

Comparative Research of the Fitness of CAPM and Fama-French Three-factor Models

Runqi Zhu

University of Newcastle, Australian, Newcastle, New South Wales, 2300, Australia

c3377850@uon.edu.au

Abstract. CAPM theory is the core of the modern financial theory. As time went on, more and more people began to invest in CAPM research, many of the contradictions of CAPM have emerged, not least the highly idealistic assumptions and harsh implementation conditions. Different from CAPM, which only has a single factor of market risk beta, The inclusion of size premium and book-to-market ratio premium in this model can effectively explain stock market results. By introducing the model concept of CAPM and FF3 and comparing the empirical evidence in Sattar, M., this paper explains why the explanatory power of CAPM factors is weak. By referring to previous scholars' articles, this essay contrasts and elucidates how the market factor, size premium, and book-to-market ratio premium may all effectively account for stock market returns. According to the study's findings, the three-factor Fama French model has a stronger capacity for explanation than the CAPM model.

Keywords: CAPM; Fama-French Three-factor; Financial Risk; Explanatory power.

1. Introduction

The importance of finance to a country's economic development is self-evident. The establishment of a financial market with a sound system, transparent information and efficient transactions can boost the development of the country's real economy in a better and higher-quality manner. How to correctly price an asset is the key to the efficient and stable operation of the financial market, and it is also one of the most basic and core issues in the stock market. The Capital Asset Pricing Model (CAPM) was developed using Markowitz's research on efficient portfolios and the assumption that all investors follow Markowitz's investing philosophy. The foundational element of contemporary finance theory is the CAPM theory. The capital asset pricing model is employed, among other things, for allocation of resources, capital cost planning, and asset assessment. The foundation of current financial market price theory is it. In the field of securities theory, the CAPM model is extensively used to assist investors in determining if the additional return they are receiving justifies the risk associated. Financial economics has two primary competitors: First, single-factor CAPM, proposed by Sharpe and Lintner in 1964 and 1965, respectively [1]. Second, the Fama - French three-factor (FF3) model is the second. (1992) [2, 3]. Over time, more and more people began to invest in the study of CAPM, and many contradictions of CAPM have emerged. The problem is not just the assumption of high idealization and harsh implementation conditions. Researchers discovered that shares of low-market capitalization companies had better average returns than shares of high-market capitalization companies in one study, and small companies also had higher returns. CAPM could not explain this situation.

Banz and Basu et al. demonstrated the empirical failure of CAPM. Despite the fact that small-cap stocks' beta is higher than large-cap companies' (small and large companies), the earnings gap between the two is larger than CAPM's forecast [4-7]. A cross-section of average stock market returns does not appear to be explained by a single market risk factor, beta. At that time, the FF3 model was developed. The three-factor model is the main challenge to CAPM [2]. Different from CAPM, which only has market risk beta as a single factor, this model also includes the size risk premium and value premium as additional explanatory variables in addition to the market factor [3]. In this paper, by comparing the different definitions of the two models and the demonstration of the model, judge whether FF3 is superior to the CAPM model and has better explanatory power than the CAPM model.

This paper introduces the model concept of CAPM and FF3 and compares the empirical evidence in Sattar (2017) to explain why the explanatory power of CAPM factors is weak [7]. Explain how the

market factor, size risk premium, and book-to-market ratio premium all work together to effectively explain returns in the stock market using Fama's (1973) work [8]. At the end of the article, the author puts forward some conclusions. Based on Fama & French (1992), there are two findings in the generation of FF3 [2]. On the one hand, Beta does not seem to be a good explanation for the average stock return. At the end of the article, the author also suggests some advantages of CAPM over FF3 and how to choose when to use the two models. Then there are the problems the FF3 claims to solve and the problems it doesn't, and the current limitations of the FF3 Model. While the CAPM model is the optimal calculation method, the data cost is not so high, and it is very practical. When using the FF3 factor model, its advantage is stronger than CAPM in interpretation ability. After adding the two factors of value and size, the model can explain 90% of stock returns. When choosing a computational model, consider the cost of time and individual capabilities as well as the desired results before choosing a method. This study will help readers choose a model to calculate the required benefits. And understand the difference between FF3 and CAPM.

