Application and Thinking about Capital Asset Pricing Model

Jianing Chen

Jinhua No.1 High School
Corresponding author. Email: 3532479204@qq.com

ABSTRACT

In the mid-1960s, the equilibrium asset pricing theory, marked by Sharpe-Lintner-Mossin, was born. Because of its ability to clearly elucidate the relationship between the expected return on assets and risk, CAPM has been widely used in various aspects of portfolio-at-risk performance assessment, securities pricing, capital budgeting, and public utility stock management. After many years of development, the status of CAPM is unshakable in the capital market. However, while the CAPM model is supported by many scholars, it is also questioned because of its stringent assumptions. In this case, the paper introduces the defining formula and assumptions of the model and provides some exploration of the model in the capital market and other application scenarios. Then, the author discusses the limitations that the model may face in practical applications. Ultimately, in the current situation of the Chinese capital market, the author found that the applicability of the CAPM model in China is still limited for many reasons and deserves further study.

Keywords: Capital Asset Pricing Model (CAPM), Applications, Risk and Return, Capital Market

1. INTRODUCTION

The Capital Asset Pricing Model, which is at the forefront of financial theory research, has been controversial since its inception. Especially, China's capital market has been established since 1990. It has been a relatively short period of time until now. Many of the basic systems that go along with the operation of the market economy have yet to be improved; therefore, the domestic stock market is still an immature and unregulated market [1]. Firstly, the existing problems in both issuance and trading programs in the Chinese stock market cannot be ignored [2]. For example, excessive government intervention in the market will inadvertently transfer part of the risks that should have been borne by investors to the government [3]. Secondly, compared to the stock markets of developed Western countries, the domestic stock market has a majority of retail investors and a small number of investors [4]. Considering that the irrational investment behavior is relatively common among retail investors, the premise of the CAPM model is destroyed to some extent [5]. Therefore, it is necessary to discuss the effectiveness of the CAPM model in a market that is not only regulated.

In this paper, the author will introduce the main content of the model and the applications of this model. Finally, the author will discuss the limitations of CAPM during practical applications. CAPM, an important cornerstone of modern financial theory, occupies a pivotal position in the field of financial investment and securities market research today. In this sense, the in-depth study of CAPM has both theoretical and practical significance.

2. THE OVERVIEW OF THE CAPITAL ASSET PRICING MODEL

2.1. The Origin and Concept of the CAPM Model

Based on asset portfolio theory, the Capital Asset Pricing Model (CAPM) is a theory established by the famous American economists William Sharpe, John Lintner, Jack Treynor, and Jan Mossin [6]. In this theory, the relationship between asset returns and risk is fully reflected by a simple model, which is a breakthrough in modern finance. The core theory of CAPM is that in a competitive equilibrium capital market, only undiversifiable systematic risk (usually measured by the β coefficient) can have an impact on expected returns by eliminating unsystematic risk through diversification. In other words, the β coefficient linearity is correlated with expected returns. Because the core concern of the empirical and theoretical communities is the

management and measurement of risk in financial investment decisions and the model is built with simplicity and operability, CAPM has been widely used in many problems such as investment risk analysis and stock return forecasting.

In 1952, Harry Markowitz, a Nobel laureate in economics, published a paper entitled "Portfolio Selection", in which he discussed in depth the problem of choosing the optimal portfolio of assets in an uncertain economic system. This paper is regarded as the origin of modern investment theory [7]. In the paper, Harry Markowitz argues that the efficient frontier of a portfolio will allow maximizing the return on all securities in a portfolio with a specified level of risk. This theory was therefore widely used in asset allocation decisions and laid a solid theoretical foundation for the later capital asset pricing theory.

