from February 2007 to February 2018 to test the capital asset pricing model on the stock market of China by time series and cross-sectional analysis, trying to analyse the characteristics of Chinese stock market and put forward own views. The birth of China's capital market has only been a short period of 30 years. Despite the rapid development rate[2], most investors are individuals. The overall professional level of investors is not high, and the market is following the hype. Many scholars and professionally knowledgeable investors are generally pessimistic about whether value investment theory can be effectively implemented in the Chinese market. If this paper through a series of research and analysis, to be able to draw exact conclusions on this issue, more accurately describe the effectiveness of China's stock market, it will be able to provide some inspiration for the analysis of securities investment of the majority of stock investors, but also help the supervisors of the China securities market formulate appropriate policies to improve market efficiency and promote the healthy development of the capital market.

1.3 Research problem

Our empirical research on the CAPM model based on the Chinese stock market is to test whether the asset pricing model that is widely used in the capital markets of developed countries is suitable for the Chinese capital market that has just started. If a series of research results tell us that the CAPM model cannot be used in Chinese capital market, it proves that the Chinese capital market still needs to be improved, because immature and imperfect capital markets still exist. In the fifth part of the article, the causes of the results based on the empirical results would be analysed.

1.4 Content

This paper divides the CAPM empirical test of Chinese stock market by 100 stocks into 20 portfolios. The following is the main contents of each chapter of this article.

Chapter one is introduction. This chapter briefly introduces the research background of capital asset pricing theory, research purposes, the main problem to be explored, as well as the main ideas of research methods.

Chapter two is to demonstrate capital asset pricing model. We would describe the theory of capital asset pricing model, including the assumptions, economic implications of the CAPM model, and the widely accepted CAPM empirical test method like BJS method[3]

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[2] Taking the Shenzhen, A-share capital market as an example, its total market value at the end of 2011 was 3.8 times that of 2001. A-shares are shares of the Renminbi currency that are purchased and traded on the Shanghai and Shenzhen stock exchanges. This is contrast to Renminbi B shares which are owned by foreigners who cannot purchase A-shares due to Chinese government restrictions.

[3] JENSEN, M. C., BLACK, F. & SCHOLES, M. S. 1972. The capital asset pricing model: Some empirical tests. The purpose of BJS the innovation of BJS method is the use of a portfolio rather than a single asset. This article uses industry groups as a portfolio in order to improve the accuracy of estimation of β.

and Fama and MacBeth (1973) method[4], which would be the reference method of this paper.

In chapter three, we would specifically introduce the empirical research methods based on sample data. On the first part of this chapter, we would review the previous literature including Chinese scholars' articles and relevant research results on CAPM model which were tested by other foreign scholars. On the second part of this chapter, we would specifically explain how to process the sample data based on the reference methods.

In chapter four, we would examine whether there is a positive linear correlation between the expected rate of return of the industry portfolio and the beta coefficient during the sample period.

In chapter five, based on the result of chapter four, further analysis of the recent characteristics of Chinese stock market, defects of CAPM model and β coefficient would be discussed.

Chapter six is the conclusion section. Since China stock market is not an efficient market which is the violation of assumption of CAPM model, CAPM model is not suitable based on China stock market, which means a certain asset with higher risk is not consistent with a higher rate of return.

2 Capital Asset Pricing Model

Capital Asset Pricing Model CAPM is the description of the relationship between the expected return and risk of risky assets in the equilibrium of investment market, and gives the equilibrium price of risky assets. Capital Asset Pricing Model CAPM plays an important role in the real financial investment market and occupies an important position in modern investment science (Bodie, 2009).

2.1 Literature review

A century has passed since the birth of securities. With the long-term development of the world capitalist economy and the financial industry, people's interest in securities investment has continued to increase. Securities investment refers to the behavior and process that investors purchase securities or their derivatives to obtain dividends, interest, and capital. Securities investment analysis refers to the use of specialized investment theories or methods to analyze various kinds of information that affect securities, so as to achieve the purpose of forecasting price changes. The vigorous development of the securities industry has spawned a large number of theories related to securities investment analysis.

The methods of securities investment analysis in modern economic life include basic analysis methods, technical analysis methods and securities portfolio analysis (Bodie, 2009). The basic analysis method relies on the basic principles of economics, finance, and investment for analysis and derivation. Technical analysis attempts to find the law

[4] FAMA, E. F. & MACBETH, J. D. 1973. Risk, return, and equilibrium: Empirical tests. Journal of political economy, 81**,** 607-636.

from the historical data of the stock market itself. The portfolio analysis method considers that investors will make trade-offs between risk and return and reduce risk through diversified investments.

Since the content of this paper is closely related to the securities portfolio analysis method, the relevant theories of portfolio analysis are highlighted here. The theoretical basis of securities analysis mainly includes Markowitz (1952) asset portfolio theory, Sharpe (1964) capital asset pricing model and Ross (1976) arbitrage pricing model. Among them, CAPM is a classic in people's hearts. Since the theory was put forward in the 1960s, many scholars have conducted a lot of empirical research on it.

One issue that is closely related to the performance of securities investment is whether the market can be effective and to what extent can it be effective? Fama (1970) puts forward a market-effective hypothesis that in a perfectly valid market, it is impossible for investors to obtain an additional benefit over the market portfolio by actively analyzing and constructing a portfolio. According to the theory of pricing efficiency, the theory divides the effective market into three types: weak efficient market, semi-strong efficient market and strong effective market. Among them, in the weak and effective market, the technical analysis method fails but fundamental analysis is still effective. In the semi-active market, the use of technical analysis and fundamental analysis cannot defeat the market, and cannot obtain any excess returns. In the strong and efficient market, even insider trading will not help defeat the market.

The following briefly introduces the theory related to portfolio analysis and their development and application.

Markowitz (1952) published an article entitled *Portfolio Selection*, marking the emergence of modern portfolio theory. The main content of this theory is to use mathematical mean and variance to analyze and manage the investment portfolio. An asset has the dual property of risk and return. A rational investor will not only pay attention to its earnings but ignore its risks. Each type of securities or combination of assets has different returns and risks. It cannot be simply used to evaluate whether a security or portfolio is the best investment. In other words, for rational investors, the higher the return on an investment product, the lower the risk and the greater the utility brought to him.

In the 1960s, Sharpe (1964) and Lintner (1965) successively deduced classic capital asset pricing models (CAPM). The main conclusion of this theory is that when all investors use (Markowitz)'s portfolio theory to make investment decisions, there is a linear relationship between the expected return rate of the assets and the system risk. The capital asset pricing model is the pillar of modern financial market price theory and is widely used in investment decision-making and corporate finance. Because it can well reflect some important determinants in the capital market, it is widely used in asset assessment, risk management and other fields.

Afterwards, many scholars gradually studied CAPM theory. Fama and MacBeth (1973) used the cross-sectional data from 1935 to 1968 to test CAPM model. It finds that the average yield and beta coefficient of the stock have an exact linear relationship. By constructing a portfolio of assets and found that the positive correlation between the

average rate of return and the beta coefficient is established, the intercept is almost equal to the risk-free rate of return, and the non-systematic risk is not compensated.

Before and after the 1980s, there were many negative news about CAPM. In 1977, Roll (1977) pointed out that because the true market mix cannot be observed and the test uses an approximate market portfolio, the CAPM model cannot be truly tested. In response to this criticism, Wallace (1980) published the paper *Is Beta Dead*, pointing out that although (Roll)'s view is theoretically correct, it is also feasible to use an extensive market index to replace the real market index that cannot be observed to test the capital asset pricing model. However, due to Roll (1977) criticism, people began to look for and test whether there are other variables other than market factors that can explain the risks faced by individual securities. Scholars believe that there are other factors that can affect the stocks' rate of return. These factors contain company financial indicators, e.g., the market value, price to book value and so on.

In 1980, Stattman (1980) proposed that the average return of stocks is positively related to the ratio of corporate book value to market value.

In 1981, Banz (1981) proved that the risk compensation on scale factor was statistically significant negative, and proposed the scale effect. In accordance with market size, companies with smaller market capitalization can obtain higher average returns. He found that on the New York Stock Exchange, the average yield of small listed companies was on average 19.8% higher than that of large listed companies.

In 1988, Bhandari (1988) proved that the ratio of the face value of the company's debt to the market price of the company's net assets was positively correlated with the average rate of return. The higher the ratio, the higher the rate of return on the stock.

In 1991, when Chan et al. (1991) used the Japanese stock market data for regression testing, it once again confirmed that there was a positive correlation between the yield and the book value to market ratio. It can be seen that the book value to market ratio, the market value scale, the debt ratio and the price-earnings ratio explain the risk factors in addition to the system risk.

Due to the relatively late establishment of China's securities market, Chinese scholars have also started CAPM in recent years.

In the analysis made by 付应变 (2012) , it was found that systematic risk and expected return presented a negative correlation. Non-systematic risk has an important impact on stock returns, and there is no obvious linear relationship between systematic risk and expected return. The effectiveness of CAPM in China's stock market. The results show that the β coefficient has no ability to interpret the average returns of the Chinese stock market, thereby negating its validity assumption in the Chinese stock market.

This article will use the latest data for the past 10 years, based on previous research results, to re-analyze the CAPM model's applicability in the Chinese stock market.

2.2 Introduction of Capital Asset Pricing model

Harry Markowitz laid down the foundation of modern portfolio management in 1952. The CAPM was developed 12 years later in articles by William Sharpe, John Linter.

The issue that Markowitz (1952) proposed portfolio theory considered was how investors balance the average income and uncertainty, and look for an optimal portfolio of assets. The CAPM discusses the theory of equilibrium prices in a single period, frictionless and fully competitive uncertain financial and securities markets, essentially pricing the uncertainty of assets.

2.2.1 Theory of Capital Asset Pricing Model

In portfolio management theory (Markowitz, 1952), we assume that all the assets in a constructed portfolio are risky assets. However, it is also possible to introduce a risk-free asset into the asset portfolio, so the asset portfolio contains a risk-free asset and a set of risk assets. Risk-free assets, there are basically only one type in the economy, such as government bonds. Risky assets in a group of risky assets are in fact just risky assets that are restricted to the stock market, such as stocks. The change of stock price reflects the risk of the issuer and the society in which the issuer is located. Therefore, the combination of all assets in the stock market to a certain extent represents a collection of all risky assets in society. Such a risky asset portfolio is called a market portfolio.

Use *f* and *m* to represent a risk-free asset and market respectively. The rate of return and risk of the new portfolio are as follows.

$$r_p = w_f r_f + w_m r_m \tag{2.1}$$
$$\sigma_p = (w_f^2 \sigma_f^2 + w_m^2 \sigma_m^2 + 2 w_f \sigma_f w_m \sigma_m \rho_{f.m})^{\frac{1}{2}}$$

r_f and r_m refers to the rate of return of risk-free asset and market portfolio respectively. w_f and w_m refers to the weights of risk-free asset and market portfolio respectively, σ_f and σ_m refers to the risk of risk-free asset and market portfolio. Since the risk-free rate has no risk, namely, $\sigma_f = 0$. Therefore, $\rho_{f.m} = 0$ as well. Obviously, the risk-free formula for a portfolio is not complicated by the introduction of risk-free assets. The risk of a portfolio is equal to the weights of risk assets in the portfolio multiplied by their standard deviation.

$$\sigma_p = w_m \sigma_m \tag{2.2}$$

This is an important step toward a capital asset pricing model. Based on the expected return on the portfolio and the risk, a straight line that is tangential to the portfolio curve can be drawn on the chart. This line is called the capital market line.

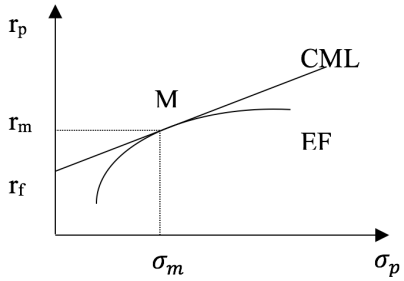

Figure 1 Capital Market Line

In Figure 1, the slope of the CML line is $\frac{r_m - r_f}{\sigma_m}$. The intercept of a straight line is the risk-free rate, which means the risk and return of the asset portfolio when all the assets in the portfolio are invested in the riskless asset, i.e., w_f = 100%, $w_m = 0\%$. The point M on the capital market line (CML) is located at the effective frontier (EF), which means that when all funds are invested in risky assets, the corresponding point of is the market portfolio. On the capital market line, all points represent a linear combination of a risk-free asset and a market portfolio M. Among them, the line r_f-M represents risk-free asset and market portfolio changes between 0 and 1. On the line extending from point M to the upper right, all the points represent the investment in riskless assets is negative, while the market portfolio M investment ratio is greater than 1. The weight of risk-free assets is negative, indicating that someone lend funds at risk-free interest and fully invest in risky assets.

The formula for the capital market line is as follows.

$$r_p = r_f + \frac{r_m - r_f}{\sigma_m}\sigma_p \tag{2.3}$$

$r_m - r_f$ refers to risk premium. That is to say, the corresponding return due to the holding of the risky assets.

