

Capital Asset Pricing Model, Fama French Three Factor Model and Carhart Four Factor Model: A Review of Literature

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ABSTRACT

This literature review paper aims to provide an overview of the Capital Asset Pricing Model (CAPM), Fama-French Three Factor Model, and Carhart Four Factor Model. The paper examines the development, assumptions, and limitations of each model, as well as empirical tests and applications in finance research. The CAPM is a model commonly utilized in finance to elucidate the correlation between expected returns and risk for an individual asset or portfolio. The Fama-French Three Factor Model expands on the CAPM by introducing additional risk factors, such as company size and book-to-market ratio. The Carhart Four Factor Model expands on the Fama-French model by incorporating momentum as a risk factor. In addition, the article examines the debates and criticisms surrounding each model, including their inability to account for all risk factors and the suppositions made about market efficiency. Lastly, the paper emphasizes the practical applications of these models in asset pricing, portfolio management, and financial decision-making. The ultimate objective of this literature review is to provide a comprehensive understanding of these asset pricing models, their advantages and disadvantages, and their importance in present-day finance research.

Keywords: *stock market, excess returns, Carhart's four-factor model, Fama and French three-factor model, Capital Asset Pricing Model (CAPM), portfolio returns.*

INTRODUCTION

Stockholders and financial analysts in the capital market find asset pricing models to be valuable because they help estimate the cost of capital and evaluate fund manager performance (Datta and Chakraborty, 2018). Portfolio managers, institutional investors, and individual investors rely on these models as essential resources in their everyday investment choices. In order to engage in profitable trading, rational investors need a comprehensive comprehension of how to recognize undervalued securities. A security is considered undervalued when its actual return deviates from the expected return, which can occur due to an inefficient market or a mis-specified pricing model. The expected return of a security is determined by the opportunity cost of equity and is used to value the security based on the present value of its cash flows. Similarly, the pricing skills are also essential for portfolio performance evaluation and capital budgeting decisions.

Several asset pricing tools have been created to elucidate the behaviour of security prices, with the Capital Asset Pricing Model (CAPM) being the most popular one. Initially developed by Sharpe, Lintner, and Black, the model has been extended to include multiple factors such as market risk, size, value, profitability, and investment. Since modern portfolio theory was introduced by Markowitz, many attempts have been made to model security returns empirically. However, the debate continues regarding the most suitable risk metrics to forecast portfolio earnings in various capital markets.

The primary concern for investors is how to value risky securities. It is widely believed that investors demand higher expected rates of return for riskier projects or securities. Estimating the expected return and risk associated with investment in risky securities is crucial in numerous financial scenarios, such as managing portfolios, allocating capital, and evaluating performance. Modern investment theories are largely based on two concepts: the first, introduced by Markowitz, is that in an efficient financial market, higher risk exposure leads to higher return expectations. The second concept, established by Sharpe, is that the risks associated with individual securities tend to offset each other in diversified portfolios, making systematic risk the relevant factor. Therefore, investors are compensated for exposure to greater systematic risk, which cannot be diversified away. This concept is known as the Capital Asset Pricing Model.

CAPITAL ASSET PRICING MODEL

Harry Markowitz and William F. Sharpe, two economists who made significant contributions to finance, were awarded Nobel Prizes. Sharpe developed the Capital Asset Pricing Model (CAPM) which suggests that stock returns and market beta have a linear relationship, and investors are compensated only for systematic risk, not unsystematic risk, as it can be varied away. Beta, which is a measure of systematic risk, is obtained from a regression of securities returns against the market's returns. However, this approach was criticized for attributing risk to a single systematic factor, while risk is a multidimensional factor. In response, other theories such as the Arbitrage Pricing Theory (APT) were proposed, which established a theoretical foundation for the existence of multiple systematic sources of risk and return.

$$r_i - r_f = \alpha + \beta_1(r_m - r_f) + \varepsilon_i$$

r_i = *The return on asset i*

r_f = *The risk-free interest rate in government bonds*

α = *Intercept of the regression line*

r_m = *Return of the market portfolio.*

β_1 = *Beta value of the independent variable $r_m - r_f$*

ε_i = *residuals of the regression model*

The CAPM is founded on Markowitz's portfolio choice model, which supposes that investors are averse to risk and strive to minimize the variance of portfolio returns based on expected return or maximize expected return given variance when selecting among portfolios. This method is called the "mean variance model." The CAPM aids in determining the accurate price of securities by considering their combination of risk and return. It allows the calculation of the required rate of return (RRR), which is the rate of return that an investor necessitates from investing in a security based on its systematic risk. The RRR has two parts: the risk-free rate and the risk premium on the given security. The risk premium is determined by the security's level of risk, with riskier securities having higher risk premiums. The CAPM is employed to gauge systematic risk and to identify the cost of capital for a single stock or a portfolio of stocks.