2.2. The Definition and Formula

$$R_i = \beta_i \cdot (R_m - R_f)$$

R_f: the risk-free rate of return, generally the one-year Treasury rate

R_i: the expected rate of return of the i-th security

β_i: β-coefficient of the ith security

R_m: expected rate of return of the market portfolio

In the CAPM model: (a) the return on risky assets is usually composed of two components-the market risk compensation which is represented by $\beta_i \cdot (R_m - R_f)$ and the return on risk-free assets which is represented by R_f. The magnitude of systematic risk is represented by the β coefficient, which means that the return is proportional to the risk. (b) The view that all risks borne by risky assets need to be compensated is incorrect, for only systematic risks need to be compensated. Systematic risk cannot be diversified and eliminated. Therefore, investors will only be attracted when there is a corresponding return. Conversely, non-systematic risks can be diversified and eliminated, in which case the compensation will not be compulsory. (c) In CAPM, it is also argued that the market portfolio is the best portfolio due to the fact that the market portfolio has the lowest unsystematic risk. As a consequence, the market portfolio should be held by all risky investors.

2.3. Assumptions

CAPM has a large number of assumptions, which are summarized in the following three main areas.

2.3.1. Return and risk assumptions

(a) Investors use the expected return (mean return) to measure the return of a single asset or portfolio and the standard deviation to measure the risk of a single asset or portfolio.

(b) When the returns of different asset portfolios are the same, investors will choose the portfolio with the lowest risk, i.e., the smallest standard deviation; When the risks are the same, investors will choose the portfolio with the highest return, i.e., the highest expected return (mean return).

2.3.2. Investor-related assumptions

(a) Investors are in the same investment period and choose the same number of assets or portfolios to invest in.

(b) Investors keep up-to-date on the expected rate of return, standard deviation, and covariance of the assets or portfolios in which they intend to invest.

(c) The difference between investors' choices of assets or portfolios lies in risk appetite.

2.3.3. Capital market assumptions

(a) Market information is completely open and transparent.

(b) Taxes and transaction costs are not considered.

(c) Investors in the market can borrow or lend money at any time and the cost of capital is the same.

3. LITERATURE REVIEW

After the establishment of the CAPM model and its further refinement, a number of foreign scholars have empirically tested the applicability of the CAPM, and SHARPE was the first of them. He applied a total of 34 data items from 1959 to 1963 as a sample of annual return data, accounting for the standard deviation of annual returns and returns for each fund, and used linear regression to find that they matched almost exactly with the linear relationship. In subsequent studies, however, economists found that the positive correlation between β and stock returns disappeared as the data was continuously updated. To solve this problem, Fama and French [8] proposed the famous three-factor model.

With the continuous development of the Chinese financial sector, more and more domestic economists began to pay attention to the CAPM model and conducted studies with data from the Chinese stock market. In 2000, Chen Langnan and Qu Wenzhou [9] used the stocks from 1994 to 1998 as the research object and studied the three scenarios of rising, falling and sideways trading respectively. The results show that there is a significant positive correlation between β and stock returns regardless of the market state, with only the explanatory power differing in the three cases. In 2015, Zhao Qing and Wu Dongfeng [10] used 100 stocks from

the Shanghai Stock Exchange as the subjects of their study, and found that there is a significant positive linear relationship between the returns of stocks of the Shanghai Stock Exchange and their β coefficient. Meanwhile, he innovatively found out the systematic risk is not the only measure of asset risk. The CAPM model has some applicability to the stock return portfolio of the Shanghai Stock Exchange, and the applicability is improving. In 2019, Wang Guan [11] tested the validity of the CAPM model on the stock data of China's real estate listed companies. A certain degree of positive linear correlation between the stock returns of real estate companies and the returns of the market is found in his study, while the beta value can better explain the fluctuation of stock returns to some extent.

4. APPLICATIONS OF CAPITAL ASSET PRICING MODELS

4.1. Making portfolio decisions

The theory of portfolios has evolved over time, giving rise to CAPM, which in turn has been widely used in portfolio decision making. The basic approach to using CAPM in portfolio decision making is based on the following four steps.

1. For different portfolios of securities, the β coefficients are identified, and in one portfolio the β coefficient is equal to the sum of the weighted average of the β coefficients of the individual securities in that portfolio.

