A Literature Review on the Capital Asset Pricing Model in Finance

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Abstract: CAPM (Capital Asset Pricing Model) plays an extremely important role in the financial sector. However, since the establishment of the model, the discussion and dispute about it have never stopped. It predicts future data through past market data. However, with the deepening of research, people find that the stock returns in the capital market do not conform to CAPM. The results obtained by the capital asset pricing model may be due to the lack of data validity in the market, which leads to its own inability to carry out relevant tests. In different regions, scholars in some regions have also conducted relevant research on the local capital market. They think that CAPM does not conform to their current regional situation.

Keywords: Capital Asset Pricing Model, finance, market risk on expected returns

1. Introduction

CAPM model, which is either called capital asset pricing model, was formed in the 1960s. The famous economist Sharp put forward the capital asset pricing model for the first time on the basis of Markowitz. He assumed that all investors are risk-averse and have an open and fair source of information. "In a balanced market, the market investment portfolio is an effective portfolio, and the ratio of the expected excess return rate, risk premium and expected excess return rate of each asset to the market portfolio is equal to the covariance between the return rate of the asset and the market portfolio return rate divided by the variance of the combined return rate of the market investment portfolio, which is called the β value of the asset. This is the famous capital asset pricing model" [1]. The formula of the CAPM is

$$E(r_i) - r_f = \beta_i[E(r_M) - r_f] \tag{1}$$

To put it simply, CAPM points out that there are two parts to the income of assets: one is the average income of the market, because all assets will bear the market risk, and the compensation for this part of the income is called β income. The second is excess return, which is expressed as total return minus market average return [2].

The author just mentioned that CAPM is an improved model based on Markowitz's model. Therefore, many assumptions of Markowitz model also exist in CAPM's assumptions. The core is summarized as follows:

1. Investors are risk-averse and like returns, and only because of these two factors affect investment decisions. The higher the income, the better, and the lower the risk, the better.

2. Information is open and fair, as well as timely and free. Anyone in the capital market has the ability to obtain all the information about relevant stocks or bonds, and everyone has the same investment return rate, and there is no internal transaction.

3. Investors in the capital market will have the same judgment ability. There is no investment like a gambler, there will only be one and only one effective boundary in the market. Investors will also have something in common: expected rate of return and variance.

4. Investors can borrow or lend the principal indefinitely, and the discount rate remains unchanged.

5. There is no inflation in the capital market.

6. The market is completely competitive, and buyers are only price recipients.

7. The random rate of return in the capital market is normally distributed.

In the model, the return of portfolio is based on the risk of portfolio. Therefore, investors hope to reduce the variance of portfolio by choosing multiple stocks. The relationship between beta value and expected return is accurate and linear, and its slope is equal to the expected excess return of market portfolio. Although this prediction looks very beautiful, it has received little support in more than 30 years of empirical research. Guermat, Cherif think this may not be surprising in the article "Yes, the CAPM is testable". Empirical tests usually use observed variables, and none of the variables involved in CAPM empirical tests are directly observed. [3]

2. The Development of CAPM

In 1972, Black, Fama and Scholes proved that there was a positive correlation between the expected return and market risk of American stocks before 1969 by comparing the data of previous years, which was in line with CAPM's inference. However, other economists found that from 1962 to 1989, the positive correlation between β value, as the representative of CAPM, and risk premium suddenly disappeared. More scholars have expressed great interest in this phenomenon because CAPM model cannot explain abnormal phenomena except systemic risk.

In fact, any financial model is controversial. Even the CAPM model that won the Nobel Prize has been opposed by many economists. In the late 1960s, because CAPM model cannot effectively explain the changes of stock prices, some scholars launched research and investigation on non-systematic risks.

In 1977, economist Richard Rolle published the article "Criticism on the Theoretical Test of Capital Asset Pricing", which criticized CAPM. In this paper, Ross specifically points out that the S&P500 or other indexes are often used to replace all risky assets in the market. When the real market portfolio is not effective, the substitution variables may be effective. And when the real market portfolio is valid, the substitution variable may be invalid. Therefore, we cannot use substitute variables to replace the real market portfolio [4]. This means that the actual expected return of market portfolio cannot be obtained, so we cannot judge whether the combination is effective. This is contrary to CAPM's hypothesis, and the results obtained by CAPM model cannot be tested. Then, the previous detection experiments have lost their persuasiveness. In the same year, Basu found that some stocks with the same beta, those with low P/E ratio, had lower returns than expected. This is the first major blow to the classical CAPM model, because this discovery violates the original "high risk, high return" theory. The classic CAPM model seems to be disturbed by the "invisible hand" in the wealth of nations book.