FAMA FRENCH THREE FACTOR MODEL

The three-factor model, which was proposed by Fama and French in 1993, contends that the portfolio's return sensitivity to three factors is the reason why the projected return on an investment exceeds the risk-free rate. A wide-ranging market portfolio's excess return (also known as the market premium) makes up the first element, while the return on a portfolio of small stocks against a portfolio of large stocks (SMB) makes up the second. The third component is the variation in return between a portfolio of high-book-to-market and low-book-to-market equities (HML). When using the Fama French technique for estimating, a simple regression is used to estimate each factor's beta, and these values are then multiplied by the risk premium for the corresponding factor to derive an estimate of price or value for the portfolio.

The regression form for the Fama French three-factor model is as follows:

$$r_i - r_f = \alpha + \beta_{1i}(r_m - r_f) + \beta_{2i}(SMB) + \beta_{3i}(HML) + \varepsilon_i$$

The variables can be explained as follows:

α = Intercept of the regression line

r_i = The return on asset i

r_f = The risk-free interest rate in government bonds

r_m = Return of the market portfolio

(SMB) = Return of the size factor

(HML) = Return of the BE/ME factor

ε_i = residuals of the regression model

β_{1-2-3} = Beta values of the three independent variables $r_m - r_f$, SMB and HML

Eugene Fama and Kenneth French, both academics at the University of Chicago, created the Fama-French three-factor model. By incorporating size risk and value risk variables in addition to the market risk component already included in the capital asset pricing model (CAPM), the model is an asset pricing tool that expands upon the CAPM. It was developed in 1992 to address the market's persistent underperformance of value and small-cap companies. The goal of the model is to account for the tendency of value and small-cap companies to perform better than other equities by incorporating these extra characteristics.

The Fama-French model employs three factors to explain stock returns, including

- (1) Market risk,
- (2) Small-cap companies outperforming large-cap companies, and
- (3) High book-to-market value companies outperforming lower-valued ones.

The model is based on the idea that small-cap and high-value companies have a tendency to outperform the overall market consistently.

CARHART FOUR FACTOR MODEL

Carhart (1995, 1997) offered a four-factor model that expands on the three-component model created by Fama and French by including a momentum element. Jegadeesh and Titman (1993), who discovered a one-year momentum effect, influenced Carhart. Fama and French (1996) contended that the momentum component was required since the three-factor model could not explain the disparities in returns seen across momentum-sorted portfolios. The four-factor model can be thought of as a market equilibrium model with four risk components or as a performance attribution model. The coefficients and premia on the factor-mimicking portfolios, according to the latter interpretation, indicate the proportion of mean return attributable to four fundamental strategies: high versus low beta stocks, large versus small market capitalization stocks, value versus growth stocks, and one-year return momentum versus contrarian stocks. The momentum factor compares the returns of a portfolio of winners to a portfolio of losers.

The Carhart four – factor model in its regression form:

$$r_i - r_f = \alpha + \beta_1(r_m - r_f) + \beta_2(SMB) + \beta_3(HML) + \beta_4(WML) + \varepsilon_i$$

The variables can be explained as follows:

r_i = The return on asset i

r_f = The risk-free interest rate in government bonds

α = Intercept of the regression line

r_m = Return of the market portfolio

(SMB) = Return of the size factor

(HML) = Return of the BE/ME factor

(WML) = Return of the momentum factor

ε_i = residuals of the regression model

$\beta_{1-2-3-4}$ = Beta values of the three independent variables $r_m - r_f$, SMB, HML and WML

LITERATURE REVIEW

Modern portfolio theory was started from the research done by Markowitz (1952) with the assumption that investors would tend to avoid risks (risk aversion). Markowitz offered the investors to diversify their assets in portfolios in order to get optimal returns. An optimal return means earning relatively high return with relatively low risk. When high risk assets are combined in a portfolio, the risk exposed by investors will be lower compare to owning the high-risk assets individually. Research on the relationship between stock return and risk continued. As a development of the theory, Markowitz (1952) came out with CAPM.