2. Methodology

2.1 The Concept of CAPM

The process used to determine the equilibrium price as well as the connection between the predicted return rates of safe and hazardous assets on the securities market are among the major subjects discussed. Based on efficient portfolios by Markowitz, Harry Markowitz looked at investments in risky assets, all the risky assets you could find in the market, and did a random mix [9, 10]. Review the portfolio's projected return and risk-portfolio standard deviation. Examine the connection between portfolio risk and anticipated return. The resulting distribution is the variance frontier. For the same return, the risk is minimal. As the same level of risk, the highest expected return can be achieved. The establishment of equilibrium price under the presumption that all investors embrace Markowitz's theory of investment management is described by the CAPM. Theoretically, the expected value and risk of an asset are directly correlated with one another. Capital market as efficient portfolio and risk-free assets portfolio after the new portfolio. The expected return of this combination satisfies the following formula [11].

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

In risk compensation, the non-systemic risk is completely spread out because you own the whole market. So δ is the systemic risk unit compensation. William Sharpe argued that if we could find a systemic risk for stock i , systematic compensation in units of time Plus the risk free rate of return, can figure out the expected return of this stock R_i , R_i is the cost of equity. When compared to the overall market risk, beta measures the systemic risk of the entire firm. In statistics, in order to identify the link between the market and certain stocks, the slope of a straight line was utilized to establish a linear regression between the returns of some stocks and the returns of the entire market. From the degree of dispersion to a straight line is the correlation coefficient ρ . Through the introduction of the β coefficient, CAPM can measure the sensitivity of the excess return of an enterprise to the excess return of the market, and better explain the relationship between enterprise risk and its future returns. However, the basic assumptions of CAPM are difficult to be fully satisfied in the overall market and specific enterprises, which makes CAPM subject to certain challenges.

CAPM model has very harsh assumptions, which are extremely difficult to realize in real life. First of all, the CAPM model assumes that every investor is rational and will choose the optimal market portfolio for investment. In reality, there is no perfect frictionless capital market. "Borrowing at the risk-free rate" is unlikely. Coupled with the yield change daily, the conditions for CAPM model implementation are difficult.

2.2 The Concept of FF3

The FF3 is the main replacement for CAPM [2]. Along with the market component, this model also includes size risk premium and book-to-market ratio premium as explanatory variables [3]. To more effectively explain cross-sectional expected returns, Fama & French suggested a novel three-factor model. Consequently, they added two extra variables to the CAPM equation.

$$E(R_i) = R_f + \beta * SMB(RSMALL - RBLG) + \beta * HML(RHBM - RLBM) \quad (2)$$

The majority of variations in stock price and stock return can be explained by adding the two elements of the stock's market value and book-to-market ratio. Small-cap companies often have larger returns than large-cap corporations, with their stock prices rising on average. Value equities beat growth companies over the long term, according to the HML factor. Size and book-to-market ratio might show cross-sectional differences in average stock returns, depending on market beta, size, and other variables [2].

2.3 Analysis of the Explanatory Power of the CAPM Model

As time went on, more and more people began to invest in CAPM research, Many of CAPM's contradictions are already apparent. According to a study by researcher Banz, shares of low-market capitalization firms had better average returns than those of high-market capitalization companies, and small companies also had high returns, which the CAPM model could not explain. Banz and Basu et al. demonstrated the empirical failure of CAPM. Despite the fact that small-cap stocks' beta is higher than large-cap companies' (small and large companies), the earnings gap between the two is larger than CAPM's forecast [4-6]. Cross-section research and time series analysis are frequently employed in CAPM testing, according to Sattar [7]. Although the link between return and beta was practically linear, Fama and French's empirical investigation revealed that the real straight line was flatter than the CAPM projected. Given the impact of additional variables including the book to market ratio, debt, size, and earnings-to-price, it cannot be explained by system risk factors alone [12].

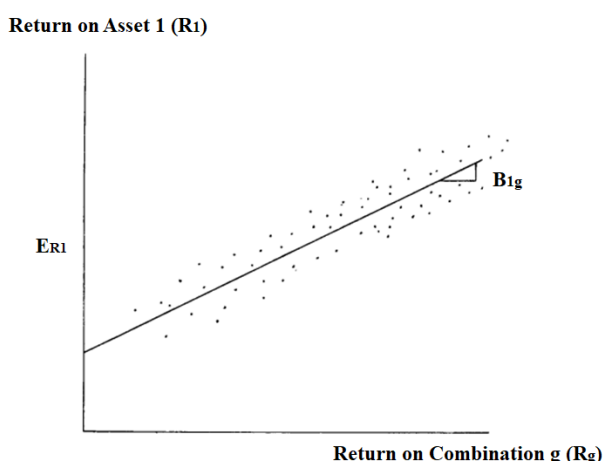


Fig. 1 The Capital Asset Pricing Model

3. Model Comparison Analysis

Figure 2 displays the ordered combination of size risk & book-to-market ratio, along with the CAPM fitting predicted return and average realized return. All of the diagram's points would follow the 45-degree line if the CAPM were perfectly interpreted. However, figure 2 data clearly shows that