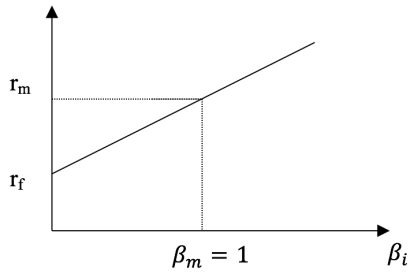

Figure 2 Security Market Line

The relationship between the single assets and the risk of the entire market portfolio can be expressed as β-coefficient. This coefficient corresponds to the ratio of the covariance of the market and the single asset to the variance of the market portfolio.

$$\beta_i = \frac{\sigma_{i,m}}{\sigma_m^2} \tag{2.4}$$

The expected return rate of a single asset can be expressed by the following formula.

$$\mathrm{r}_i = r_f + \beta_i\left(r_m - r_f\right) + u_i \tag{2.5}$$

This formula is capital asset pricing model (CAPM).

The capital asset pricing model reflects the relationship between the risk of a particular asset and its expected return. The first term on the right side of the formula indicates the opportunity cost of the investment, expressed as a risk-free rate, and the second one represents the risk compensation for the investment, expressed as a market risk premium. The relationship between the risk of a particular asset and the expected rate of return can be expressed in the stock market SML (see Figure 2). The stock market line is a risk-free rate intercept, β is the slope of the line. It visually shows the relationship between the risk of a particular asset and the expected rate of return.

From the above analysis, we can see that Markowitz (1952) portfolio theory is the basis of the Capital Asset Pricing Model (CAPM). Since Markowitz (1952) systematically elaborated the theory and methods of how to select the optimal assets through effective decentralized investment, he was awarded the 1990 Nobel Prize in Economics awarded. But Markowitz (1952) portfolio theory is also not perfect.

According to Markowitz (1952) theoretical hypothesis, the correlation coefficient is a correct measure of the future relationship of securities, and variance is a most suitable measure of risk. These views all have problems. Firstly, historical data cannot represent future data. Secondly, since the various variables of a security are constantly changing over time, the interrelationship between securities cannot be fixed. Third, according to Markowitz (1952) theory, using the short-term fluctuation of prices to determine the expected return of a security, there should be a variance. However, in practice, if investors are subject to restricted liquidity constraints, or if they are willing to keep the securities they hold, then the short-term price volatility itself will not have a practical significance to them.

In practice, Markowitz (1952) also has a lot of limitations. First of all, creating a combination requires a set of high-level and rather complex computer programs to operate and take time and effort. Secondly, using sophisticated mathematical methods to establish portfolios by computer operations requires the input of several statistical data. However, the key to the problem is whether it can guarantee the correctness of the input data. Since the expected rate of most returns is subjective (we do not use historical data at this time), an amount of error would exist. Using these data as input data to build a portfolio, it is possible that a portfolio that has not been produced will have a large biased error. In addition, the difficulty lies in a large number of unforeseen accidents. For example, the earnings per share of a company's stock have been increasing in recent years, but may decline due to the decline in the overall stock market price, resulting in the previous the prediction completely loses its authenticity. Furthermore, the stock market changes frequently, and each time there is a change, the position of the existing portfolio must be adjusted to maintain the required risk-return equilibrium. Therefore, a large number of

continuous mathematical calculations are required to be guaranteed. This is not only a difficult operation but also a huge waste in practice.
In contrast, the capital asset pricing model (CAPM) has unique advantages.

(1)Simple and clear. CAPM provides an easy way to solve the problem of determining the price of a single asset: The β coefficient is used to determine the amount of system risk contained in a single asset. Through the concept of market combination, the overall market yield could be obtained with β coefficient equal to 1. Combining the systemic risk of a single asset with the market as a whole provides a standardized formula for calculating the value of a single asset under equilibrium market conditions.

(2)Practicality. The CAPM model provides investors with such a mechanism. Investors can choose financial assets based on the systematic risk they face, rather than the total risk. Investors can use the authoritative market composite index to determine the expected rate of return of the market portfolio, and based on which to calculate the β coefficient of the individual assets available for selection, at the same time determine the risk-free rate of return according to the interest rate of T-bills or other appropriate government bonds.

The pricing process for a single stock can be derived from the following steps:

$$r_i = r_f + \beta_i(r_m - r_f)$$

$$r_i = \frac{p_t - p_0}{p_0}$$

$$\frac{p_t - p_0}{p_0} = r_f + \beta_i(r_m - r_f)$$

The capital asset pricing model is a forecasting model based on the balance of expected returns of risky assets. The reasonable risk premium for the individual depends on the degree to which the risk of a single security contributes to the risk of the entire portfolio. The risk of a single security consists of systematic and non-systematic risks. Non-systematic risks can be eliminated by constructing a portfolio of assets. Thus, after several decades of development, a single security pricing theory has produced a variety of capital pricing models. As the first capital pricing model under uncertain conditions, CAPM has great historical significance.

In short, the capital asset pricing model provides ideas on how to price securities and the measurement of how expected returns react to the risk. It can also be applied to investment management and corporate finance. Of course, there are also imperfections in the capital asset pricing model that we would discuss below.

2.2.2 Assumption of CAPM model

To understand how capital assets are priced, a model needs to be established, which is a theory. In order to make the model simple and straightforward, the model builder must refine the very real situation and concentrate on the most important elements. This goal can be achieved by making certain assumptions about the actual situation. In order to successfully build a model, a certain degree of abstraction is required and the assumptions need to be simplified (Bodie, 2009).

Any economic model is a simplification of complex economic issues, and CAPM is no exception. The core assumption of CAPM is to treat all investors in the securities market as individuals with the same initial preferences, and the capital asset pricing model develops on the basis of the Markowitz (1952) mean-variance principle. CAPM also inherits the assumptions of securities portfolio theory. The criteria for setting hypotheses are: The assumptions made should be sufficiently simple, so that we have enough freedom to abstract our problems and achieve the purpose of modelling. With regard to the hypothesis of a theory, our concern is not whether they completely describe the reality, because no model can fully characterize the reality. We are concerned that they are fully close to what we want to achieve. The answer is: Can the theory be fully and accurately predicted under assumptions?

The CAPM assumptions are as follows(Bodie, 2009).

1. Investors evaluate the pros and cons of this portfolio through its expected rate of return and risk over a period of time.
2. Investors will never be satisfied, so when faced with the other two options of the same conditions, they will choose the one with the higher expected rate of return.
3. Investors are risk averse, so when faced with two other options that are the same, they will choose the one with the smaller standard deviation.
4. Every asset is infinitely divisible, which means investors could buy a portion of a share.
5. Investors can lend or borrow funds at a risk-free rate.
6. Tax and transaction costs are negligible.
7. All investors have the same investment period.
8. The risk-free rate is the same for all investors
9. For all investors, the information is free and immediately available
10. Investors have the same expectation that they have the same estimation of expected return, standard deviation and covariance between securities.

Under the above assumptions, the following equation can be deduced.

$$\mathrm{E}(r_i) - r_f = \beta_i\left[E(r_m) - r_f\right] \tag{2.6}$$
$$\beta_i = \frac{\sigma_{i,m}}{\sigma_m^2}$$

$E(r_i)$ refers to the expected rate of return of a stock or a portfolio.
r_f refers to return of risk-free asset.
β_i can be seen as the sensitivity of changes in stock returns to changes in the market portfolio, as a measure of stock market risk, people also call β_i market risk premium.
$E(r_m)$ refers to expected rate of return of the entire market.

In addition to these explicit assumptions, there are implicit assumptions that the distribution of returns for each security is subject to normal distribution, transaction costs are negligible, and each asset is infinitely separable, which means investment in a portfolio, investors can hold any part of a security.

The advantage of making these assumptions is that we can use the simplified reality to explain and analyze the problem of changes in securities returns.

2.2.3 Economic implications of the CAPM model

The main implication of Capital Asset Pricing Model (CAPM) is that the expected rate of return on an asset is linked to a value of β_i that measures the risk of that asset. The return on risky assets equals the sum of risk-free returns and risk offsets, and high-yielding assets must be accompanied by high risk. The size of the systematic risk can be expressed by the systematic risk measure coefficient. The expected return rate of a stock is directly proportional to the β_i coefficient. It is the first time that capital asset pricing model proves the linear relationship between risk and return from a mathematical point of view.

As systemic risk cannot be dispersed by constructing an asset portfolio, to attract investors to invest, investors must be given the appropriate risk compensation with the corresponding rate of return. Since non-systemic risk can be dispersed, you can avoid the risk of a particular company by constructing a portfolio.

The CAPM theory is the core content of the modern financial theory. Its role is to consider the rationality of the prices of different listed securities by predicting the quantitative relationship between the expected return and the standard deviation of the securities. This can help prepare the listed securities for pricing, and can estimate changes in various macroeconomic variables affect the price of securities. CAPM theoretically states that in an efficient portfolio, the β coefficient describes the systematic risk of any asset, and any other factors that affect the yield on the securities have been included in the β coefficient.

Capital Asset Pricing Model deriving the relationship between the return on securities and the risk of securities with a scientific rigorous reasoning method is of great significance to the investment management industry. If the stock market line can accurately predict the return on securities, securities analysts can use it to conduct investment analysis and make the right decisions. The CAPM model can also be used for capital budgeting, calculating the required return on an investment project and using it to measure whether a new investment project is worth investing. With the continuous development of academic research, the capital asset pricing model has prevailed in the financial field for over a decade, and the controversy over its effectiveness has been endless. In any case, this reflects the significant impact of the CAPM model in academia. After long-term repeated argumentation and test by academics and real investors, this theory has been widely recognized in the investment management industry. At present, many large fund companies in the world use negative investment management methods to imitate the market portfolio to build index funds, which is based on the CAPM model. In addition, the market portfolio yield is also seen as a performance evaluation standard for active portfolio management. Many industrial companies also use the theory of capital asset pricing for decision-making analysis of investment projects, management of investment income target and so on.

The basic idea of CAPM is that all investors are price receivers, and under a given price system, they decide on their own needs for each type of securities. Since this demand is a function of price, total demand is also a function of price when we sum up all individual needs to get the total market demand. The price changes affect the demand for securities. If the total demand of each type of securities exactly meets the total supply of the market under a certain price system, the securities market will reach equilibrium. At this time, the price will be the equilibrium price, and the rate of return will be the equilibrium rate

of return. The theoretical idea of CAPM is to give the return rate of any portfolio of securities or securities by assuming the return on portfolios of known markets. In theory, the market portfolio includes not only ordinary stocks but also other types of investments such as bonds. However, in the actual calculation process, it is generally considered that the market portfolio consists only of stocks.

2.2.4 Arbitrage pricing theory

After the emergence of capital asset pricing theory (CAPM), scholars tried to find a superior pricing model because of its strict establishment of assumptions. Roll and Ross (1984)put forward a remarkable arbitrage pricing model (APT). The model no longer uses the method of constructing an effective combination of mean-variance but computes the relationship between expected return rates in addition to the risk-free rate on the capital market.

Before understanding arbitrage pricing theory, we must accurately grasp the concept of arbitrage. Arbitrage refers to the use of the relative price differences between two or more securities to obtain risk-free interest rates. When investors can build a zero-cost portfolio to achieve a certain profit, risk-free arbitrage opportunities arise. Zero-cost investment means that investors do not need to invest their own funds. Investors can sell assets by selling them short and then use them to buy other assets. Even small investors can use speculative methods to profit on a large scale. Although arbitrage pricing theory does not require strict assumptions to derive the same expected yield-risk relationship as the capital asset pricing model, the reason for this difference is that the arbitrage pricing model only applies to highly diversified portfolios.

In the following part, we would focus on the relationship between the arbitrage pricing theory and the capital asset pricing model.

Firstly, in the capital asset pricing model (CAPM), the risk of securities is only explained by the systematic risk β coefficient which means a certain security risk relative to the market portfolio. The β coefficient can only tell the size of the investor's risk, but cannot tell the investor where the risk comes from. In the arbitrage pricing theory, the risk of securities is commonly explained by multiple factors. For example, in the article *the Arbitrage Pricing Theory Approach to Strategic Portfolio Planning* published in 1984 by Roll and Ross (1984), unexpected changes in inflation, unexpected changes in industrial production, unexpected changes in risk compensation, and unexpected changes in the term structure of interest rates were used to explain the return of securities. Later, people used many factors such as economic growth rate, inflation rate, and company size to explain the return of securities. This shows that the arbitrage pricing theory and many multi-factor models can not only tell investors the size of the securities risk, but also tell investors where the risk comes from and how much the impact is.

Secondly, the capital asset pricing model assumes that investors treat the type of risk, that is, investors are risk-averse. However, the arbitrage pricing theory model does not stipulate the risk preferences of investors. Therefore, the adaptability pricing theory is more adaptable.

Thirdly, since according to the arbitrage pricing theory, investors can construct a pure factor combination, and for the same securities investor may construct an arbitrage pricing

model of various factors. In this way, investors may choose their own willingness based on their own attitude toward risk. And the risks that can be undertaken, and completely avoid the risk that they do not want to bear, which is an important help for investors to choose assets. The relationship between the arbitrage pricing model and the capital asset pricing model is summarized as follows:

The similarities are summarized as follows:

(1) Both CAPM and APT are asset pricing models, which reflect the impact of variables on the expected rate of return. The expected rate of return on each security is the risk-free rate plus a set of risk premiums.
(2) Both CAPM and APT believe that only by taking systematic risks, a risk premium could be obtained.
(3) Both CAPM and APT are linear factor models.