Black et al. (1972) developed a model about the relation between stock return and risk where the risk is stated in beta (market risk). In Markowitz theory, risk is denoted as standard deviation and it can be reduced through asset diversification (portfolio). Reduction in risk will be more effective when the correlation between assets is negative. The closer the correlation value to negative one (-1), the more effective the risk reduction will be. However, risks in a portfolio cannot be entirely eliminated. Although more assets are added in the portfolio, the risk can only be eliminated up to a certain limit. In CAPM, the risk that cannot be eliminated is called systematic risk or market risk while the risk that can be eliminated through diversification is called unsystematic risk. The sum of both risks will then become the total risk. Since unsystematic risk cannot be eliminated through diversification, this type of risk is not relevant in the risk equation. Research done by Black et al. (1972) resulted in the positive and significant relationship between systematic risk (beta) and the stock return.

Fama and French's 1993 paper titled "Common Risk Factors in the Returns on Stocks and Bonds" is a highly influential study on the Fama-French Three Factor Model. The authors conducted a test on a sample of US stocks from 1963 to 1990, using data from the Center for Research in Security Prices (CRSP). They discovered that the size and value factors played a crucial role in determining stock returns, even when market risk was taken into account.

The law of one price by Ross (1976) stated that there will be no possibility for mispricing which means the same stocks sold in two different places will not be priced differently. When mispricing exists, there will be a chance for arbitrage as what is explained in the Arbitrage Pricing Theory (APT). Based on Ross (1976), stock return is not influenced only by the market risk. Instead, there are other factors that will affect the return such as those factors that involve macro economy and the company itself. Fama & French (1993) did another research by combining the theory by Ross (1976) and Black et al. (1972). By taking samples from New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and National Association of Securities Dealers Automated Quotations (NASDAQ) from year 1963 to year 1991, it was found that systematic risk in CAPM has not explained the changes in stock return completely. Therefore, Fama & French came out with the Fama & French Three Factor Model by adding other risk factors such as firm size and book to market equity which is better in explaining the changes in stock return.

Firm size factor was first studied by Banz (1981). By taking samples from NYSE from 1936 to 1975, it was found that firm size can explain the changes in the stock return. This result was also supported by the study done by Blume & Stambaugh (1983) on New York Stock Exchange (NYSE), American Stock Exchange

(AMEX) for the period of 1963 to 1980. On the other hand, the research about book to market equity was first conducted by Rosenberg & Lanstein (1985). NYSE was taken as the sample from the period of 1973 to 1984 and the result indicated that there is a book to market equity effect. This research was also supported by Davis et al. (1994), Chan et al. (1991), and Capaul et al. (1993). All these researches supported the Fama & French Three Factor Model.

Fama & French did the research on American Stock Market and the result was supported by another study done by Davis, Fama & French (2000) on Moddy Industrial Stock for the period of 1929 to 1997. It was found that the Three Factor Model is suitable to measure the changes in the stock return. Liew & Vassalov (2000) tested the Three Factor Model on 10 countries which are Australia, Canada, France, Germany, Italia, Japan, Netherlands, Switzerland, UK and USA from 1978 to 1996 and the result also supported the Three Factor Model. The same result was also obtained by Charitou & Eleni (2003) who did research on UK Stock Market for the period of 1992 to 2001 and Ajili (2003) who took France as the sample for the period of 1976 to 2001. However, research done by Griffin & Lemmon (2002) on NYSE, NASDAQ and Amex for the period of 1965 to 1996 showed that Three Factor Model cannot properly explain the changes happened on stock return.

Chan et al. (1991) did research on Japan Stock Market from 1971 to 1988 and firm size effect and significant positive relationship from book to market equity were found. However, Djajadikerta & Gilbert (2009) who did research on New Zealand Stock Market from 1994 to 2002 confirmed that firm size can indeed explain about the changes in stock return, but not for book to market equity. Hence, Three Factor Model was not supported.

