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Applicability of Each Pricing Model in the Chinese Stock Market

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Abstract: In order to obtain a higher long-term average return from a portfolio, investors need to increase the level of risks that cannot be dispersed by diversification in the portfolio, and the asset pricing model can help investors to judge how much risk is reasonable to take. This paper will introduce the development process of several asset pricing models, and integrate and overview the applicability of the above several asset pricing models in China's capital market by combining the relevant research of domestic and foreign scholars over the years based on existing literature and data analysis results. Finally, it can be found that due to its strict prerequisites, Capital Asset Pricing Model (CAPM) has the lowest applicability in the Chinese stock market, while the Five-Factor Model and the pricing model based on beta decomposition both have good applicability, but it is hard to say which one is the best one to adapt to the Chinese stock market at present.

Keywords: Chinese capital markets, CAPM model, APT model, three-factor model, five-factor model

1. Introduction

Until now, the Chinese stock market has become an important capital market that can provide investors with a convenient investment platform [1]. At the same time, the stock market can always reflect the trend of our recent economic development. In the current research on asset pricing and market risk measurement at home and abroad, Markowitz first used portfolio variance and mean value to define portfolio risk and return respectively. Then, on the basis of Markowitz's portfolio theory, Sharpe (1964), Lintner (1965) and Mossin (1966) proposed the classic CAPM model. The CAPM model divides stock risk into systemic risk and non-systemic risk. In addition, the scholars constructed a sensitivity factor β based on how sensitive stocks were to market movements in the past.

At present, the capital market in China and the western capital market still exist big gap. First of all, as a market economy, China's policies have far greater influence on the market than foreign countries. Secondly, most of the participants in mature foreign capital markets are institutional investors, while in China, it is obvious that retail investors dominate the market. In addition, the transaction mechanism of the capital market in China is also different from the mature capital market. Mature foreign markets generally implement T+0 trading system, which suggests that you can buy and sell on the spot; In contrast, while Chinese stock market has a T+1 system, which means buying on the day and selling on the second trading day, which greatly limits liquidity [2, 3]. On the whole, there are still big differences between the Chinese capital market and the western capital market in

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many aspects, and the domestic market is not mature enough compared with foreign countries. Therefore, investing in China requires developing an investment methodology with Chinese characteristics. Through horizontal comparison, it can find out the pricing models that are relatively suitable for Chinese investors to refer to, so as to help Chinese investors make better decisions when investing.

2. Portfolio Theory

In 1952, Markowitz proposed portfolio theory. According to this theory, the risks of investing in a single stock can be divided into systemic and non-systemic risks. The so-called systemic risks refer to market risks in general, such as macroeconomic changes or policy changes, while non-systemic risks refer to specific risks, such as company bankruptcy and other specific events. Non-systemic risk is especially bad for individual stocks, so it should be spread through a portfolio. The core idea of this theory is that :"don't put all your eggs in one basket." In this theory, Markowitz used portfolio variance and mean to define portfolio risk and return respectively.

For example, if a portfolio contains two assets, he then assigns weight to the two assets according to the proportion of capital invested in them and combines the covariance of the two assets to get the variance and mean of the combination. The formula is as follows:

$$\begin{cases} E_P^2 = \omega_1^2 E_1^2 + \omega_2^2 E_2^2 \\ \sigma_P^2 = \omega_1^2 \sigma_1^2 + \omega_2^2 \sigma_2^2 + 2\omega_1 \omega_2 \sigma_1 \sigma_2 \rho_{1,2} \end{cases} \tag{1}$$

where ω stands for weight, ρ stands for relative coefficient, E stands for expectation and σ stands for standard deviation.

According to the above formula, a rectangular coordinate system of expectations and variances can be constructed, and a region can be obtained by inserting different weights. A line can be drawn by taking the point in the region where the variance is smallest at different expectation levels. Since the bottom half of the line is a decreasing function, that is, as the variance increases, the expectation decreases, this part of the curve is invalid. So the top half should be taken, and this curve is the effective frontier. On this line, each point is the optimal weight ratio for its corresponding expectation.