The differences between the two are summarized as follows:

(1) CAPM is a one-factor model, and the expected return on securities is only affected by market factors. APT is a multi-factor model. According to Roll and Ross (1984), factors can include:
    a. Individual industry output
    b. Difference in long-term interest rate gap
    c. Changes in default risk discount
    d. inflation rate
(2) The theoretical structure of CAPM is more rigorous than APT, but APT is more practical.
(3) The arbitrage pricing model does not assume that investors will make decisions based on the mean-variance guidelines and does not assume that the returns are normally distributed.

The arbitrage pricing theory itself does not specify what factors affect revenue, which are the main factors, and the number of factors. In general, factors such as gross domestic product (GDP) growth rate, inflation rate, interest rate, and company credit are all factors that affect the return on securities. However, this issue has yet to be further explored in theory and practice. The modern portfolio theory has many shortcomings such as too many theoretical assumptions, limited risk distribution methods, risk concepts and judgments on machinery, practical application and operation difficulties, and so on. It needs further improvement and research.

Strictly speaking, there is no absolute advantage or disadvantage between the arbitrage pricing model and the capital asset pricing model. The former does not require many strict assumptions, but only applies to highly diversified portfolios, while the latter is more extensive and applies to all assets. In view of the comprehensiveness and actual situation of the model, this paper still adopts the original CAPM model for empirical research.

2.3 The calculation of α and β coefficients and their applications

The risk factor can be measured by β. The β coefficient is an indicator used to determine the degree of change in the returns of a portfolio or portfolio over the entire stock market. It can also be interpreted as a measure of the sensitivity or extent of the return of one

security or portfolios to market average returns. The various β values of various securities reflect the extent to which their prices are affected by the securities market.

2.3.1 Definition of β coefficient

In the use of CAPM, the most important factor is the determination of the β coefficient. The β coefficient measures an indicator of the systematic risk of an asset, or the β coefficient indicates the degree to which the return of certain asset reacts to systemic risk. It is usually defined as the degree of change in the return rate of an asset and the market portfolio's rate of return. Its formula is follows:

$$\beta_i = \frac{cov(r_i, r_m)}{\sigma_m^2} = \frac{\rho_{i,m}\sigma_i\sigma_m}{\sigma_m^2} = \rho_{i,m}\frac{\sigma_i}{\sigma_m} \tag{2.7}$$

where $cov(r_i, r_m)$ is the covariance between the yield of the securities and the market portfolio yield. It is equal to product of the standard deviation of the security, the standard deviation of the market portfolio, and the correlation coefficient between the two. From equation (2.7), it can be seen that the size of the β coefficient depends on:

- The correlation between the securities and the entire securities market.
- The standard deviation of the security itself.
- The standard deviation of the entire market.

2.3.2 Calculation of α and β coefficients

There are usually two methods for calculating the β coefficient, one is determined by the linear regression of the change in the individual stocks, that is, the rate of return, on the change in the market index. The second method is a definition method that uses the equation (2.7) to calculate the β coefficient. Using the standard deviation of stocks and market indices and the correlation coefficient to calculate directly. The following discussion specifically discusses the β coefficient calculation and derivation. We assume that $\{y_t\}$ is the series of returns of individual stocks and $\{x_t\}$ is the series of returns of the market index. Consider the following regression model.

$$y_t = \alpha + \beta x_t \tag{2.8}$$

- α coefficient calculation method. The constant term of the linear regression model obtained by the statistical software is the α coefficient.
- β coefficient calculation method. Similarly, the slope of the regression equation obtained using statistical software is the β coefficient. The specific formula can be expressed as follows[5]:

$$\beta = \frac{n\sum_{t=1}^{n} x_t y_t - \sum_{t=1}^{n} x_t \sum_{t=1}^{n} y_t}{n\sum_{t=1}^{n} x_t^2 - (\sum_{t=1}^{n} x_t)^2} \tag{2.9}$$

The second method is to use the definition method. Select the historical yield of a single stock for a period of time $\{y_t\}$ and historical yield of the market index for the same period

[5]GUJARATI, D. N. & PORTER, D. C. 2003. Basic Econometrics. 4th. New York: McGraw-Hill.

of time $\{x_t\}$. Unbiased estimates of population parameters using sample statistics, see Formula (2.7).

- Average rate of historical yield of individual stocks: $\bar{y} = \frac{1}{n}\sum_{t=1}^{n} y_t$.
- Average rate of historical yield of market index: $\bar{x} = \frac{1}{n}\sum_{t=1}^{n} x_t$.
- Sample standard deviation of stocks' historical yield: $\sigma_y = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(y_t - \bar{y})^2}$.
- Sample standard deviation of market index yield: $\sigma_x = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}(x_t - \bar{x})^2}$.
- The correlation coefficient between stock returns and market index returns: $\rho = \frac{\sum_{t=1}^{n}((y_t-\bar{y})(x_t-\bar{x}))}{\sqrt{\sum_{t=1}^{n}(y_t-\bar{y})^2}\times\sqrt{\sum_{t=1}^{n}(x_t-\bar{x})^2}}$.

Substituting the above calculation result into formula (2.7), namely

$$\beta = \rho\times\frac{\sigma_i}{\sigma_m} = \frac{\sum_{t=1}^{n}\big((x_t - \bar{x})(y_t - \bar{x})\big)}{\sum_{t=1}^{n}(x_t - \bar{x})^2} \tag{2.10}$$

Formally, the equations (2.9) and (2.10) are different, but after deriving the equation (2.10), the β coefficients calculated by the two different methods are exactly the same[6].

According to the deduction, the β coefficients calculated by the regression analysis method and the definition method are equal. Therefore, the β coefficient can be directly obtained by regression analysis by using statistical software. EViews and EXCEL are used in this article.

2.3.3 Application of β coefficient

The calculated β value indicates the extent to which the return of a security or changes with changes in market returns, thus illustrating its degree of risk. The greater the value of β, the greater the system risk of a single security.

When the value of β is greater than 0, the return of securities or portfolios changes in the same direction as the market. When the value of β is less than 0, the return of securities or portfolios changes in the opposite direction as the market. The β coefficient is widely used in securities analysis and investment decisions. The application of β coefficients is mainly reflected in the following aspects.

Firstly, it is used to divide the type of securities. According to the size of the β value, the securities can be of the following types. if β is less than 1, when the market income rises,

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[6] The derivation process is as follows: $\beta = \frac{\sum_{t=1}^{n}(x_t y_t - \bar{x}y_t - \bar{y}x_t + \bar{x}\bar{y})}{\sum_{t=1}^{n}(x_t^2 - 2x_t\bar{x} + (\bar{x})^2} = \frac{\sum_{t=1}^{n}x_t y_t - \bar{x}\sum_{t=1}^{n}y_t - \bar{y}\sum_{t=1}^{n}x_t + \sum_{t=1}^{n}\bar{x}\bar{y}}{\sum_{t=1}^{n}x_t^2 - 2\bar{x}\sum_{t=1}^{n}x_t + \sum_{t=1}^{n}(\bar{x})^2} = \frac{\sum_{t=1}^{n}x_t y_t - n\bar{x}\bar{y} - n\bar{x}\bar{y} + n\bar{x}\bar{y}}{\sum_{t=1}^{n}x_t^2 - 2n(\bar{x})^2 + n(\bar{x})^2} = \frac{\sum_{t=1}^{n}x_t y_t - n\bar{x}\bar{y}}{\sum_{t=1}^{n}x_t^2 - n(\bar{x})^2} = \frac{\sum_{t=1}^{n}x_t y_t - \frac{\sum_{t=1}^{n}x_t\sum_{t=1}^{n}y_t}{n}}{\sum_{t=1}^{n}x_t^2 - \frac{(\sum_{t=1}^{n}x_t)^2}{n}} = \frac{n\sum_{t=1}^{n}x_t y_t - \sum_{t=1}^{n}x_t\sum_{t=1}^{n}y_t}{n\sum_{t=1}^{n}x_t^2 - (\sum_{t=1}^{n}x_t)^2}$.

that the return rate of individual securities rises is lower than the market average, and when the market income declines, its decline rate is also relatively small, which is a conservative securities or securities portfolio. For example, the food industry stocks. When β is equal to 1, the rate of change in the return of a single security or portfolio is exactly the same as the market rate of return. When $\beta > 1$, changes in the yield of individual securities or portfolios are larger than the market average and are considered as high-risk industries.

Secondly, it is used to determine risk compensation. The β coefficient, as a measure of risk, measures the part of the risk that can be compensated for in return, i.e. systematic risk. Systematic risk cannot be eliminated through the portfolio of securities. Investors investing in portfolios and investing in individual assets will require compensation for the risks they assume. Unlike individual investments, portfolio investment only requires compensation for non-dispersible part. Therefore, in the capital asset pricing model, the independent variable on the right side of the equation is the market index yield minus the risk-free interest rate, which refers to risk compensation[7].

Thirdly, based on the forecast of market trends, investors can choose different β values for different portfolios. For example, investors predict that the stock market will become a big bull market, you can choose a portfolio with a higher risk factor, which will multiply the market rate of return, resulting in yields that exceed the market average. Conversely, if investors predict that the market will become a bear market, then stock portfolios with lower risk factors can be selected to avoid inevitable system risks.

2.4 Systematic risk and non-systematic risk

Modern asset portfolio theory holds that the risks faced by asset portfolio can be divided into systematic risks and non-systematic risks. Systematic risk refers to the change in the rate of return on all assets in the market caused by an overall change in market rate of return. It is caused by risk factors that affect the entire market and is related to the overall economic performance, for example, inflation, economic crisis and so on. Systemic risk is the risk affecting all assets. Systemic risk has an unavoidable impact on all companies, companies, and securities investors. Therefore, diversification investment cannot offset such risks. Therefore, it is also called non-dispersible risk or market risk.

Non-systematic risk is the risk associated with the characteristics of the asset. It refers to the effect of a specific cause on the yield of a particular asset. By diversifying investments, non-systematic risks can be reduced. If dispersed investments are fully effective, theoretically, non-systematic risks will be completely eliminated. In real life, the operating conditions of various companies will be affected by their own factors, such as failure of investment decisions, failure of new product development, etc. These factors will not affect other companies and have nothing to do with the macro economy.

A basic idea of CAPM is that, apart from the fact that the system risks related to the changes in the entire market cannot be dissipated, other risks can be eliminated by using a portfolio approach. Therefore, investors usually do not regard risks that can be dispersed as risks, and only market risks that cannot be dispersed are real risks. The size of such

[7] Standard capital asset pricing model: $\mathrm{E}(r_i) - r_f = \beta_i[E(r_m) - r_f]$.

systematic risks can be determined by the return on individual securities as a function of market portfolio returns. The degree of fluctuation of the rate could be calculated.

The risk of securities investment is of great importance to investors. By scientifically classifying securities investment, it is beneficial to minimize risks and maximize returns. The following sections will analyze the occurrence and influencing factors of each type of risk, which will help investors to make reference in the most investment decisions.

2.4.1 Systematic risk division

Market risk. Market risk refers to the risk caused by changes in market conditions. Market conditions are generally cyclical, and their cycles can be roughly divided into four phases: recovery, prosperity, recession, and depression. During the period of economic recovery and prosperity, total social demand, total social investment, and economic growth rate would increase. Employment and personal income levels have also been greatly increased. The securities market is also very active in fundraising and investment. The return on securities investment is good. During the period of economic recession or even depression, the entire socio-economic activities are stagnating or even shrinking and regressing. The economic order is unstable and the securities market is bound to be affected. Demand for funds would decrease, market transactions would shrink, and securities prices would experience large-scale fluctuations. The stock market is a barometer of economic activity. This is a high-level summary of the relationship between the securities market and macroeconomics.

Interest rate risk. Interest rate risk refers to the risk of investment returns due to fluctuations in the interest rate of banks. When the interest rate is raised, it will generally cause:

- The opportunity cost of bank depositors would decline, some potential investors deposit money into banks, or existing securities investors choose to deposit money into banks. As the demand for securities decreases, the price of securities will fall.
- The reduction in the money supply would lead to a reduction in the scale of securities transactions and a reduction in the price of securities.
- The rise in interest rates will increase the company’s loan costs and investment expectations, profits, and share prices would decrease.

Policy risk. Policy risk refers to the risk to investment income due to the adjustment of macroeconomic policies. For example, the national industrial policy determines and adjusts pillar industries and restricted industries, and adjusts the industry's income level through economic and legal measures.

Devaluation risk. The risk of devaluation is the risk that the price will continue to rise generally and the currency devaluation will make investors bear it. When inflation occurs, the nominal return on investment remains the same, but the actual rate of return and value would decline. Although during the inflation period, due to the rise in commodity prices, the company’s sales revenue would increase, profits would increase, and share prices would rise. However, continued high inflation will increase the company’s cost and profits, and investors’ expectations for the market are bearish. Therefore, the stock price may drop.

Exchange rate risk. Exchange rate risk refers to the risk of exchange rate fluctuations and investment returns. In addition to international investment, the relationship between the exchange rate and the securities market are mainly reflected in two aspects:

- Exchange rate changes will affect the raw material costs and sales revenue of the operating companies associated with the import and export products, thereby affecting the price of the security that the companies have issued.
- For countries whose currencies are freely convertible, changes in exchange rates may cause the import and export of capital, thereby affecting the supply of domestic currency funds and the supply and demand of the securities market.