The same result was also obtained by Drew et al. (2003) and Wang & Xu (2003) who studied the Chinese Stock Market. Based on Wang & Xu (2003), two-thirds companies in China were owned by the state. Besides, the shares owned by insurance companies, mutual funds and pension investment were only less than 10%. The private companies only owned 30% of it. The remaining 60% was owned by individual investors who were more likely to be the speculators in the short term rather than investing for a long term period. They did not really look at companies' fundamental and also had limited understanding about the financial statements. This might explain the reason for the absence of book to market equity in Chinese Stock Market.

Meanwhile, the research done in Indian Stock Market showed a different result. Both studies done by Taneja (2010) for the period of 2004 to 2009 and Senthilkumar (2009) for the period of 2002 to 2008 on Indian Stock Market indicated that Three Factor Model was applicable in Indian Stock Market. Only that Senthilkumar (2009) found a negative and significant relationship for the firm size, while positive and significant relationship for book to market equity.

The research about Fama & French Three Factor Model on emerging market was also done by Al-Mwalla (2012). Amman Stock Market was taken as the sample for the period of 1999 to 2010. The result indicated that both firm size and book to market equity have really convincing roles in explaining the changes in stock return and this also means that Three Factor Model was applicable there. On the other hand, research done by Rehman et al. (2013) on Karachi Stock Exchange in Pakistan for the period of 2003 to 2007 showed a different result. It was found that CAPM can better explain the changes in stock return in Pakistan compare to the Three Factor Model.

The research on Colombo Stock Exchange done by Shafana et al. (2013) also explained that Three Factor Model is not completely effective in explaining the changes in stock return. Book to market equity has a significant but negative relationship, while firm size has a positive but not significant relationship. Similar result was also obtained by Eraslan (2013) who studied Istanbul Stock Exchange for the period of 2003 to 2010. It was found that firm size only has significant influence on medium to big companies, but not on small companies. However, book to market equity can well explain the changes in stock return. Hence, the Three Factor Model was not fully applicable in emerging market. It is only the research done by Drew & Veeraraghavan (2002) which confirmed the well application of this theory in Kuala Lumpur Stock Exchange.

Studies done in Indonesia Stock Exchange also ended up with various results. On one side, Hardianto & Suherman (2009) who studied the companies in Indonesia Stock Exchange for the period of 2000 to 2004 and Ferdian et al. (2011) who took the sample from companies in Jakarta Islamic Index for the period 2007 to 2009 obtained the result that confirmed with the Three Factor Model. They concluded that Three Factor Model can well explain the changes in stock return in Indonesian Sharia Market compare to CAPM. Only that the influence of book to market equity was negative even though it was significant. On the other hand, research on LQ-45's companies by Murtini & Dede (2008) for the period of 2000 to 2007 and Sudiyanto & Irsad (2011) for the period of 2007 to 2009 resulted in the same conclusion where CAPM can better explain the changes in Indonesian stock return compare to Three Factor Model.

It can be seen that inconsistency exists from the studies done on emerging market, especially on Indonesia Stock Exchange where a contrastive research result was obtained. Besides, the research done by Fama & French in Indonesia is still very limited, particularly in the banking sector. Hence, this research will examine the Fama & French Three Factor Model on banking sector in Indonesia Stock Exchange.

After Carhart (1997) introduced the four-factor model, further studies were conducted to explore its potential applications. Wermers (1997) and Daniel et al. (2001) found evidence that the fourth factor of Carhart's model could be used to analyze strategies that lead to persistence in mutual fund performance. Brav et al. (2000) discovered that the four-factor model could explain the underperformance in returns observed in samples of companies conducting an initial public offering (IPO) and seasoned equity offering (SEO). Kim and Kim (2003) reported that the four-factor model could account for the abnormal pattern of returns observed after earnings announcements, which were sorted with standardized unexpected earnings (SUE).