In 1964, based on Markowitz's investment theory, Sharpe assumed that every portfolio contained risk-free assets, and that there was a linear correlation between asset returns and risk-free assets. Then, assuming that there are only two assets in a portfolio, and one of them is risk-free. Thus, the following formula is obtained:

$$\begin{cases} E(R_P) = \omega_{r_f} r_f + \omega_1 E(R_1) \\ \sigma_P^2 = \omega_{r_f}^2 \sigma_{r_f}^2 + \omega_1^2 \sigma_1^2 + 2\omega_{r_f} \omega_1 \sigma_{r_f} \sigma_1 \rho_{r_f,1} \\ \omega_{r_f} + \omega_1 = 1 \end{cases} \tag{2}$$

where ω_{r_f} stands for weight of risk free asset, ρ stands for relative coefficient, E stands for expectation and σ stands for standard deviation.

Since risk free asset has no risk, according to Markowitz's Portfolio Theory, it can be shown as

$$\sigma_{r_f} = 0 \tag{3}$$

Then the former formula can be simplified to:

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$$\begin{cases} E(R_P) = \omega_{r_f} r_f + \omega_1 E(R_1) \\ \sigma_P^2 = \omega_1^2 \sigma_1^2 \\ \omega_{r_f} + \omega_1 = 1 \end{cases} \tag{4}$$

2.1. CAPM Model

In 1966, Lintner and Mossin, on the basis of Markowitz and Sharpe's research, put forward a strict assumption premise: assume that the stock price is only affected by one factor, namely its systemic risk β, so as to construct the CAPM model. The formula of individual stock is as follows:

$$E(R_i) = r_f + \beta \frac{E(R_m) - r_f}{\beta_m} \tag{5}$$

where r_f stands for risk free rate, β stands for sensitivity factor, and E stands for expectation [4].

Since β reflects the sensitivity of individual stocks to market changes, it is obvious that:

$$\beta_m = 1 \tag{6}$$

Then the formula transfers into:

$$E(R_i) = r_f + \beta \left[E(R_m) - r_f \right] \tag{7}$$

Moreover, when seeking the sensitivity factor of a portfolio, the formula can be translated into:

$$\beta_P = \omega_1 \beta_1 + \omega_2 \beta_2 + \cdots + \omega_n \beta_n \tag{8}$$

According to the formula above, taking β as the independent variable and expectation as the dependent variable, a curve can be portrayed in the coordinate system, which is the Capital Market Line (CML) [5].

Many scholars have analyzed the applicability of CAPM in China's stock market using historical data. In 1998, Yang Zhaojun and Xing Jing used the data of Shanghai stocks from 1993 to 1995 to construct 18 portfolios according to the size of β [6]. Then, they conducted multiple linear regression analysis on their returns. The results show that the effect of the CAPM model on the Shanghai stock market is not ideal. On the other hand, in 2011, Liu Jiazhen used the data of Shanghai stock market from 2008 to 2010 to test the validity of the linear relationship between yield rate and systemic risk. The results show that there is no significant linear relationship between the two, which means that the research hypothesis of Sharpe used by the CAPM model is not valid. To sum up, the applicability of the CAPM model is poor in the Chinese stock market, that is, this is not a qualified asset pricing model for China.

2.2. APT Model, Three-Factor Model and Five-Factor Model

Since the academic circle gradually found that the premise assumptions of the CAPM model were too strict and that these assumptions did not conform to the real operation law of the capital market, especially because it believed that the market was only affected by the single factor of systemic risk [7]. Then, many scholars began to study the asset pricing model, which is composed of multiple factors. In 1976, ROSS proposed the APT model in his research, which considered various influence factors.

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In essence, both Three-Factor and Five-Factor Models belong to APT models, but one model has three impact factors and the other has five. The Three-Factor Model states that there should be three factors used to measure each stock: market factor, size factor and value factor, while the Five-Factor Model believes that there should be five factors, which has a higher profit level and investment level than the Three-Factor Model. Since the Three-Factor Model is not the result of economic theory derivation, but a model summarized from market data and market anomalies over the years, it cannot accurately price assets in the face of new anomalies in the market. In contrast, the five-factor model has received more recognition.