Market organization risk. Market organization risk refers to the possibility that investors will suffer losses in the transaction process due to the level of market management. Market organizations include:

- Whether the legal system is complete or not.
- Whether the trading system, information system and liquidation method are scientific and reasonable.
- The configuration of hardware facilities is complete and advanced.

The level of market organization influences investment returns by affecting the liquidity of securities, transaction costs, market efficiency, and the volatility of securities prices.

Political risk. Political risk refers to the fluctuation of the securities market due to changes in the political situation of a country, which affects the return on investment. For example, war, regime change. In addition, political scandals such as politicians' participation in securities speculation and insider trading of securities practitioners pose a great threat to the securities market. As soon as the scandal is disclosed, the stock price falls.

2.4.2 Non-systematic risk division

Default risk. Default risk, also known as credit risk, means that a company cannot pay interest and principal to the security holder on time, mainly for bonds. Securities issuers cannot fulfill their obligations to their debts, mainly because of poor financial conditions.

Financial risk. Financial risk refers to the risk brought by the use of different financing methods. Funds required for the company's business operations, from the perspective of direct financing, mainly adopt two methods to raise funds, issue stocks and issue bonds, and the ratio of stocks and bonds constitutes the capital structure of the company. The stock needs to distribute a portion of the net profit to the shareholders as dividends, but it is not fixed, sometimes more or less, or it may not be paid, depending on the profitability. Bonds are different. Irrespective of whether the company has profit or how many profits in the current year, it must repay principal and interest on schedule. Repaying debt becomes a fixed expense for the company. If the proportion of debt financing in the company’s capital structure is large, this means that the company’s financial pressure is also greater. First of all, if the amount of capital raised by a bond increases and the profit does not decrease due to various reasons, it may even fail to pay the fixed debt, thus causing the bond holder of the company to bear the loss. Secondly, even if the company has a certain amount of profit, the number of dividends that are required to be repaid will be reduced because the company has a certain amount of debts. The company’s stockholders will suffer losses, which will affect the company’s share price.

Operating risk. Operating risk refers to the possibility of loss of earnings and principal due to changes in profitability caused by changes in the company's operating conditions. There are many factors that affect the company's business operations, mainly including:

- Changes in the company's earnings caused by the economic cycle.
- Changes in competitors, if the company is in a disadvantageous position in the industry competition, the rate of return will decline, which will cause the company's share price to drop substantially, causing losses to investors.
- Company's business decision-making and management level. Mistakes in the company's business decisions can lead to product crushing. Poor management can lead to a decline in product quality and a rise in costs that can cause the company's profit to decline.

Product risk. Product risk refers to the possibility that life cycle of the products would change and bring losses to investors. The product life cycle can be divided into four phases. In these four phases, the risks and benefits faced by investors are different.

- Generation period. In the initial stage of product development, due to the immature nature of the new technology, the market prospects are uncertain, and it requires large investment in research and development, and less profit. At this time, investors often take greater risks.
- Development period. When the products enter the development period, new products are recognized by the society, and the sales volume rises sharply. The huge profits brought will attract many companies to invest in research and more products will be put into the market. At this stage, investors can often get quite generous returns.
- Maturity period. At this stage, the sales volume has only grown slowly, and the competition in the industry has become more intense. Companies have competed for market share with low-price strategies and profits have also dropped. Entering this stage, most of the companies have shown the characteristics of stable development. Although the growth of earnings is not as good as the development period, the risks are even smaller.
- Recession. As products enter the recession period, profits decline, and the scale will gradually shrink. Competition will mainly come from the growth of new products. At this time, the risks faced by investors will increase. Close attention should be paid to the changes in the price of securities and the corresponding investment portfolios should be adjusted accordingly.

Technical risk. Technical risks are various uncertainties in technology development, such as technical difficulties. The main risk factors are:

- Technological development is difficult, and key technologies are not expected.
- Technical knowledge cannot be obtained.
- Key technologies are difficult to break through.
- There are technical barriers and technical barriers.
- Lack of test sites, equipment and tools.

With the rapid changes in technology in today's world, existing technologies will soon become obsolete, which will weaken the competitiveness of products, thereby reducing market share, and ultimately affecting the overall profitability of enterprises. This poses a great risk to the securities investment market.

The causes of various risks in the securities investment market are not single, and in many cases, they are the result of various factors.

2.5 The empirical testing method of CAPM model

The test of Capital Asset Pricing Model (CAPM) does not directly test the assumptions of CAPM. Instead, it tests the characteristics of the securities market line, namely, testing whether there is a positive correlation between the beta coefficient of a security or a portfolio and the expected return.

Since the capital asset pricing model gives a succinct description of the relationship between the returns and risks of various assets in the capital market, if the model can successfully describe the actual conditions in the capital market, then the capital asset pricing model is undoubtedly of great importance to investors. In fact, many empirical tests have been conducted on the capital asset pricing model.

The key issue to empirically test the capital asset pricing model is to determine the market portfolio. Market portfolio is a portfolio of all assets in the market based on their market value ratio, but it is obviously impossible for a market index to contain information on all aspects of the market. Researchers usually use the stock price index as a representative of the market portfolio. For example, when researching the US stock market, researchers usually use the S&P 500 index to replace the real market portfolio. Obviously, if the stock index cannot effectively represent the market portfolio, the quantitative study of the capital asset pricing model cannot be correctly concluded. The capital asset pricing model assumes that the system risk of the market portfolio is all its risks, that is, the non-systematic risk is zero. If the stock index used as a market portfolio is not efficient, non-systematic risk cannot be zero.

The capital asset pricing model considers that the income of a single asset is divided into two parts, one is risk-free gain, and the other is risk premium. The risk premium is defined as the product of the system risk β of a single asset and the excess return $r_m - r_f$. The β value of the market portfolio is assumed as 1.

The empirical research on the capital asset pricing model is very rich in specific content. These tests generally include three aspects: The first is the test of the relationship between risk and return. The second is the time series CAPM test. The third is a cross-sectional CAPM test.

The American scholar Sharpe (1964) research is the first example of the relationship between risk and return. Sharpe (1964) selected 34 mutual funds in the United States as samples, calculated the standard deviation of the annual average yield and yield for each fund from 1954 to 1963, and returned the standard deviation of the fund's annual return and yield. His main conclusion is: From 1954 to 1963, the return rate of the US stock market exceeded the risk-free rate of return. The correlation coefficient between the fund's average return and the standard deviation of its return was greater than 0.8, and the relationship between risk and return was almost linear.

When examining the theory, early tests adopted a two-step regression. In the first step, the β coefficient of the portfolio is estimated using time series. The second step is to use the cross-sectional data to conduct regression analysis of the β coefficient and the average

return rate of each portfolio. The best fitting line of the observation is the stock market line.

The famous time series CAPM is the study of Black Jensen et al. (1972), abbreviated BJS method. The BJS method will be described in detail below.

2.5.1 Black Jensen Scholes method

Black, Jensen, Scholes made the following research in 1972.The purpose of testing is to examine whether there is a positive linear correlation between the expected return of a portfolio and the beta coefficient. The sample they selected was monthly rate of return on all stocks traded on the NYSE from 1926 to 1965.

The method they used is as follows.

(1) a regression model of each stock with market index is established, a $\beta_i (\ i = 1, 2, \dots, n)$ value of each stock is obtained, and the stock is divided into 10 groups according to the size of the β_i value and constructed 10 portfolios.

$$r_i - r_f = \alpha_i + \beta_i \left(r_m - r_f \right) + u_i, i = 1, 2, \dots, n \tag{2.11}$$

r_i refers to the rate of return of each stock over the sample period.
r_f refers to the risk-free rate over the sample period.
r_m refers to the rate of return of market index over the sample period.
u_i refers to the random items which has no correlation with r_m and satisfy the normal distribution.

(2) For each portfolio, a regression model of its return and market index return is established, the $\beta_{p_i}, (i = 1, 2, \dots, 10)$ coefficient of each investment portfolio could be obtained.

$$r_{p_i} - r_f = \alpha_{p_i} + \beta_{p_i} \left(r_m - r_f \right) + u_i, i = 1, 2, \dots, 10 \tag{2.12}$$

r_{p_i} refers to the rate of return of each portfolio over the sample period, $r_{p_i} = \frac{\sum_{i=1}^{n} r_i}{N}$.
r_m refers to the rate of return of market index.
u_i refers to the random items which has no correlation with r_m and satisfy the normal distribution.

(3) Use the sets of data for plotting a correlation graph and γ_{p_i} would be obtained.

$$r_{p_i} = \alpha_i + \gamma_{p_i} \times \beta_{p_i} + u_i, i = 1, 2, \dots, 10 \tag{2.13}$$

r_{p_i} refers to the rate of return of each portfolio, $r_{p_i} = \frac{\sum_{i=1}^{n} r_i}{N}$.
β_{p_i} refers to the systematic risk.

The innovation of the BJS approach is that the use of a portfolio rather than a single asset, by diversifying the portfolio, eliminates most of the corporate heterogeneity and improves the accuracy of the beta (systematic risk) estimator, i.e. $\widehat{\beta_{p_i}}$ and the expected return on the

portfolio. This means that the statistical problem due to the measurement error of the beta estimate is mitigated by means of a portfolio[8].

The experimental results done in 1972 (Jensen et al., 1972) showed that there is a positive linear relationship between the expected rate of return and the beta coefficient, and this relationship is significant. This shows that the expected return on the portfolio is closely linked to market risk and provides a strong empirical evidence of the capital asset pricing model. There is almost no nonlinearity in their estimated stock market lines, and the slope is significantly positive. In addition, almost all differences in the simple average return for a portfolio can be explained by differences in beta coefficients, with few other variables explaining the expected return difference.

Black, Jensen and Scholes, their research (Jensen et al., 1972) referred to as the BJS method for short, has become the standard model for time series CAPM testing and can be summarized as follows:

(1) In the first stage, calculate the β_i coefficient of each stock over the time period.
(2) In the second stage, divide each stock into a portfolio based on the size of β_i.
(3) Use data from stock portfolios and market indices, calculate the β_{p_i} of each portfolio over the time period.
(4) Use β_{p_i} as independent variables, and then conduct regression analysis of β_{p_i} and average return of each portfolio and γ_{p_i} would be obtained.

The famous cross-sectional CAPM test is Fama and MacBeth (1973) study, which will be described in detail below.

2.5.2 Fama and MacBeth (1973) method

Fama and MacBeth (1973) used the sample data of BJS method, using NYSE as the market portfolio, testing the relationship between the β_{pi} factor and the portfolio return r_{p_i}. The main method is to establish a nonlinear regression model.

$$r_{p_i} = \gamma_{0i} + \gamma_{1i}\beta_{p_i} + \gamma_{2i}\beta_{p_i}^2 + \gamma_{3i}\sigma_{ep_i} + u_i \tag{2.14}$$

r_{p_i} refers to the average portfolio return over the time period.
β_{p_i}refers to the portfolio systematic risk which could be calculated by BJS method.
$\beta_{p_i}^2$refers to the square of β_{p_i}, which is a non-linear variable. If CAPM is effective, the value of γ_2 coefficient of $\beta_{p_i}^2$ is supposed to be very small.
σ_{ep_i} refers to non-systematic risk of each portfolio, which is the standard deviation of the residual in the first-step regression function.

Then Fama and MacBeth (1973) tested the significance of each coefficient in the model. The test results showed that the γ_{2i} coefficient is not significant, that is to say $\beta_{p_i}^2$ has no significant effect on r_{p_i}.

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[8] It should be noted that in this paper, we would use 100 stocks from different industries to combine 20 portfolios.

In summary, the model mainly tests four hypotheses as below:

(1) $\mathrm{E}(\gamma_{0i}) = r_f$, so $\gamma_{0i} > 0$.

(2) $\mathrm{E}(\gamma_{1i}) > 0$.

(3) $\mathrm{E}(\gamma_{2i}) = 0$, for there is no non-linear relationship between β_{pi} and r_{pi}.

(4) $\mathrm{E}(\gamma_{3i}) = 0$, for non-systematic risk σ_{epi} could not affect r_{pi}.

The result of FM method showed that there is no non-linear relationship between the β_{p_i} coefficient and the return of the portfolio r_{p_i}. That is to say, the yield of the portfolio strongly depends on the market system risk, which means CAPM is effective.

It is worth noting that both the BJS method and the Fama and MacBeth (1973) method use the asset portfolio instead of a single asset to test the capital asset pricing model. The capital asset pricing model is a linear model between the expected returns of individual assets and system risk β values. However, there are some obvious problems with using a single asset inspection capital asset pricing model. These issues include:

Firstly, when estimating the β value of each asset, there is a random error, which makes the β value of some assets overestimated, while the β value of some assets is estimated to be too low, which makes the use of these data to test the capital asset pricing model, the credibility must be reduced.

Secondly, since the capital asset pricing model uses the expected return on assets, in the empirical study, the current real data (that is, historical data) are used, and the current return rate of each asset contains a lot of non- systematic risks, and the changes in the returns caused by these non-systematic risks cannot be explained by β values.