Ross put forward a new model called arbitrage pricing model(APT) after his criticism. The arbitrage pricing theory is essentially based on three assumptions. First, capital markets are perfectly competitive. Secondly, investors always prefer more to less wealth with certainty. And lastly, the stochastic process generating asset returns can be represented as a k-factor cross sectional model of the form：

$$\widetilde{R_i} = E_i + b_{il}\widetilde{\delta_1} + \ldots + b_{ik}\widetilde{\delta_k} + \widetilde{\varepsilon_i} \qquad (2)$$

Compared with the capital asset pricing model, APT model is more reasonable. CAPM's explanation of risk is only expressed by β, but it does not tell other factors such as the source of risk, and there is only one risk factor. However, APT is more comprehensive, and APT is a multi-factor model in essence. When investors use this model, investors can not only judge the degree of risk, but also reveal the source of risk and the degree of influence [5]. The advantage of the APT is presented in the following three points: loosening the assumptions of single period, investor's average value-variance of capital asset pricing model; the income of securities is not only influenced by the combination of market investment and capital; according to the single price rule, based on the factor model, when the return of securities is only affected by a single factor, the pricing model of capital-based assets can be regarded as a special case of arbitrage pricing theory.

Subsequently, Fama and French extracted three important factors based on the previous research model: market portfolio, market value factor and book-to-market ratio, and established a three-factor model. "This model improves the explanatory ability of portfolio returns and helps investors to better estimate the potential returns of asset portfolios in the stock market" [6]. The formula is the following:

$$E(r_i) = r_f + \beta_i(E(r_m) - r_f) + s_i SMB + h_i HML \qquad (3)$$

Among them, SMB represents the rate of return of the market value factor, and HML is the rate of return of the book market value ratio factor. β, S and H are the sensitivity of market factor, market value factor and book ratio factor respectively. Fama believes that each industry has its own characteristics, so there will be different evaluation methods [7]. With the deepening of research, they also gradually established four-factor and five-factor models. To some extent, it has a greater impact on the β value.

3.   Advantages of CAPM

Through the formula, it is seen that the biggest feature of this model is clarity. It is an obvious one-dimensional linear equation, and we only need to get three values that we can start calculating the expected return. Only the risk-free rate of return, the price of risk and the calculation unit of risk are summed up as the price of a risky securities, which is convenient for the model to solve and clear the purpose. This ensures that although capm has been criticized, some people will still adopt this model. Because it conforms to some laws of reality. In the real capital market, people will choose to buy different stocks to reduce systemic risks.

4.   Disadvantages of CAPM

With the development of the times and the deepening of research. People began to realize that CAPM is not a realistic model. On the contrary, excessive idealization is its label, which exists in a perfect and inaccessible capital market. Among them, β, using past data, uses these as experience to solve present and future problems. However, in different time periods, the data often fluctuate based on the social environment at that time, such as inflation, so in this case, bringing in historical data often leads

to deviations in the results. Or because of the lack of historical data, it is difficult to estimate the β of some securities (solving asset pricing problem based on CAPM model and improving the model). Then there will be the lack of validity mentioned above, and we can't test the results of the model.

5.   The Failing Use of CAPM

The first case was in Hong Kong. Li Fuwen used the data of Hong Kong stocks from 2000 to 2010 to make regression analysis through OLS, and made regression analysis on the expected rate of return of stocks to obtain the β coefficient of each stock. Results The expectation of CAPM model is generally lower than the real data, and the correlation coefficient is also low. He believes that "CAPM provides a simple linear relationship between risk and return, which is convenient for using historical data for statistical analysis, but as an objective pricing of assets in the market, its statistical reliability is not enough" [8].

