A Literature Study on the Capital Asset Pricing Model

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Abstract. Capital Asset Pricing Model (CAPM) is an important theory in financial economics. It was based on Markowitz's Modern Asset Allocation Theory (MPT) and proposed by Sharpe. This model expresses the relationship between risk coefficient, asset return rate, and systematic risks by simple mathematical formulas. The model has four advantages, handling of risks when evaluating investment behavior, accuracy when estimating equity capital, relatively reliable and better than Weighted Average Cost of Capital (WACC) in investment evaluation. CAPM also has some weakness, consisting of variables and application in investment evaluation. There are three variables in CAPM model, risk-free rate of return, equity risk premium and beta. The weakness about application in investment evaluation shows that in beta of projects and firms are different, complex restructure and periods. The Arbitrage Pricing Theory (APT) can be an option of CAPM, and it is a more flexible and complex model compared with CAPM. However, the latest research proves that Portfolio Theory has very big problems. High-risky assets do not necessarily have high returns. This view may be embodied in "low-risk anomalies" and "Idiosyncratic Volatility". In the future, researchers will introduce more elements for CAPM to improve accuracy, or develop new models.

Keywords: Capital asset pricing model; Markowitz's modern asset allocation theory; Arbitrage pricing theory.

1. Introduction

One of the most influential models in finance, the CAPM can be applied to assess the performance of investment portfolios as well as to estimate the systematic risk of assets and their expected rates of return. This model is derived from portfolio theory, which believes that the volatility of asset return can measure its risk, investors are risk averse, and high volatility assets must have high returns before investors can hold them. The CAPM model is quite conceptual. It operates on the presumption that the financial market has a very simple structure, which facilitates analysis and permits the expression of results using relatively simple mathematical formulas. CAPM has some strict assumptions. In this model, all investors are perfectly rational, and their analyses of the market are solely tied to anticipated value and standard deviation of return variables when evaluating risks and returns. There are no transaction fees or taxes, and the capital market is fully functional. Therefore, while considering asset allocation, all investors will face the same problem for optimization, resulting in the same effective frontier and capital market line. To maximize expected return and reduce standard deviation, all investors will choose the same point on the capital market line for asset allocation. In other words, a certain percentage of an investor's portfolio is comprised of cash and market investments. This portfolio is truly a "market portfolio" because the entire market distributes assets in accordance with it. As a result, volatility and uncertainty pose a systemic risk to the market as a whole, as well as a risk to a specific portfolio. At the same time, the CAPM formula, which is a mathematical expression derived from the model framework discussed above, expresses the relationship between the return rates of any hazardous asset and market portfolio. CAPM is calculated according to the formula (1).

$$E(R) = R_f + \beta * (E(R_m) - R_f) \quad (1)$$

The proposal and improvement of CAPM has gone through a long process. The introduction of history in this paper refers to French (2003) and Sullivan (2006) [1, 2]. Before 1952, there were some investment theories, but they only considered the maximization of expected returns and ignored risks. In 1952, Harry M. Markowitz put forward the portfolio theory in his famous article Portfolio Selection.

He abandoned the method of using descriptive language to express financial thoughts in the past and used mean and variance to measure returns and risks, which means using mathematical formulas and geometric figures to elaborate financial views. In the article, Markowitz denied the traditional view of maximizing expected return regardless of risks, and replaced it with the "mean-variance" theory, that is, investors should weigh both expected return (mean) and risk (variance) when choosing financial assets, and look for the best course of action in all conceivable combinations [3]. However, there are two defects in this theory. Firstly, as the number of securities is huge, the amount of data calculation studied is too huge to calculate in that time, so the operability of the model is low. Secondly, Markowitz mentioned in his article that the research focus is on the second stage of portfolio selection, and the premise of this focus is that it is assumed that the tone of securities has been formed through observation of data, and portfolio selection is based on this, but this theory does not specify how expectations are formed [4]. In the article published on Journal of Finance by William Sharpe, Sharpe inherited the views of Markowitz's point and investigated the connections between single asset prices and different components of risks, and Sharp suggested the idea of a market portfolio to address the issue of Markowitz's theory's inapplicability in 1964 [5]. Assuming that the market portfolio is linearly related to return of asset, risk and return of risky assets can be expressed by three parameters, the mean value, standard deviation and the sensitivity to market portfolio, thus greatly simplifying the model. After that, Black et al improved the model, which brought this model to two factors [6].