If risk-similar assets form a portfolio of assets, the random error of the β value of the portfolio will be greatly reduced, and many non-systematic risks will be effectively dispersed, which will increase the credibility of the test results of the capital asset pricing model.

3 Empirical Study on CAPM Model of China's stock Market

The basic assumption of CAPM is a fully efficient market, which makes people think of its practicality in the Chinese securities market. China's securities market has been established since 1991, although it has experienced rapid development, there is still a considerable gap from the fully effective market. As for this thesis, we would follow BJS method and Fama and MacBeth (1973) method to determine the test method as follows.

3.1 Sample data selection

3.1.1 The choice of research period

This article selected January 1, 2007 to February 1, 2018 as the research period, during 2007~2018 the Chinese stock market experienced intense fluctuations. Taking the CSI

300 index[9] for example, it once hit a high of 5353.75, after which it dropped until 2853.76. It can be said that in the past ten years Chinese stock market has undergone two complete cycles, which also makes the analysis more representative and persuasive.

Figure 3 Shanghai-Shenzhen 300 capitalization-weighted stock market index

3.1.2 The choice of sample stocks

This article selects 100 stocks[10] from 20 industries as sample stocks. These 20 industries are Aerospace Defense, Automobile Parts, Beverages, Chemicals, Construction, Electricity, Food producers, Paper, Multi-utilities, General Industry, General Retailers, Household Goods, Industrials engineering, Oil equipment, Oil Gas producers, Pharmaceuticals, Real Estate Investment Services, Software Computer service, Hardware[11]. These sample stocks are industry representative, and all stocks listed for more than 10 years, which reflects the characteristics of the Chinese stock market. The selected stocks had been listed before 2007, and stocks that had abnormal business conditions or had recently suffered severe losses in their financial reports has been excluded. It is noteworthy that these 100 stocks are listed on the Shanghai Stock Exchange.

3.1.3 The choice of market index

As the stock price index cannot effectively represent the market portfolio, quantitative research on the capital asset pricing model is difficult to achieve correct results because the capital asset pricing model considers the systematic risk of the market portfolio as its total risk rather than the systemic risk does not exist. When the stock price index used in a market portfolio is not efficient, there is a non-systemic risk. Standard & Poor's 500, the New York Stock Exchange index is usually used by US researchers and financial services agencies. In China, the Shanghai Composite Index, a weighted composite index, provides a wealth of basic data to calculate the market rate of return. Shanghai Composite Index can more accurately reflect the overall market changes and the overall price trend,

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[9] The CSI 300, i.e. Shanghai-Shenzhen 300 is a capitalization-weighted stock market index designed to replicate the performance of top 300 stocks traded in the Shanghai and Shenzhen stock exchanges.

[10] See specific stock monthly return in appendix.

[11] Industry classification and data sources are from DataStream.

so the Shanghai Composite Index is usually regarded by most researchers as a market index, this article as a comparable object.

3.1.4 The calculation of rate of return

The method of calculating the rate of return uses the natural logarithmic rate of return, i.e. $r_{it} = ln\,(\mathrm{P}_{it}/P_{i(t-1)})$.

3.1.5 Risk-free rate delimitation

The risk-free rate is the rate at which investors could be absolutely profitable and without any risk. Since the participants of transactions of Chinese government bonds are mostly institutional investors, and the majority investors of Chinese stock markets are individual investors, the interest rate of national debt cannot be used as a risk-free rate. For Chinese residents, saving accounts for a large proportion of investment behavior. We would like to choose one-year deposit to represent the return on risk-free assets and select one-year time deposits from January 2007 to February 2018 during the sample period and convert them into monthly rates. As calculated, 2007.01-2018.02 the average interest rate of one-year deposits was 2.66% with a monthly interest rate of 0.22% (2.66%/12=0.22%).

Table 1 January 2007 - February 2018 RMB deposit benchmark interest rate[12]

time period	2007 - 2008	2008 - 2009	2009 - 2010	2010 - 2011	2011 - 2012	2012 - 2013	2013 - 2014	2014 - 2015	2015 - 2016	2016 - 2017	2017 - 2018
1Y deposit rate (%)	3.15	3.96	2.25	2.29	3.23	3.27	3.00	2.98	2.15	1.50	1.50

3.2 The procedure of testing CAPM

This paper uses the traditional Black Jensen Scholes (BJS) method to test the validity of the CAPM model. Using time-series tests and cross-sectional inspection methods, 100 stocks from January 2007 to February 2018 would be divided into 20 groups according to the size of the β coefficient and second-pass regression would be then conducted. The specific implementation steps are as follows:

(1) According to the historical data of the monthly returns of various stocks from January 2007 to February 2018 and the monthly returns of the Shanghai Stock Exchange Index, the β coefficient is obtained. The regression equation is:

$$r_i - r_f = \alpha_i + \beta_i\left(r_m - r_f\right) + u_i, i = 1, 2, \ldots, 100. \tag{3.1}$$

r_i refers to the rate of return of each stock over January 2007 to February 2018.
r_f refers to the risk-free rate over January 2007 to February.
r_m refers to the rate of return of market index over the sample period.

[12] Sources are from Datastream.

u_i refers to the random items which has no correlation with r_m and satisfy the normal distribution.

(2) According to the calculation result of formula (3.1), 100 stocks are divided into 20 portfolios according to the β_i coefficient. The simple average monthly yield of stocks in the portfolio and the monthly return of the market index would be regressed in order to obtain the $\beta_{pi,}$ $(i = 1, 2, \dots, 20)$coefficient of each portfolio. The regression equation is as follows:

$$r_{pi} - r_f = \alpha_{pi} + \beta_{pi}(r_m - r_f) + u_i, i = 1, 2, \dots, 20. \quad (3.2)$$

r_{p_i} refers to the rate of return of each portfolio over the sample period, $r_{p_i} = \frac{\sum_{i=1}^{n} r_i}{N}$.
r_m refers to the rate of return of market index.
u_i refers to the random items which has no correlation with r_m and satisfy the normal distribution.

(3) According to formula (3.2), we get r_{pi} and β_{pi} use the following regression equation to do a second-pass analysis:

$$r_p = \gamma_0 + \gamma_1 \beta_p + u_i \quad (3.3)$$

Then the cross-sectional analysis would be conducted as follows:

$$r_p = \gamma_0 + \gamma_1 \beta_p + \gamma_2 \beta_p^2 + \gamma_3 \sigma_{pe} + u_i \quad (3.4)$$

4 CAPM empirical research results

4.1 Estimation of individual stock β_i coefficients

Based on the 100 single stock data, the minimum $\beta_i$coefficient is 0.119772, the maximum is 1.482231, and the average value is 1.044617[13]. According to the size of β_i divided into 20 portfolios, the following results are obtained:

Table 2 Portfolio details

The 1st portfolio		The 2nd portfolio		The 3rd portfolio		The 4th portfolio	
code	β	code	β	code	β	code	β
600133.SS	0.119772	600664.SS	0.688488	600671.SS	0.749434	600306.SS	0.835085
600847.SS	0.517551	600697.SS	0.715247	600633.SS	0.794668	600588.SS	0.857732
600681.SS	0.574793	600854.SS	0.727912	600323.SS	0.797067	600613.SS	0.8603
600519.SS	0.598764	600817.SS	0.734502	600610.SS	0.82352	600871.SS	0.871633
600600.SS	0.620483	600693.SS	0.747981	600645.SS	0.826734	600699.SS	0.898894
The 5th portfolio		The 6th portfolio		The 7th portfolio		The 8th portfolio	

[13] Detailed results are in the appendix.

code	β	code	β	code	β	code	β
600809.SS	0.902391	600388.SS	0.937654	600824.SS	0.961513	600698.SS	0.996723
600461.SS	0.912158	600506.SS	0.951804	600990.SS	0.966096	600389.SS	1.002084
600690.SS	0.924361	600666.SS	0.956439	600038.SS	0.980379	600567.SS	1.004741
600419.SS	0.928885	600845.SS	0.957734	600674.SS	0.987587	600829.SS	1.005977
600332.SS	0.931885	600365.SS	0.960628	600309.SS	0.995975	600356.SS	1.017997
The 9th portfolio		The 10th portfolio		The 11th portfolio		The 12th portfolio	
code	β	code	β	code	β	code	β
600462.SS	1.029883	600303.SS	1.056852	600562.SS	1.072175	600660.SS	1.089966
600825.SS	1.031215	600866.SS	1.057094	600028.SS	1.072674	600601.SS	1.095002
600621.SS	1.031931	600812.SS	1.059614	600433.SS	1.073721	600339.SS	1.103184
600868.SS	1.0393	600657.SS	1.071189	600680.SS	1.078782	600642.SS	1.10602
600256.SS	1.045702	600562.SS	1.072175	600614.SS	1.086254	600686.SS	1.113735
The 13th portfolio		The 14th portfolio		The 15th portfolio		The 16th portfolio	
code	β	code	β	code	β	code	β
600336.SS	1.11728	600313.SS	1.123389	600316.SS	1.166978	600807.SS	1.203771
600850.SS	1.120279	600530.SS	1.127424	600684.SS	1.171456	600658.SS	1.204367
600378.SS	1.120739	600624.SS	1.131514	600805.SS	1.171479	600008.SS	1.206817
600863.SS	1.121247	600675.SS	1.140321	600668.SS	1.18052	600696.SS	1.207414
600644.SS	1.122074	600559.SS	1.154656	600823.SS	1.184515	600695.SS	1.213174
The 17th portfolio		The 18th portfolio		The 19th portfolio		The 20th portfolio	
code	β	code	β	code	β	code	β
600328.SS	1.213863	600536.SS	1.252363	600665.SS	1.320098	600635.SS	1.367563
600320.SS	1.220196	600802.SS	1.254904	600157.SS	1.321248	600391.SS	1.388899
600571.SS	1.224187	600683.SS	1.265178	600864.SS	1.333909	600800.SS	1.401921
600801.SS	1.225771	600385.SS	1.287266	600326.SS	1.334661	600685.SS	1.470244
600387.SS	1.251778	600804.SS	1.288122	600677.SS	1.33783	600678.SS	1.482231

4.2 Estimation of portfolio $\boldsymbol{\beta_{pi}}$ coefficient

Using formula (3.2) $r_p = \gamma_0 + \gamma_1\beta_p + u_i$ to get the following result:

Table 3 Portfolio first-pass regression results

portfolio	α	t-stat	β	t-stat	σ_{ei}	DW-stat	average return
1	0.009639	1.86013	0.486273	8.638654	0.059533	2.051186	0.009472
2	0.002133	0.361544	0.722826	11.28018	0.067771	1.677267	0.006884
3	0.007791	1.20122	0.798285	11.33089	0.074511	1.994683	0.007516
4	0.005623	0.800128	0.864729	11.32822	0.080732	1.870228	0.005325
5	0.010827	1.975026	0.919936	15.4488	0.062978	2.172146	0.01051
6	0.010546	1.514653	0.952852	12.59833	0.079991	2.148513	0.010218
7	0.009411	1.439551	0.97831	13.7764	0.075105	2.012501	0.009074

8	0.004923	0.810567	1.005504	15.23993	0.069779	1.936775	0.004577
9	0.004782	0.736641	1.035606	14.68507	0.074584	2.183236	0.004426
10	0.006599	0.938351	1.063385	13.91958	0.080796	1.826894	0.006233
11	0.007781	1.267983	1.076721	16.15163	0.070504	1.686799	0.007411
12	0.001732	0.348523	1.101581	20.40534	0.057095	1.748377	0.001353
13	0.006318	0.900966	1.120324	14.70687	0.080566	1.880266	0.005932
14	0.007705	1.255507	1.135461	17.03237	0.070506	2.157915	0.007314
15	0.007689	1.345384	1.17499	18.92744	0.065655	1.779041	0.007284
16	0.006437	0.901496	1.207109	15.5627	0.082033	2.157725	0.006021
17	0.005111	0.945319	1.227159	20.89486	0.062114	1.978717	0.004688
18	0.007111	0.968628	1.269567	15.92024	0.08434	1.733039	0.006674
19	0.004717	0.846948	1.329549	21.97538	0.063987	2.099753	0.004259
20	0.005246	0.733251	1.422172	18.29859	0.082198	1.993621	0.004756

From the Table 3 results, among the 20 portfolios, the minimum value of the estimated β_{pi} coefficient is 0.486273, the maximum value is 1.422172, and the average value is 1.044617. All combinations passed the t-test (suppose that the significance level is 5%, namely t-stat is more than 1.96) and the β_{pi} coefficient was significantly nonzero.

From the regression results, the estimated α_{pi} coefficients of all portfolios are all greater than 0, which is better than the market portfolio. The β_{pi} coefficient of 13 portfolios is greater than 1, indicating that the 13 portfolios are active and have high system risk. There are seven portfolios with β_{pi} coefficient less than one, and the risk is less than the market risk.