As for the applicability of these three models in the Chinese market, many scholars have conducted research. In 2007, Jiang Lirong selected the data of the Chinese stock market from 2001 to 2005 as samples, studied the stability of β coefficient and made a comparative analysis of the performance of the CAPM model and APT model in the Chinese stock market. The results show that the APT model is more applicable than the CAPM model in China [8]. In 2003, Yang Xin and Chen Zhanhui tested and found that the three influencing factors of the three-factor model were significant, so they believed that the three-factor model was suitable for the Chinese stock market. However, in the same year, Fan Longzhen and Wang Haitao studied the data of China's stock market from 1995 to 2000 and found that although the three-factor model was superior to the CAPM model in explaining the difference in stock returns, it could not fully explain it either. For the five-factor model, there are many studies and tests in the academic circle. In 2016, scholars such as Zhao Shengmin selected the data of A-share market from 1993 to 2014 to test the applicability of the five-factor model. The results show that the five-factor model has significant scale and value effects in the Chinese stock market. In 2017, Li Zhibing and other scholars found through research that although the five-factor model has a strong explanatory ability for the Chinese stock market, its investment factor and profit factor can only have a better explanatory ability after adjustment.

2.3. Pricing Model Based on Beta Decomposition

In market activity, investors have an expected rate of return. Asymmetric risk refers to the difference in attitude of investors when the actual rate of return is higher or lower than the expected rate of return. Through research, scholars find that investors are more sensitive in the face of downward fluctuations. Many methods such as skewness, semi-variance and descending beta are used to measure the asymmetric characteristics of investment returns [9].

However, the traditional beta coefficient did not distinguish such risks, so some scholars proposed to redefine the concept of risk, and downside risk has received more attention. In 2009, Zhang Xiaoe and Zhao Xuan established an asset pricing model based on downside risk by using semi-variance as a risk measurement index. The results show that semi-variance and β based on downside risk can better explain the cross-sectional return relationship than traditional variance and β [10]. Since then, many scholars have conducted more in-depth research on beta based on downside risk.

In 2014, Wang et al. used the price-earnings ratio to construct the discount rate factor and the ROE to construct the cash flow factor, thus obtaining a two-beta pricing model. After analyzing its explanatory power, it is found that the two-beta pricing model is more applicable in the American market than the undecomposed beta pricing model. In 2021, Bollerslev and other scholars divided market beta into four and a half betas and built a four-beta asset pricing model, considering the symbol of asset income. After comparing the explanatory ability of the CAPM model, the two-beta pricing model, and the four-beta pricing model to the Chinese stock market, it was found that the four-beta pricing model has strong applicability to the Chinese stock market.

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3. Discussion

This paper summarizes the applicability of each pricing model in China's stock market by selecting early samples. However, in the course of decades of history, the stock market also changes all the time, so some applicability test results are not very convincing for the current stock market. In the future, the researchers will focus on missing variables; factor premium estimation when missing or irrelevant variables exist; dimensionality reduction and aggregation factor information; variable error problem and SDF estimation to optimize the pricing model.

4. Conclusion

It can be found that since the birth of the CAPM model in the 1970s, the academic circle has always paid high attention to the asset pricing model. Scholars are constantly exploring and researching to improve and develop the existing asset pricing model and improve its applicability to all stock markets.

(1) In the research history of asset pricing models, the first CAPM model has been widely recognized. But as time went on, skepticism grew in the academic community. Many scholars think that the premise of the CAPM model is too strict, so they relax the constraints and get the APT model. The APT model increases the influence factor of revenue from one to multiple, overcoming the shortcoming of the CAPM model, which does not conform to the real market law. Both the three-factor model and the five-factor model make use of the idea of the APT model. Subsequently, in order to better face asymmetric risks, scholars decomposed β and paid more attention to downward fluctuations.

(2) In the review of empirical results of domestic and foreign asset pricing models, it is found that the CAPM model does not have strong applicability in the Chinese stock market due to its strict preconditions. The APT model is improved on the basis of the CAPM model, and its applicability to the A-share market is better than the CAPM model. Among them, the five-factor model is better than the three-factor model in explaining the Chinese stock market, but for emerging markets, its applicability to European and American markets is still higher than that of Asian markets. The pricing model based on beta decomposition takes asymmetry risk into account in previous studies, and this type of model has strong ability to explain the A-share market, especially the four-beta pricing model. However, the comparison between the five-factor model and the model based on beta decomposition is lacking at present, so it is hard to charge which one is better in the Chinese stock market.

This paper is not comprehensive enough to summarize the research on the applicability of various asset pricing models in China's stock market. In the future, the author will focus on the stock market data in recent years to test the applicability of the pricing model.

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