2. Advantages

As one of the most important models in the financial field, CAPM has many advantages. One of the advantages is its handling of risks when evaluating investment behavior. As the investors in the market are all the same in the market portfolio no matter how the capital market line moves, this model simplifies complex risk analysis into systematic risk analysis. This assumption is idealized, but in the real capital market it is more accurate because most investors will adopt a variety of strategies, such as diversifying their investment portfolio, which can reduce unsystematic risks to some extent [7]. And this assumption also makes it possible to conduct quantitative analysis of individual investment behavior, otherwise individual emotions will greatly hinder quantitative analysis in investment analysis. Another advantage is its accuracy when estimating equity capital. Compared with Dividend Growth Model, CAPM is more accurate most of the time. The fair value of a share of stock is calculated using the dividend growth model, which assumes that dividends will rise either at a constant rate over time or at a variable rate during the current period. Dividend Growth Model is only relevant to businesses in a steady growth stage due to its simplicity, and the calculation results are highly dependent on the anticipated growth rate of profits and dividends. However, the CAPM model, which is significantly more intricate and stringent than the Dividend Growth Model, compares the systematic risk level of a firm to that of the whole stock market in detail. CAPM also has the advantage that it has experienced lots of tests and relatively reliable. According to Cherif (2014), testing the CAPM is problematic all the time, and in different papers researchers used all kinds of ways to test this model, and this process will continue until a more accurate and efficient model is found [8]. The limitation is never just the usage of an inefficient index. However, the idea that the indexes generally utilized in empirical tests of the CAPM are inefficient casts doubt on whether the CAPM or a different model is actually being evaluated. Better than WACC in investment evaluation is also an advantage of CAPM. WACC refers to the overall capital cost, which is determined by averaging the capital costs of various long-term funds according to their share of the enterprise's total capital. For an average venture capital project, WACC may be used to calculate the needed rate of return. The issue is that the historical value utilized for the equity return in WACC, which assumes that the future return would be consistent with the past, is problematic. At the same time, the proportion of capital structure is not constant, but choosing WACC means assuming that the capital structure is constant in a period.

3. Weakness

Nevertheless, despite being one of the most significant theoretical models in the area of financial management, CAPM also has clear flaws and restrictions. The weaknesses of CAPM are shown in the perspectives of variables and the application in investment evaluation. There are three variables in CAPM model. The first is risk-free rate of return. To simplify, it is sometimes calculated using the interest rate on short-term treasury. Although using the average value of these short-term bonds can be utilized to reduce volatility and reduce impact, the interest rate on these bonds is not set. The next factor is the equity risk premium (ERP). Calculating the market risk premium is a challenge, and stock market's return is calculated by adding the average capital gains and dividends of all its stocks. However, if investors want to get the equity risk premium, it's necessary to do a large amount of empirical research, and it's not fixed. Then, the uncertainty in value adds uncertainty to the reward calculation as well. The third variable is β value. The β value is not stable and always changes over time. As a result, market risk's necessary return is likewise ambiguous. At the same time, the application of CAPM model has the Defects in investment evaluation. Firstly, the coefficient applied to the project itself differs from the coefficient applied to the stock of the company. Differentiating between the two beta coefficients is necessary. One method to differentiate is to see the company's equity beta as a weighted average of the beta coefficients resulting from various organizational investment activities based on the relevant assets' fair value. However, it is challenging to find the accurate value. Second, it's challenging to obtain the financing structure of the business. As an illustration, certain businesses may have complicated capital structures, meaning there are numerous sources of funding. Additionally, certain companies could employ complex financing techniques like convertible bonds or raise bond capital on the private market. To simplify calculation, debt beta coefficient is also assumed to be zero, nevertheless, this assumption may result in a more erroneous assessment of the project discount rate.