4.3 The relationship between system risk and rate of return

Using the monthly average yield r_p and β_p coefficient of the portfolio and formula (3.3) $r_p = \gamma_0 + \gamma_1\beta_p + u_i$, the following conclusions are obtained:

Table 4 Relationship between monthly average yield and system risk

parameter	estimator	St. Error	t-stat	p-value	multiple R-Square	F-stat	P-value
γ0	0.0117	0.0023	5.1741	0.0001	0.2354	5.5417	0.0301
γ1	-0.0050	0.0021	-2.3541	0.0301			

More vivid figure is shown below:

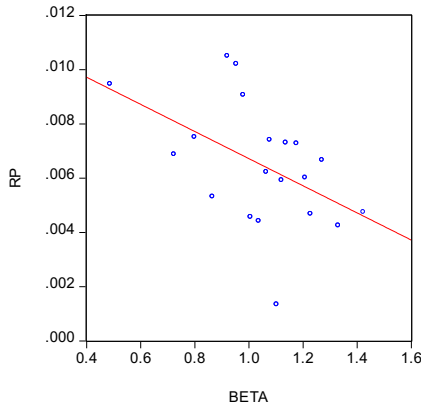

Figure 4 The relationship between the monthly average yield of 20 portfolios and market risk.

The analysis results are as follows:

(1) $\gamma_0 > 0$, The risk-free rate of return is positive and is in line with the capital asset pricing model.

(2) $\gamma_1 < 0$, There is a negative correlation between systemic risks and returns in China's stock market, which can be clearly seen from Figure 4. The t-test has a value of -2.3541, which means that at a 5% significance level, γ_1 is significantly negative. In other words, the higher the risk is, the less rate of return the certain stock would get. This finding is inconsistent with the conclusion of CAPM and consistent with the conclusion drawn by 付应变 (2012) . He concluded that in the Chinese stock market, there is a negative correlation between risk and return.

It is noteworthy that the regression fitting coefficient $R^2 = 0.2354$ is small, indicating that other risk factors play an important role in stock pricing.

The FM model proposed by Fama and MacBeth (1973) is used for further verification. Use formula (3.4) $r_p = \gamma_0 + \gamma_1\beta_p + \gamma_2\beta_p^2 + \gamma_3\sigma_{pe} + u_i$ to get the following result:

Table 5 Cross-sectional testing results

parameter	estimator	St. Error	t-stat	p-value	multiple R-Square	F-stat	P-value
γ0	0.00842	0.00729	1.15587	0.26470	0.28715	2.14839	0.13416
γ1	-0.0070	0.0143	-0.4878	0.6323			
γ2	0.0007	0.0072	0.0926	0.9274			
γ3	0.0636	0.0591	1.0754	0.2982			

The results are analyzed as follows:

(1) $\gamma_0 > 0$, the risk-free interest rate is positive, and the t-test statistic shows that it is not significantly different from 0.

(2) $\gamma_1 < 0$, the estimated value of γ_1 is -0.0070, and at the 95% significance level, the t-test statistic has the value -0.4878, which indicates that the regression coefficient γ_1 is not significantly different from zero. Since $\widehat{\gamma_1}$ is negative, we can see that in the Shanghai stock market, there is no positive correlation between the

system risk and the expected rate of return as revealed by the CAPM, but a negative correlation, that is, the stocks with higher systematic risk can only receive lower expected return, and the negative effect of this systemic risk on the expected return is not statistically significant.

(3) $\gamma_2 > 0$, the estimated value of γ_2 is not significantly different from zero, indicating that there is no non-linear relationship between systemic risk and expected return in a statistical sense.

(4) $\gamma_3 > 0$, The γ_3 estimator is not significantly different from 0, which indicates that returns of stocks cannot be determined by non-systematic risk.

In summary, from the Table 5, the t-test results of each estimator are not significant, indicating that the independent variable's interpretation of the portfolio yield is low, that is, in the Chinese stock market represented by the Shanghai stock market, the relationship between the rates of return and risks is not as the CAPM anticipates that the relationship between income and risk is linear and quadratic. The rate of return cannot be determined by non-systematic risk neither.

5 Discussion

5.1 Defects in China's securities market

Non-effective market. CAPM is based on strict assumptions. For example, requiring securities markets to be effective markets is one of the key assumptions. The so-called effective market means that the capital market has no obstacles to the flow of capital and information, that is, there are no obstacles to investment. The potential obstacles are taxation, transaction costs, risk-free borrowing, and loan interest rate differentials, but these are gradually taken into account in subsequent CAPM revision models, such as the Brennan and Buchanan (1980) model, which focuses on discussing the existence of personal income taxation. Describe the zero-beta pattern of CAPM in which it is impossible to borrow at a risk-free rate.

The degree of information disclosure is low. An important feature of an effective market is that information is completely open, and every investor can get all valuable information for free. Once the market information is made public, it will immediately affect the price of securities, which will be reflected in the price of securities (Bodie, 2009). Only when the price of the securities reflects the real value of the securities will the pricing mechanism not be distorted. In China, the problems in information disclosure are still very prominent. On the one hand, laws and regulations are not perfect, and technical defects such as the content and time of information disclosure make it difficult for information to be fully disclosed through normal channels. On the other hand, some information disclosure culprits are guilty of falsification of various market entities. In particular, some listed companies have colluded with intermediary agencies to overstate the company’s image and mislead investors. Article 13 of the "Interim Measures for Prohibiting Securities Fraud" issued in 1993 stipulates the administrative penalties for insider trading, that is, the confiscation of illegal gains and a fine of between 50,000 and 500,000 yuan. As a basic law prohibiting insider trading, Article 202 of the "Securities Law" stipulates that, on the basis of confiscation of illegal income, a fine of 1 time or more and 5 times or less shall be imposed on the basis of the amount of illegal income. It can thus be seen that confiscation of illegal income and punitive fines are the most

commonly used administrative penalties by regulatory agencies. However, this penalty has obvious limitations, mainly in two aspects:

- There is no clear standard for the concept of illegal gains.
- In practice, the amount of punishment is obviously lighter. The amount of punishment is within 30,000 yuan, which is equivalent to approximately 5,000 US dollars. After the securities supervision agencies confiscated illegal income, most of them were only fined 1 times the illegal income. The number of fines has not been comprehensively considered in light of the circumstances of the law, social harm, and losses caused.

According to the information disclosed on the website of the China Securities Regulatory Commission, the China Securities Regulatory Commission issued a "Market Ban Decision" in only four cases, accounting for 3% of all administrative penalties. Excess income is the economic driving force generated by insider trading, while lower fines and lighter penalties reduce the risk of legal sanctions for insider trading, causing the perpetrator to ignore the legal prohibition, and thus lose the administrative penalty to the offender. Protection of the securities market and small and medium investors would fail.

Under such circumstances, all investors could not obtain fair information in an equitable manner, and that false information also played a role in misleading the market. The price of securities was seriously deviated, and a few information manipulators obtained excessive profits by manipulating the stock price.

The ratio of securities circulation is relatively low. According to CAPM's hypothesis, each investor has exactly the same expectation and chooses a combination according to the Markowitz (1952) method. When the market reaches equilibrium, the market portfolio should be a valid combination of Markowitz (1952). Therefore, the stock price index that we have chosen to represent the market rate of return should meet these two characteristics:

- The constituent stocks account for a considerable portion of the market value.
- The market index is compiled based on the value-weighted average of the stock market price.

However, the Shanghai Stock Index and the Shenzhen Stock Index, which are now commonly used in China's stock market, are all based on the weighted average of the market prices of all the stocks listed on the exchange. On the surface, it seems that it better reflects the characteristics of the market portfolio. The problem is that the number of state shares and legal person shares in the stock issuance account for approximately 70% to 80% of the total share capital. These stocks cannot be listed and circulated, but they are still included in the weights. The Shanghai Stock Index and Shenzhen Stock Index can only reflect the potential circulation market, and cannot reflect the real situation of the stock market price in the circulation market. Therefore, it is obviously unreasonable to use the Shanghai Composite Index and Shenzhen Stock Index as representatives of the market portfolio. Only when the state shares and legal person stocks become truly tradable stocks a more suitable market index for the CAPM model could be obtained.

The structure of investors is abnormal and investment concepts are not matured. CAPM assumes that all investors will use the Markowitz (1952)-portfolio theory to analyze and process information so as to adopt the same investment attitude and then review the

securities pricing mechanism. Therefore, the scientific and rigorous nature of investor decision-making is the premise of the CAPM model. First analyze the composition of investors in the Chinese stock market[14]:

- As for the number of investor accounts, in 2012, the number of individual investors holding a market value of less than 5 million per day accounted for more than 99% of the total. Among them, the number of individual retail accounts for 93.2% of the A-share accounts in the Shanghai stock market. The number of individuals in small accounts and medium accounts accounted for a decrease in 2011, accounting for 5.6% and 0.4% respectively. Other types of investors accounted for about 0.5%, of which the general institutional accounted for 0.4%, and the proportion of institutional accounts remained unchanged.
- From the perspective of various investors holding stock market value. General institutions have a stock market value as high as 64.9%. Individuals and investment funds account for 7.5% and 5.8% respectively.

It can thus be seen that the Chinese stock market is actually a stock market whose main body is individual investors. Among them, the percentage of total investors below the technical secondary school continued to fall to 28.0%, and the total proportion of undergraduate or higher education continued to increase, reaching 19.9%. Investors with technical secondary education or below technical secondary school education accounted for 54.1% of total investors. Most investors lack experience and lack professional knowledge. Even general institutional investors are not professional financial companies or fund investment companies. They rely on their adequacy of funds and well-informed information to conduct speculative short-term speculation. They do not rely on the quality of professional investors to implement rational and scientific operations. It is obviously not realistic to require those investors to have the same understanding of expected returns, securities price volatility and covariance.

The independence of China Securities Regulatory Commission. China's securities market was established by the government, and policy makers at the time only considered the stock exchange as a response to special political goals[15]. The emergence of China's securities market only focused on the establishment of market exchanges. In the two years after the establishment of the securities market, there was no simultaneous establishment of securities regulators. It was not until two years later that the central government took over the dominance of the securities market. The rich government color of the China Securities Regulatory Commission born under such a background is self-evident, which also determines that the China Securities Regulatory Commission has so far been unable to get rid of the fate of the government's interests. In the face of pressure from the reform of state-owned enterprises, corporate finance, and social stability, the securities regulators first consider the political, economic and other factors of the same period, and sometimes have to compromise on the reality. For example, when securities market transactions and investment are sluggish and share prices are weak, the China Securities Regulatory Commission will be more cautious about penalties.

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[14] The data comes from *the investor structure and behavior report (2013) in the Shanghai securities market* Published by Shanghai Stock Exchange.

[15] After the Chinese Communist Party established political power in China, it had implemented a planned economy for 30 years until its reform and opening up in 1978. Establishing a securities market is considered a political event to abandon planned economic policies.

5.2 CAPM's Assumption Fails to be established in China's Stock Market

The assumption that there is no transaction cost of securities is not established in China at all. China's stock market transaction fees and stamp duty, buy and sell up to 1.5% at one time, equivalent to the bank's one-year fixed deposit interest. The cost is 3 to 4 times higher than that of mature securities markets (such as Hong Kong and the United States).

In addition, systematic risks in China's securities market are too large, and non-systematic risks cannot be completely eliminated through asset portfolio diversification.

It is for these reasons that the effectiveness of the CAPM model in the Chinese securities market is limited. However, this does not exclude the logic of the CAPM model theory. Therefore, in practice, the error of the variable value and the correction model of CAPM under various restrictions should be fully considered.

In short, in China, due to the short time of the capital market, especially the stock market, there are at least the following problems:

(1) Laws and regulations are not yet founded, and laws and regulations that have already been enacted have not yet been implemented.
(2) The self-discipline of securities companies and other institutional investors is insufficient. There are different forms of illegal business operations, and there are many market speculations.
(3) Some listed companies participate in the speculation of the company's stock, and the information disclosure of listed companies is not standardized.
(4) Lack of professional investors.

Based on the empirical study of this article and the actual situation of the Chinese market, it is not advisable at this stage to vigorously advocate the use of modern asset portfolio theory to guide the operation of investment funds that have been established in China.

5.3 Measures and suggestions

Objectively, investing in the securities market is based on modern asset portfolio theory or traditional experience, there are many controversies on its own. I am afraid that no investment manager can claim that they only rely on modern portfolio theory for portfolio management. Moreover, the application of modern asset portfolio theory is costly, and any investor must inevitably make a comparative tradeoff between its application costs and application effectiveness. As the market is more fully effective, the more effective the application of the capital asset pricing model is. According to the current situation of China's stock market, and according to the conditions of market effectiveness, the author believes that the effectiveness of China's stock market should be improved from the following aspects in order to create a more favorable market environment for portfolio investment.

The first point is to increase the market competition among Chinese financial industry enterprises. In the past, there was a lack of market competition between the Chinese stock market and other types of fund-raising markets, and the competition between various stock markets was too inadequate. In order to standardize stock market behavior and increase market efficiency, over-the-counter transactions should be legalized and diversified, and more financial trading varieties and markets should be opened, including

the opening up of more and more levels of equity trading markets, so that the Chinese stock market can be standardized in the competition and could be improved the effectiveness.

The second point is to continuously improve the information release system, open up normal information channels, increase the openness, transparency, and simultaneity of information and expand the coverage of information.

The third point is to encourage investors to carry out reasonable competition, reduce human intervention, market monopolies and manipulations, and create a good atmosphere for competition. Maintain a modest market size, form a basic equilibrium of supply and demand, reduce the restrictions on investors entering the market to participate in transactions, and combat insider trading and illegal price manipulation.