CAPM data are not distributed along a 45-degree line [13]. In contrast to The Fama & French model, the distribution of the FF3 chart is close to 45 degrees.

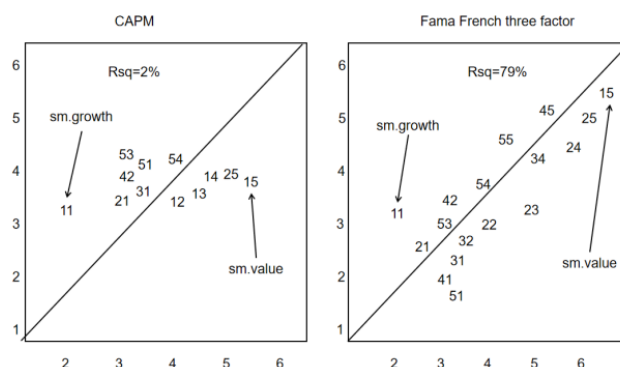


Fig. 2 Realized vs. fitted returns: Fama-French portfolios: a, CAPM; b, Fama-French

Fama & French developed a three-factor model that incorporates book-to-market and market size components. Contrary to CAPM, three-factor models have proved incredibly effective at capturing a cross-section of the average return of these portfolios. The photograph depicts this discovery. According to Fama & French (1993, 1995), this three-factor approach is effective [14, 15]. Fama & French found two findings in the generation of FF3: one is that beta seems unable to explain the average stock returns well; the other one is the combination of size and book-to-market value seems to contain the role of average stock return [2]. The average return rate and company size have a strong inverse relationship, as demonstrated by Banz [4]. The strong association between the average return process and the book to market ratio was demonstrated by Stattman, Rosenberg, Reid, and Lanstein, and these two factors are different methods of obtaining income reporting [16, 17]. As suggested by Fama & MacBeth, Banz showed that there is a significant inverse link between average rate of return and business size. The average rate of return and beta have a very significant positive correlation [4, 8].

However, when grouped according to Beta, there is no obvious trend of change in yield. When controlling for the market value of variables, Beta has no significant correlation with yield. It can be concluded that Beta alone cannot explain the rate of return, while market value has significant explanatory power. The return rate decreases as market value increases. The paper also discusses how size factors help to explain the distribution of typical stock market returns.

4. Conclusion

Both the CAPM and the consumer capital asset pricing model have faced significant challenges in recent years as a result of empirical asset pricing. One of these issues, which were brought up in two publications by Fama & French, was that the FF3 model has greater explanatory power than the CAPM model since beta cannot anticipate the majority of fluctuations in cross-sectional returns. However, the Fama & French three factor model's major flaw is that it is not supported by economic theory: it cannot explain the good effects of SML and HML as factors. According to some academics, SMB and HML are empirical variables, and no one is certain which global economic aspects they represent. SML and HML risk variables cannot be deduced from fundamental economic theory, making the FF3 model solely an econometric model. Compared with CAPM's single factor model, the calculation of the FF3 model is much more complicated. In real word situation, investors may not have as much financial knowledge and computing power to concretely get the desired results. At this time, the single factor CAPM model is the optimal calculation method, and the cost of data is not so high. The CAPM model is not only computationally simple, but it is also very practical, and investors can use it to make portfolio choices based on systematic wind selection. This model is very suitable to help investors in the financial market and can solve most of their problems in general. When the

FF3 factor model is used, its explanatory ability is not only stronger than CAPM. In the past, CAPM only used one market factor to explain half of the stock fluctuations. After adding two factors of value and scale, the explanatory ability of this model for stock returns is up to 90%. We can basically understand the difference in stock returns. First, it may be that the market risks exposed are different. Second, maybe the size of the company is different. Third, the growth of the company is different. That's what the FF3 Model is for. When choosing a model to calculate, time cost and personal ability should be considered before selecting a method.

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