In addition, APT can be an alternative of CAPM. According to APT, an asset's expected returns and the macroeconomic variables that influence the risk of the asset have a linear connection, which makes it possible to predict an asset's returns. Stephen Ross, an American economist, developed the hypothesis in 1976 [9]. A multi-factor pricing model for securities is made available to analysts and investors by the APT. The APT looks for the security's fair market value that could be temporarily estimated inaccurately. It bases its argument on the idea that periodically, market behavior is not totally efficient, which causes assets to be temporarily mispriced—either overpriced or undervalued. However, market activity is supposed to ultimately cause the price to revert to its fair value. Securities that are currently mispriced present an arbitrageur with an almost risk-free opportunity to make a rapid profit. Analysts and investors have the opportunity to customize their study based on the premise. It is more difficult to put into effect, though, because it takes a while to find out the factors which might affect the price of an asset. CAPM and APT perform many of the same tasks. It provides a yield benchmark that can be utilized for investment performance analysis, capital budgeting, and securities valuation. The idea of arbitrage pricing also emphasizes the critical distinction between risk that cannot be dispersed (system risk factor) and risk that can. The latter does not require a risk premium to make up for what the former needs. The foundation of arbitrage pricing theory is the idea that chances for arbitrage will vanish as soon as the capital market reaches a state of rational equilibrium. Even if only a few investors are aware of the imbalance, there will be enormous pressure to adjust it as long as the pricing connection violates APT. Using a fully diversified portfolio, APT creates the aforementioned anticipated return beta connection. The endogenous unobservable market portfolio is a presupposition of CAPM. The mean variance efficiency serves as the foundation for the CAPM. The relationship of expected return beta is violated by any security, many investors will shift portfolios. Regardless of the insignificant impact of individual investors, the cumulative pressure on the stock price will allow it to return to equilibrium and satisfy this connection once more. CAPM's anticipated return beta connection is erratic for all assets, but the arbitrage pricing theory demonstrates that all securities, with the exception of a tiny subset of securities, exhibit this relationship. Arbitrage pricing theory cannot completely mitigate the effects of any specific asset breaching the anticipated

return beta relationship since it concentrates on no arbitrage circumstances and lacks a market or index model to make additional assumptions. The arbitrage pricing model's ability to cope with various circumstances, which can better mirror actual life, is one of its merits. This is an issue that the capital asset price model ignores.

In general, CAPM is still widely used in both the current academic circles and the industry, even though the model is not perfect. The question of whether the stock index can replace the market portfolio is no longer at the forefront of the general public's CAPM skepticism. The present doubts center on a number of market anomalies, including the first ones strongly connected to CAPM, "low-risk anomalies" and "idiosyncratic volatility," which cannot be explained by CAPM. In a way, β And idiosyncratic volatility both are risk measurement, and these two anomalies have indeed overturned the rule of "high risk, high return", which is universally held. For the "low-risk anomalies" and "Idiosyncratic Volatility", the academic community has given some explanations. The explanation of "low-risk anomalies" mainly focuses on leverage constraint, gambling preference, institutional investor behavior and risk preference under floating losses [10]. The major focus of the "idiosyncratic volatility" argument is on gamblers' risk preference and floating losses. Investors' risk preferences and leverage limitations are the focus of current hypothesis research on CAPM. Investors who had early losses aim to recover by "gambling" from a risk preference perspective. Such investors would select assets with significant variations without risk mitigation because they are not risk averse. As a result, risk and return have a negative association, with high risk resulting in low return. According to the leverage constraint theory, investors with low risk aversion might allocate funds to high-risk assets too much by leveraging without limitation. But funding is scarce in the real world. These investors can only allocate assets with higher risk in the portfolio, resulting in high current return and low future return of these assets.

4. Conclusion

This paper introduces the background, advantages and weakness of CAPM model. The development of CAPM has gone through a long process, in which many researchers were devoted to. To review the advantages of CAPM, this model is a necessary part in investment evaluation, estimating equity capital and evaluating investment behavior, it is obvious that the CAPM is one of the most significantly current financial. It may be used to determine the systematic risk of assets, calculate their anticipated returns, and assess the performance of investment portfolios. At the same time, as the research has demonstrated, CAPM also has some weakness. A portion of weakness is derived from the characteristic of CAPM itself, like errors caused by three variables or its complex usage in application in investment evaluation. These shortages is ineluctable and reasonable because the complexity ensures the accuracy of CAPM. However, the latest research proves that Portfolio Theory, the foundation of CAPM, has very big problems. The present questions center on a number of market anomalies, such as "low-risk anomalies" or "idiosyncratic volatility," which are the first ones strongly connected to CAPM but cannot be explained by it. In the future, researchers will introduce more elements to the model to try to explain and quantify these unusual phenomenon, and this research is likely to improve CAPM or even promote the emergence of a more universal model.

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