2. For each portfolio, the risk-return ratio is calculated.

3. For each portfolio, the payoff rate is determined.

The payoff rates of the portfolios are compared, and then the portfolio solution is determined based on the investor's risk attitude and risk-return rate.

4.2. Assessing Asset Portfolio Management Performance

Performance assessment of portfolio management differs from traditional performance assessment in that it takes into account not only the return on investments, but also the risk of investments [12]. As with other aspects of portfolio management, the methods and guidelines for performance evaluation remain inseparable from the development of CAPM.

In the early days, the method of evaluation was the single index approach, such as the Jensen index and the Sharpe index, which assumed a linear relationship between investment returns and the returns of certain average indices. In fact, these early single indices were associated with the CAPM. Since the 1980s, in order to gain insight into the sources of investment performance,

performance evaluation methods have developed performance attribution models to determine whether performance comes from the investment strategy or the asset selection. For equity investments, the typical performance attribution models are Barra's factor model and Wilshire's factor model, whose essence is some form of multi-factor asset pricing model.

4.3. Pricing human capital

As mankind enters the knowledge economy, human resources can be measured as an asset and therefore can be priced using the CAPM [13]. Human resources can be seen as an investment made by the business owner in the business, and any investment involves risk. In human capital, the human being is the object of investment, and there are risks in terms of life safety and health during its existence. According to the principle of time value, the longer the period, the higher the uncertainty. Therefore, the long period of return on investment in human capital increases its risk to some extent. In addition, besides the risk in terms of personal safety, human capital is also affected by the iteration of knowledge updating. We can construct different values of β coefficients to measure the risk of human capital, then construct the CAPM of human capital based on the average risk level, and calculate the expected payoff of human capital investment. Different companies choose the suitable human capital investment according to their own risk appetite.

5. CONTRADICTIONS AND LIMITATIONS OF THE CAPITAL ASSET PRICING MODEL

5.1. The inherent contradiction of Capital Asset Pricing Model

From the expectation assumption of CAPM, it is known that investors in the securities market have the same expectations in terms of standard deviation, expected return, covariance of securities, etc. The CAPM model assumes that investors are optimizing their asset portfolios according to the theory of asset portfolios, and so investors will choose the same portfolio of risky assets. When the stock market reaches equilibrium, all investors in the market are holding exactly the same portfolios which contain all the risky assets in the market, and the percentage of these risky assets is also the same.

In the process of market equilibrium, the share of risky assets in the value of all risky assets should be equal to the share of risk contained in the optimal asset portfolio M. The optimal asset portfolio is related to the risk-free rate, the characteristics of the security and also the market. In fact, the duration of securities holdings and the market risk-free rate are constantly changing under the influence of the central bank's monetary policy. The

corresponding optimal portfolio composition changes accordingly, which requires the investor to sell some assets or buy some assets. According to the hypothesis, because of the consensus of the investment decision objectives, some of the assets held by the investors have exactly the same composition. However, the two sides in the securities market cannot trade the assets in the same direction, because every seller should and must have a corresponding buyer to complete a deal. The assumption of equilibrious market and the conclusion that investors hold the identical portfolios sentence the inherent contradiction within CAPM.

5.2. Limitations of the Capital Asset Pricing Model

Although the CAPM is simple and practical, it is based on a set of assumptions that are difficult to meet in China's securities market.

5.2.1. Existence of risk-free rate

The 'risk-free rate' in the CAPM, which assumes that investors in the market can borrow at a rate without restriction, is obviously not possible in China's financial markets. The risk-free interest rate is based on the interest rate of treasury bills in China. The short investment time and the guarantee of the state's creditworthiness of treasury bills allow them to be generally considered an asset without both the credit risk and the interest rate risk. However, with the continuous development of China's economy, inflation is becoming more and more serious, along with the increasing purchasing power risk. Once there is inflation, there is no risk-free asset or risk-free interest rate.

5.2.2. The validity of no transaction costs and no tax burden

The other assumption of the CAPM is that there are no transaction costs and no tax burden. Transaction costs and tax burdens are ever-present in China and have a considerable influence on stock prices as well. Since there are different standards for dividend and capital gains tax collection and the existence of transaction costs, investors in the stock market will hold multiple risky portfolios at the same time.