The fourth point is to strengthen the construction of market infrastructure, realize the modernization of transaction methods and trading methods, reduce transaction costs, and increase transaction speed and market operating efficiency.

The last point is to raise investors' knowledge level of information. If the investor's knowledge level is relatively high, there is no disagreement between investors on information interpretation and judgment. Investors can make investment decisions based on the principle of rationality and do not blindly follow suit. This will undoubtedly have a positive effect on improving market efficiency.

When the Chinese securities market develops to meet the following conditions, modern portfolio models can be used to guide the operation of investment funds.

(1) The national regulatory authority has a proper macro control over the securities market.
(2) Complete and detailed policies and regulations were established and effectively implemented.
(3) Institutional investors are strict with self-discipline.
(4) Listed company information disclosure specifications, focus on how to develop production.
(5) More investment funds entered the securities market and played a supporting role in the securities market.

Although the capital asset pricing model occupies an important position in modern investment studies, it is also not perfect.

5.4 Defects in CAPM

Although the capital asset pricing model occupies an important position in modern investment studies, it is also not perfect for the following reasons.

According to the concept of the CAPM model, investors who use β analysis are willing to accept returns equal to or close to the market, eliminating the possibility that investors do better than the market. This method negates the selective analysis of securities by analysts to identify the investment ability of good securities. However, facts have proved that selective investments based on a large number of researches can achieve excellent

results. Otherwise, there is no need for investment banks to set up industry research departments, nor do they need to learn professional financial knowledge. It is only necessary to buy funds based on market indices, which is obviously unrealistic.

At the same time, the market index does not necessarily reflect the market conditions of all stocks. It is entirely possible for an investor to construct his asset portfolio like the market index. However, investment in the actual market may not necessarily achieve the expected benefits.

In addition, according to CAPM's assumptions, we can think that the optimal risk asset portfolio chosen by market investors must be the same, and of course, this optimal risk asset portfolio is also a market portfolio. Secondly, the equilibrium of the market is achieved by investors dynamically adjusting funds between risk-free assets and market portfolios based on the comparison of different asset risks and returns. This is not the case. In securities investment, there are so-called "ultimately optimistic investors" and "last pessimistic sellers". This type of phenomenon is difficult to interpret with the CAPM model. The flaw of this analysis is that it ignores how the investor's optimal portfolio of risk assets is obtained. In forming an optimal portfolio of risky assets (i.e., the mix of market portfolios and riskless assets), investors need to buy some assets and sell other assets. However, according to the above assumptions, since the investors have the same goal, the asset structure they hold is exactly the same, and both parties in the market are these investors, which means that both parties of the transaction want to buy or sell an asset at the same time. The transaction is obviously unlikely to happen.

Another possibility is that centralized demand or concentrated supply will lead to capital asset price adjustments, thereby creating a new equilibrium. This is impossible either. Since trading information is completely transparent, investors all know the transaction information, and the judgment on the value of assets is exactly the same, so there will be no substantive asset trading activities. At the same time, we must also consider such a problem. Affected by the central bank’s monetary policy, the risk-free interest rate is constantly changing during the holding period of the investment portfolio, which means that the proportion of the internal assets of the optimal portfolio is adjusted. This adjustment will encounter the previously mentioned problem of unable to trade (Bodie et al., 2009). In other words, when the risk-free interest rate adjustment occurs, the original equilibrium will still be maintained, and no substantial asset trading activity will take place between investors. The equilibrium point is still in place, but this point is not the best point.

Moreover, random walk theorists are fundamentally opposed to asset portfolio theory, and they believe that future yields cannot be predicted because short-term fluctuations in stocks are completely unpredictable. In their view, the actual input data does not exist, so the combination of construction is just a fun math game.

The key reason for this paradox is that the model assumes that investors fully agree with the characteristics of the asset. In addition, the model believes that investors will pursue any optimal investment portfolio that is unanimously recognized by all investors. Therefore, all investors will choose the same optimal portfolio, that is, investors will unanimously make a decision to buy or sell an asset. As a result, the market cannot reach a deal (Bodie et al., 2009). We can see from the book written by Bodie et al. (2009) that

the theoretical analysis of the CAPM model paradox is that investors have fallen into the dilemma of whether they believe they can beat the market. Therefore, we have reason to believe that there are problems in the analysis of the original equilibrium market. The consequence of this is that we will question whether the model is valid. Additionally, a basic view of the discussion of the pricing of capital assets in non-cooperative game theory is that the price of assets can be truly reflected in transactions, and transactions can be seen as the process of Nash's bargaining process influenced by institutions, economy, and other variables. In other words, it is obvious that the pricing of assets is affected by threat points, bargaining power, and the degree of fear of negotiating breakdown. This view is also more personalized than the capital asset pricing model.

The core issue of whether the capital asset pricing model is established is whether the equilibrium price exists or not. The revision of the CAPM model and the arbitrage pricing theory have all evaded this issue. Of course, one reason to evade this issue may be that the equilibrium price is not necessarily a point, but may be a range. Of course, such explanation is weak.

The specific problems of the Capital Asset Pricing Model (CAPM) can be summarized as follows:

(1) The assumptions of CAPM do not conform to the reality. The actual conditions include transaction costs, information costs, and taxes. The actual market is not a fully effective market. In fact, investors' expectations are not homogeneous, otherwise they will not be able to reach a transaction. Borrowing and lending rates are not equal. The actual situation is that the loan interest rate is greater than the deposit interest rate.
(2) CAPM applies only to capital assets and human capital cannot be traded.
(3) The estimated β coefficient can only represent the variability of the past, but investors are concerned about the future price changes of the securities. CAPM is a theory linking expected return rate with risk-free interest rate, beta coefficient and market premium. Since it focuses on the future, it is an expected situation and a kind of ex-ante theory, but, the actual rate of return was obtained afterwards. Although the results afterwards do not generally agree with the ex-ante expectations, the CAPM's average and long-term results are close to the prior theory and the time. This is the general logic of statistical inference.
(4) In reality, risk-free assets and market portfolios may not exist. To know that the stock index does not fully represent the entire market situation.

5.5 Controversy over the β coefficients

The central idea of CAPM is that stocks with high β coefficients are expected to receive higher returns. If this expectation does not exist in practice, the evidence in this area will be very much in conflict with CAPM.

For now, all discussions of market effectiveness and the value of the capital asset pricing model are contradictory, and the research will continue. Here, we will introduce the completely opposite view held by scholars who have always supported the market effectiveness and capital asset pricing models.

Fama and French (1992) proposed that there is basically no relationship between the beta of the stock and the return of the stock. This view strongly criticized the core view of

CAPM and incidentally attacked the effective market hypothesis. Fama and French (1992) constructs 10 investment portfolios. The stocks with the lowest beta constitute the first portfolio, and the stocks with the highest beta constitute the tenth portfolio. If the horizontal axis represents the beta coefficient and the vertical axis represents the monthly average rate of return, a simple regression line could be obtained. The graph shows that the combined beta coefficient has little to do with the actual rate of return of the portfolio. If there is a relationship, there is a certain negative correlation, that is, a combination with a high beta, but a lower return rate. As Fama and French (1992) pointed out in the article, these results contradicted their results in the early 1970s. However, they found that the ratio of book value and actual value and the company's size have a strong relationship with the rate of return. If Fama and French (1992) conclusion is reasonable, then the central idea of positive correlation between system risk β value and rate of return in CAPM will be overturned.

Some scholars do not accept Fama and French (1992) conclusion. Black (1992) believed that it is likely that data mining led to their conclusions. Black (1992) believed that in the case of data mining, people may get some forged relationships, such as the above-mentioned return rate and corporate market size, or the relationship between return rate and book value to market value ratio. Black (1992) believed that there is no theory that shows the relationship between returns and those explanatory variables. What exists is the capital asset pricing model, which interprets the rate of return as a function of beta. In the study, Black (1992) analyzed the excess returns and compared the stock returns to the beta. Similar to the Fama and French (1992) study, he also constructed 10 portfolios consisting of the lowest beta to the largest beta. His research results show that there is a positive correlation between the excess return rate and the beta coefficient, and this result completely contradicts the conclusion of Fama and French (1992).

How to explain the above two opposing conclusions? Some scholars believe that part of the reason is that they are looking at different periods. Fama and French (1992) used data from 1963 to 1990, while Black (1992) used data from 1931 to 1991. Furthermore, the companies selected by these two studies were different. It is precisely because of the difference in the sample period and the choice of companies that led them to completely different conclusions. People cannot see who is right or wrong. Obviously, the contradiction between the conclusions will make the controversy over the rationality of the beta coefficient continue.

6 Conclusion

This article collates, analyzes, and tests data from January 2007 to February 2018 for a total of 20 stock portfolios of 100 stocks in the Shanghai stock market and draws the following conclusions:

(1) According to the basic framework of the Jensen et al. (1972) method to test the relationship between the expected rate of return of the investment portfolio and the β coefficient, it is found that there is a significant negative correlation between the sample portfolio return and the systematic risk during the sample period. This result shows that the systematic risk cannot explain the expected return of the portfolio, which is inconsistent with the conclusion of the capital asset pricing model.

(2) Cross-sectional test results show that the statistics of each independent variable are not significantly different from zero, (since the P-value is more than 0.05, the null hypothesis that the parameter is equal to 0 cannot be rejected) indicating that the interpretation level of independent variables to portfolio returns is very low. In other words, the relationship between returns and risks in China's stock market does not conform to the linear or secondary power relations as expected by the capital asset pricing model, nor can it be determined by non-systemic risks.

The above result is because there are some limitations in the application of CAPM in China's securities market, which are worth considering. Firstly, it is difficult to obtain appropriate and accurate stock returns and market returns, which reduces CAPM's operability. Secondly, China's securities market has not developed for a long time. The market itself has certain flaws, and it is not maturing enough to apply CAPM market conditions.

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8 Appendix

Appendix 1 Stock name, code and industry

Aerospace & Defense		Automobile		Beverages	
Name	Code	Name	Code	Name	Code
AECC AERO-SCI&. TECH.'A'	600391.SS	LIAONING SG AUTV.GP. 'A'	600303.SS	TONGHUA GRAPE WINE 'A' SUSP - SUSP.	600365.SS
JIANGXI HONGDU AVIATION 'A'	600316.SS	HUNAN TYEN MACHINERY 'A'	600698.SS	TSINGTAO BREWERY 'A'	600600.SS
AVIC HELICOPTER 'A'	600038.SS	NINGBO JOYSON ELECTRONIC 'A'	600699.SS	SHANXI XINGHUACUN FEN WINE FAC. 'A'	600809.SS
GLARUN TECHNOLOGY 'A'	600562.SS	XIAMEN KING LNG.MTR.GP. 'A'	600686.SS	KWEICHOW MOUTAI 'A'	600519.SS
ANHUI SUN-CREATE ELTN. 'A'	600990.SS	FUYAO GLSS.IND.GROUP 'A'	600660.SS	HEBEI HENGSHUI LAOBAIGAN LIQUOR 'A'	600559.SS
Electricity		Food producer		Forestry & Paper	
Name	Code	Name	Code	Name	Code
SICHUAN CHUANTOU EN.'A'	600674.SS	ZHONGNONGFA SEED IND.GP. 'A'	600313.SS	SHANYING INTL.HDG.'A'	600567.SS
LESHAN ELEC.POWER 'A'	600644.SS	SHAI.JIAO DA ONLLY 'A'	600530.SS	MUDANJIANG HENGFENG PAPR 'A'	600356.SS
SHENERGY 'A'	600642.SS	SHANGHAI GREENCOURT INVESTMENT GROUP 'A'	600695.SS	XINJIANG TIANRUN DAIRY 'A'	600419.SS
INNER MONGOLIA MENGDIAN HUANENG	600863.SS	STARLAKE BIOSCIENCE CO. ZHAOQING	600866.SS	GUANGDONG GUANHAO HIGH TECH 'A'	600433.SS

THERMAL PWR. 'A'		GUANGDONG 'A'			
GUANGDONG MEIYAN JIXIANG HYPW.'A'	600868.SS	XINJIANG KORLA PEAR 'A'	600506.SS	SHENZHEN GEOWAY 'A'	600462.SS
General Retailers		Household Goods		Industrial engineering	
Name	Code	Name	Code	Name	Code
SHENYANG COML. CITY 'A'	600306.SS	AUCMA 'A'	600336.SS	SHAI.ZHENHUA HEAVY IND. 'A'	600320.SS
SHANGHAI XINHUA MEDIA 'A'	600825.SS	QINGDAO HAIER 'A'	600690.SS	FUJIAN LONGKING 'A'	600388.SS
SHAI.YIMIN COML.GP.' A'	600824.SS	CHONGQING WANLI NEW EN. 'A'	600847.SS	CSSC OFFS. & MAR.ENGR .GP. 'A'	600685.SS
CHANG CHUN EURASIA GP. 'A'	600697.SS	JIANGSU CHUNLAN REFRIGG. EQU.STK.'A '	600854.SS	SHANGHAI ZHONGYIDA 'A'	600610.SS
FUJIAN DONGBAI (GP.) 'A'	600693.SS	GLARUN TECHNOLOGY 'A'	600562.SS	JIANGSU YUEDA INV.'A'	600805.SS
Oil & Gas producer		Pharmaceuticals		Real Estate	
Name	Code	Name	Code	Name	Code
SINOPEC OILFIELD SERVICE 'A'	600871.SS	GUANGZHOU BAIYUNSHAN PHARM.HDG.'A'	600332.SS	SHANGHAI SHIMAO 'A'	600823.SS
SHANGHAI SHENQI PHARM. INV.MAN.' A'	600613.SS	SOUTHWEST PHARM. 'A' SUSP - SUSP.27/04/17	600666.SS	METRO LAND 'A'	600683.SS
PENGQI TECH.DEV.' A' SUSP - SUSP.26/12/17	600614.SS	HANGZHOU TIANMUSHAN PHARM.ENTER.'A'	600671.SS	SHANDONG TYAN HOME 'A' SUSP - SUSP.25/12/17	600807.SS
SHANDONG JINTAI GROUP 'A'	600385.SS	HARBIN PHARMS.GP. 'A' SUSP - SUSP.28/09/17	600664.SS	GZH.PER.RVR.IND.DEV.'A'	600684.SS