Another case was occured in Mainland China. Yang Shuanghui and Zheng Zhinan collected the data of China A shares from 2014 to 2019 for analysis. They collected 50 stock samples, but only five samples have a determinable coefficient greater than 0.5. This means that "systematic risk accounts for a small proportion of the total risk in the stocks listed on the A stock market, and the price changes of stock tickets are mostly caused by non-systematic risks". CAPM does not apply to Chinese mainland's stock market. There are many reasons for this. For example, in China's capital market, the state-owned economy occupies a dominant position and has unparalleled credit. Shareholders are more willing to believe that state-owned enterprises make investment tend to these enterprises. [9]

The third case was investgated in Japan. KEIICHI KUBOTA1 and HITOSHI TAKEHARA conducted a regression analysis on Fama-Macbeth of the whole sample by studying the Japanese stock market, and found that under the single-factor model, market portfolio's adjustment R was only 0.1, far less than r in other models. When market portfolio vw uses both the vwf market index and the VWF index excluding financial companies, the adjustment R is 0.14. If the three-factor model is used for calculation, the adjustment R becomes 0.65. Continuing to use the four-factor model, the vwf index is still significant and is 0.73. So they think that "adjusted R2 is only, 10%: a strong evidence against one-factor CAPM" [10]. The single factor CAPM here refers to the classic CAPM model.

6.   Conclusion

With the deepening of research, it is found that the single variable CAPM model is not enough to explain the impact of a single market risk on expected returns. The larger the mean, the better, and the smaller the variance, the better. Even the three-factor model inevitably entered this area. This does not mean that CAPM is wrong, but it will be biased to substitute the perfect and ideal market into reality. Because CAPM's stochastic returns need to conform to the normal distribution. However, according to the theory of econometrics, the expected return often does not obey the normal distribution. This is one of the reasons why capm has been criticized by many scholars. However, existence is reasonable. CAPM can make Sharp win the Nobel Prize by no means accidental. As a simple linear model, CAPM lists and integrates all the most direct systemic risk factors for us. In some areas, there may be a coincidence in a certain period of time. Zhu Shunquan, a scholar from China, selected all the stocks in the Shanghai stock market from 2003 to 2006 as samples for analysis during the period of share-trading reform in China. Zhu Shunquan found that in these three years, the expected return of the selected stock samples was surprisingly consistent with CAPM.

But no matter what shortcomings and advantages a model has. In the capital market, it is always neccessary to understand that there is no free lunch in the world, and any return has inevitable risks. The higher the income people expect, the more risks they need to take. However, as mentioned above, CAPM needs to be analyzed through historical data, and the omission of data and the lack of index

validity lead to the inability to predict the future development of CAPM market. Fama's three-factor and multi-factor models comprehensively consider more factors, and make a more comprehensive modeling and prediction for the capital market. From a certain point of view, multi-factor analysis may become the main theme of capital market research.

References

[1] Zhu Yeming, Wang Jitao. Limitation analysis of capital asset pricing model [J]. Gansu Finance, 2005(05):20-22.

[2] Chen lihong, song yawen. empirical study on capital asset pricing model [J]. cooperative economy and technology, 2022 (03): 71-73. doi: 10.13665/j.cnki.hzjykj.2022.03.029.

[3] Guermat, Cherif. "Yes, the CAPM Is Testable."Journal of Banking &Finance,vol.46,2014,pp.31–42,https://doi.org/10.1016/j.jbankfin.2014.05.001.

[4] Zhang Zhaoguo, zhang yi, Zheng Baohong. Richard Rolle's Contribution to Financial Economics [J]. Economics Trends, 2014(02):99-105.

[5] Khoon, Cung Huck, et al. "CAPM or APT? A Comparison of Two Asset Pricing Models for Malaysia." Malaysian Management Journal, 2020, https://doi.org/10.32890/mmj.3.2.1999.8564.

[6] Wen Yiming, Yin Zongcheng. An empirical study on the excess stock return of listed companies in pharmaceutical and biological industries in China based on Fama-French three-factor model [J]. China-Arab Science and Technology Forum (in Chinese and English), 2022(09):87-90.

[7] Lianna. research on the multi-factor stock selection model based on investor sentiment index [D]. Changchun university of technology, 2022. doi: 10.7805/d.cnki.gccgy.20080.00000000000605

[8] Yang Zunhan. Test of CAPM model and Fama-French three-factor model in China's A-share market [J]. economic research guide, 2022(08):117-119.

[9] Li Fuwen. Testing asset pricing model with Hong Kong stock data [J]. Times Finance, 2020(02):74-75+82.

[10] KEIICHI KUBOTA1 and HITOSHI TAKEHARA, "Financial Sector Risk and the Stock Returns: Evidence from Tokyo Stock Exchange Firms", Asia-Pacifific Financial Markets 10: 1–28, 2003.