5.2.3. Reasonableness of the rational person's assumption

Another assumption of CAPM is that the deals in the capital market are dominated by rational people. In fact, such an assumption does not hold under all conditions. There are many studies in China and abroad regarding the issue of rational and irrational investors in the securities market. The results of these studies show that people seek not only material benefits but also spiritual

satisfaction. In many conditions, people will sacrifice part of their material interests in order to be spiritually satisfied. Therefore, the rational person assumption in the CAPM model is not reasonable.

In summary, the theoretical assumptions of CAPM are contradictory to the current socioeconomic situation in China. Its own assumptions are logically contradictory to the model itself as well.

6. CONCLUSION

Since the CAPM establishes a linear influence relationship between risk and return and is relatively simple to calculate, it is widely used in the calculation of various asset prices. However, because of the assumptions of the model and the gap between the real capital environment, the model has been questioned a lot while it is widely used. As for the asset market in China, although it has been developed for more than a decade, it has not yet formed a market portfolio in the real sense. Meanwhile, some studies by Chinese scholars have shown that the ratio of systematic risk to total risk in China's capital market is much higher than that in other mature capital markets in the world. The main reason is China's asset market information asymmetry. At the same time, there is a large amount of irrational speculation. The strict underlying assumption conditions of CAPM theory are difficult to meet in China's securities market. Therefore, CAPM in China is a problem worthy of in-depth exploration.

Due to the constraints of time, conditions, and my own ability, there are certain limitations in this paper. First, this paper lacks empirical testing. This paper sorts out the research results of the CAPM model since its inception through literature reading, and then outlines its application scenarios and the limitations that are exposed in these application scenarios. However, this paper lacks the process of empirical testing using primary data to prove the research results. Second, this paper does not compare the CAPM model with other pricing models, such as the multi-factor model and the input-output model. In the future the author will further study the regression model and combine it with the use of computers to verify the findings of this paper. In the longer term, the author would like to acquire more knowledge in capital pricing to provide investors with references for investment decisions.

REFERENCES

[1] Chu, Q.W.. Research on stock valuation methods and applications in A-share market. Suzhou University, 2013.

[2] Hu Xuejie,Xie Mingyang. Research on the application of capital asset pricing model based on

Chinese A-share market data. Economic Perspectives, (05), 2019, pp. 99-108.

[3] Lina Wang. Application of Capital Asset Pricing Model in China's Securities Market. Business, 2013, p. 10.

[4] Wu Kunsheng. Analysis of the application of Markowitz model in the A-share market. New Economy, (26), 2015, p. 50.

[5] Wang Qingshi,Meng Qingru. Research on the impact of macroeconomic factors on stock returns in China's A-share market--based on the application of macro multi-factor model. Price Theory and Practice, (07), 2018, pp. 91-94.

[6] Zhigang Gao. Research on Capital Asset Pricing Model Theory and Its Application. Wuhan University of Technology, 2013.

[7] Qing Li. Theoretical Research and Empirical Research on Asset Pricing Model. Huaibei Normal University, 2010.

[8] EUGENE F. FAMA,KENNETH R. FRENCH. The Cross‐Section of Expected Stock Returns. The Journal of Finance, vol. 47(2), 1992.

[9] Chen, Longnan, Qu, Wenzhou. An empirical study of capital asset pricing model. Economic Research, (04), 2000, pp. 26-34.

[10] Zhao Q,Wu D.F. CAPM asset pricing mechanism and its applicability in China. Southeast Academic, (06), 2015, pp. 12-18+274.

[11] Wang G. Testing the effectiveness of CAPM model in real estate industry. Industry and Technology Forum, vol. 18(17), 2019, pp. 139-140.

[12] Senghua Wang. Asset Pricing Model and Empirical Test. Taiyuan University of Science and Technology, 2010.

[13] Ma Kewei. Research on the pricing model and incentive effects of executive options for listed companies under performance constraints. Jilin University, 2018.