NORTH CHINA PHARM. 'A'	600812.SS	ZHONGYUAN UN. CELL & GENE ENGR.'A'	600645.SS	P2P FINL.INFO. SER.'A'	600696.SS
Construction & Materials		General Industry		Telecommunication	
Name	Code	Name	Code	Name	Code
TIBET TIANLU 'A'	600326.SS	TIAN JIN GLB.MAGNETIC CARD 'A'	600800.SS	SHAI.POTEVIO 'A'	600680.SS
HUAXIN CEMENT 'A'	600801.SS	AEROSPACE COMMS.HDG.'A'	600677.SS	FOUNDER TECH.GP. 'A'	600601.SS
FUJIAN CEMENT 'A'	600802.SS	SHAI.FUDAN FWD.S & T 'A'	600624.SS	XI'AN HONGSHENG TECH.'A'	600817.SS
SICHUAN GLDN.SMT. (GP.) JOINT-STOCK 'A'	600678.SS	ZHEJIANG DLY.DIG.CUL.GP. 'A'	600633.SS	SHAI.ET.CHIN.CMP.'A'	600850.SS
ZHEJIANG JIANFENG GP.'A'	600668.SS	SHANGHAI CHINAFORTUNE 'A'	600621.SS	HPGC RENMINGTONGTAI PHARM.'A'	600829.SS
Chemicals		Multi-utilities		Oil equipment	
Name	Code	Name	Code	Name	Code
INNER MONGOLIA LANTAI 'A'	600328.SS	GRANDBLUE ENVM.'A'	600323.SS	CHINA PTL. & CHM.'A'	600028.SS
XJG.DUSHANZI TIANLI HI. & NEW TECH.CTD. PRC 'A'	600339.SS	BESTSUN ENERGY 'A'	600681.SS	GUANGHUI ENERGY 'A'	600256.SS
WANHUA CHEMICAL GP.'A' SUSP	600309.SS	SHANGHAI DAZHONG PUB. UTILS. (GP.) 'A'	600635.SS	ZHEJIANG HAIYUE 'A'	600387.SS
NANTONG JIANGSHN AGROCHM 'A'	600389.SS	HARBIN HATOU INVESTMENT 'A'	600864.SS	WINTIME ENERGY 'A' SUSP	600157.SS
SICHUAN TIANYI SCI. & TECH. 'A'	600378.SS	BEIJING CAPITAL 'A'	600008.SS	JIANGXI HONGCHENG WTW. 'A'	600461.SS
Software		Hardware			

Name	Code	Name	Code
CHINA ENTERPRISE 'A'	600675.SS	CHENGDU DR. PENG TELC. & MDA.GP.'A'	600804.SS
CINDA REAL ESTATE 'A'	600657.SS	SHAI.BAOSIGHT SOFTWARE 'A'	600845.SS
BEIJING ELECTRONIC ZONE INV.& DEV.'A'	600658.SS	CHINA NATIONAL SOFTWARE & SERVICE 'A'	600536.SS
WUHAN ET.LK.HI.TECH.GP. 'A'	600133.SS	YONYOU NETWORK TECH.'A'	600588.SS
TANDE 'A'	600665.SS	SUNYARD SYSTEM ENGR.'A'	600571.SS

Appendix 2 100 stocks basic information

Code	α	t-stat	β	t-stat	σ_{ei}	DW-stat
600133.SS	0.004444	0.305172	0.119772	0.757107	0.167311	2.125908
600847.SS	0.006581	0.683329	0.517551	4.947128	0.110644	1.714174
600681.SS	0.015207	1.300832	0.574793	4.52621	0.134309	2.098025
600519.SS	0.01634	2.247298	0.598764	7.580655	0.083536	2.04966
600600.SS	0.005622	0.830181	0.620483	8.43456	0.077803	2.299502
600664.SS	0.000959	0.11003	0.688488	7.274043	0.100103	1.914644
600697.SS	0.004593	0.663865	0.715247	9.517867	0.079477	2.16351
600854.SS	0.00017	0.017872	0.727912	7.040328	0.109348	2.120002
600817.SS	-0.000631	-0.050389	0.734502	5.396072	0.14396	1.713762
600693.SS	0.005574	0.607033	0.747981	7.499245	0.105487	1.499391
600671.SS	0.00799	0.890828	0.749434	7.692401	0.103038	2.218149
600633.SS	0.008378	0.662813	0.794668	5.787613	0.145215	1.899591
600323.SS	0.008156	1.093435	0.797067	9.836648	0.085699	1.91151
600610.SS	0.003045	0.238131	0.82352	5.928587	0.146909	2.310359
600645.SS	0.011384	0.897707	0.826734	6.001349	0.145695	2.087842
600306.SS	0.005526	0.421293	0.835085	5.860456	0.150704	2.349957
600588.SS	0.009486	0.834905	0.857732	6.949784	0.130529	2.050436
600613.SS	-0.002147	-0.190755	0.8603	7.03586	0.129318	1.910389
600871.SS	-0.002493	-0.196464	0.871633	6.323935	0.145772	2.189903
600699.SS	0.017741	1.467057	0.898894	6.842953	0.138928	2.072794

600809.SS	0.008925	0.883095	0.902391	8.21976	0.116108	2.204104
600461.SS	0.007157	0.907984	0.912158	10.65293	0.090558	2.23953
600690.SS	0.014882	1.899655	0.924361	10.8623	0.090001	2.174832
600419.SS	0.015461	1.356923	0.928885	7.504608	0.130906	2.098621
600332.SS	0.007708	0.765397	0.931885	8.518328	0.1157	1.88711
600388.SS	0.011993	1.174147	0.937654	8.450968	0.117345	2.247305
600506.SS	0.010295	0.89197	0.951804	7.591196	0.132606	1.822948
600666.SS	0.016641	1.253276	0.956439	6.630964	0.152548	2.296915
600845.SS	0.008905	1.025736	0.957734	10.15604	0.099735	2.009188
600365.SS	0.004896	0.450087	0.960628	8.13032	0.124961	2.182559
600824.SS	0.002787	0.365691	0.961513	11.61608	0.087543	1.860203
600990.SS	0.014736	1.165608	0.966096	7.034716	0.145245	2.055388
600038.SS	0.006508	0.553117	0.980379	7.670587	0.135174	2.530634
600674.SS	0.01565	1.66132	0.987587	9.650848	0.108227	1.96286
600309.SS	0.007373	0.948498	0.995975	11.79489	0.089306	1.788566
600698.SS	0.003404	0.274857	0.996723	7.408461	0.14229	2.177662
600389.SS	0.012527	1.009525	1.002084	7.433876	0.142566	1.706234
600567.SS	0.006157	0.813938	1.004741	12.22715	0.086907	1.983008
600829.SS	0.001545	0.165027	1.005977	9.888671	0.107591	2.269226
600356.SS	0.000982	0.139684	1.017997	13.33382	0.080746	2.218275
600462.SS	0.002533	0.222283	1.029883	8.318553	0.130938	2.251593
600825.SS	-0.000202	-0.02216	1.031215	10.42353	0.104631	2.142694
600621.SS	0.008428	0.771738	1.031931	8.698212	0.125472	2.455915
600868.SS	0.002987	0.285542	1.0393	9.147478	0.120162	2.27848
600256.SS	0.010165	1.061616	1.045702	10.05401	0.110001	1.824604
600303.SS	0.004625	0.408014	1.056852	8.582783	0.13023	2.030084
600866.SS	0.00284	0.264994	1.057094	9.079133	0.123139	1.804292
600812.SS	0.002986	0.285556	1.059614	9.327197	0.12015	1.842357
600657.SS	0.00459	0.471701	1.071189	10.13312	0.111802	2.272672
600562.SS	0.017953	1.509783	1.072175	8.300161	0.136617	1.832539
600562.SS	0.017953	1.509783	1.072175	8.300161	0.136617	1.832539
600028.SS	-0.0017	-0.261674	1.072674	15.20032	0.074635	2.364235
600433.SS	0.008127	0.66934	1.073721	8.140706	0.139494	1.704116
600680.SS	-0.002196	-0.169017	1.078782	7.643183	0.149275	1.562323
600614.SS	0.016722	1.418059	1.086254	8.479783	0.135479	1.964193
600660.SS	0.00784	1.051192	1.089966	13.45351	0.085685	2.019653
600601.SS	-0.000408	-0.046615	1.095002	11.51003	0.100616	1.707884
600339.SS	0.001702	0.193079	1.103184	11.51781	0.101299	2.026042
600642.SS	-0.000394	-0.076967	1.10602	19.87091	0.058867	2.10145
600686.SS	-7.95E-05	-0.008557	1.113735	11.02957	0.106795	1.860462
600336.SS	0.005366	0.496108	1.11728	9.510008	0.124253	1.972889
600850.SS	0.011373	0.935786	1.120279	8.485338	0.139632	2.1836

600378.SS	0.009362	0.840355	1.120739	9.260702	0.127993	2.178931
600863.SS	0.004627	0.618081	1.121247	13.78946	0.085996	2.042588
600644.SS	0.000863	0.096482	1.122074	11.54945	0.102751	1.999278
600313.SS	0.004567	0.514893	1.123389	11.66045	0.101892	2.098994
600530.SS	0.007255	0.753968	1.127424	10.78608	0.110548	2.319365
600624.SS	0.006296	0.555699	1.131514	9.194083	0.13016	1.760932
600675.SS	0.001167	0.123779	1.140321	11.13106	0.108347	2.207823
600559.SS	0.01924	1.685541	1.154656	9.31179	0.131143	2.36331
600316.SS	0.000269	0.02494	1.166978	9.964814	0.123857	2.188361
600684.SS	0.012654	1.447854	1.171456	12.33928	0.100407	2.165575
600805.SS	0.005938	0.678703	1.171479	12.32637	0.100514	1.978539
600668.SS	0.012309	1.200645	1.18052	10.60055	0.11778	1.76326
600823.SS	0.007273	0.842961	1.184515	12.63756	0.09913	1.704178
600807.SS	0.011661	0.914387	1.203771	8.689381	0.146515	1.938347
600658.SS	0.006689	0.710815	1.204367	11.78125	0.108117	2.124286
600008.SS	0.002346	0.26294	1.206817	12.45415	0.102483	2.119237
600696.SS	0.004849	0.381884	1.207414	8.753224	0.145886	2.442115
600695.SS	0.00664	0.608805	1.213174	10.24038	0.125295	2.198624
600328.SS	0.004671	0.536282	1.213863	12.83053	0.100058	2.052541
600320.SS	-0.005221	-0.905237	1.220196	19.47591	0.066261	2.276357
600571.SS	0.009944	0.832662	1.224187	9.436145	0.137208	1.998235
600801.SS	0.010712	1.080039	1.225771	11.37757	0.113943	2.231418
600387.SS	0.005449	0.536013	1.251778	11.33608	0.116786	1.915259
600536.SS	0.003278	0.24103	1.252363	8.477931	0.156231	2.029962
600802.SS	0.004406	0.391792	1.254904	10.27184	0.129208	2.158203
600683.SS	0.006517	0.617304	1.265178	11.03211	0.121288	2.179156
600385.SS	0.010673	0.799652	1.287266	8.878717	0.153336	1.749733
600804.SS	0.01068	1.01057	1.288122	11.22005	0.12142	1.989685
600665.SS	-0.00066	-0.08802	1.320098	16.20732	0.086143	2.409934
600157.SS	0.012266	0.982337	1.321248	9.740632	0.143458	2.369226
600864.SS	0.004037	0.391141	1.333909	11.89839	0.118567	2.17108
600326.SS	0.007406	0.836916	1.334661	13.88342	0.101672	2.144528
600677.SS	0.000536	0.050501	1.33783	11.59713	0.122005	2.059769
600635.SS	0.006992	0.742469	1.367563	13.36932	0.108184	2.107525
600391.SS	0.006278	0.601769	1.388899	12.25525	0.11986	2.095917
600800.SS	-0.001462	-0.121925	1.401921	10.76586	0.137721	1.957412
600685.SS	0.003338	0.403962	1.470244	16.37784	0.094942	2.07447
600678.SS	0.011084	0.807741	1.482231	9.943328	0.157656	2.139936