Awwaliyah and Husodo (2011) used US data from January 1963 to December 2010 to assess the accuracy of the Fama-French three-factor model and the Carhart four-factor model. According to their findings, the Carhart four-factor model outperforms the Fama-French three-factor model in explaining the excess return of stock portfolios in the United States. Fama and French (2012) examined the influence of size, value, and momentum in 23 developed nations across four regions (North America, Japan, Asia Pacific, and Europe) in a separate research. Their review of data from November 1989 to March 2011 found that, with the exception of Japan, there was a value premium and return momentum in all areas. They came to the conclusion that asset pricing is not completely integrated in all four regions.

Cakici et al. (2013) examine the effects of value and momentum in 18 developing countries divided into three regions: Asia, Latin America, and Eastern Europe from January 1990 until December 2011. The outcomes provide strong evidence of value effects in all regions and momentum effects in all regions except Eastern Europe. In addition, Cakici et al. document that local factors show much better performance than global factors, indicating market segmentation in developing countries.

Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) claimed that companies with a high book-to-market equity value provide greater average returns when adjusted for their individual betas, showing the limits of the CAPM. Fama and French (1993) responded to criticism by presenting a three-factor asset pricing model that considers beta, size, earnings-to-price ratio, leverage, and book-to-market equity value of companies. Their research discovered that size and book-to-market equity value had greater explanatory power than beta in determining stock performance across markets. They expanded their investigation to include bonds in 1993 and discovered that a three-factor model consisting of market premium, size, and book-to-market equity value may explain stock returns. Jagannathan and Wang (1996) found support for the CAPM while testing the assumption that betas remain constant over time for NYSE and AMEX-listed stocks from 1962 to 1990.

Heston, Rouwenhorst, and Wessels (1995) found that value-weighted portfolios are likely to have lower average returns compared to equally-weighted stock portfolios in European markets.

Hawawini and Keim (1998) argued that the prediction of stock returns is affected by many factors, including size, book-to-market value ratio, and EPS, instead of just beta.

Ashton and Tippett (1998) concluded that a mis-specification in the estimation of assets can lead to the dismissal of the CAPM in favor of other factors.

Rahman and Baten (2006) tested the CAPM on the Dhaka Stock Exchange and found that beta is not the only factor affecting returns, and timing and other factors such as size and EPS ratio are also important.

Howton and Petersons (1998) examined stock returns in bullish and bearish markets and found that beta has a significantly positive association with returns in bullish markets but a significantly negative association in bearish markets, with book-to-market equity being a crucial factor in bearish markets and size being a key factor in January in bullish markets.

Abbas et al. (2015) examined the Karachi Stock Exchange 100 Index from 2004-2014 and excluded firms with negative book equity to investigate the impact of market premium, size premium and value premium. Their study found that all three factors were significant in explaining the variation in average stock returns, and that small stocks had a higher slope than large stocks, and value stocks yielded higher returns than growth stocks.

Along the same lines, Chandra (2015) studied the stock returns of 29 banking companies in Indonesia from January 2010 to December 2013. The study tested both the Fama-French three-factor model and the CAPM. The results revealed that the CAPM was valid in predicting stock returns for banking companies in Indonesia. However, the Fama-French three-factor model was not entirely applicable in Indonesia as only excess market

return and firm size had a significant impact on stock returns, while the effect of book-to-market equity was not noticeable.

Data & Data Analysis Used by Different Studies Covering Capital Asset Pricing Model, Fama - French Three Factor Model and Cahart Four Factor Model

Author	Financial Model Used	Statistical Techniques & Methods Applied	Sample & Unit of study	Time period
Adam Karp, Gary van Vuuren (2017)	CAPM & FF3M	Descriptive statistics, multicollinearity, factor analysis, time series regression	53 highly tradable stocks of Johannesburg Stock Exchange (40 were also part of the JSE Top 40 index during that time)	January 2010 to January 2015
Dr. S Poornima and Swathiga P	CAPM	Standard Deviation	10 listed companies of NSE	*
Shweta Bajpaia, Anil K Sharmab	CAPM	Regression	500 Continuous stocks which were traded in the NSE CNX 500 and NSE CNX 500 index in 10 yrs.	January 2004 to December 2013
Yashashri Shinde, Teja Mane	CAPM	ANOVA	45 companies listed on the NSE.	April 2013 to March 2018
Muhammad Azam, Jasir Ilyas	CAPM & FF3M	ANOVA	50 companies that were listed on the KSE (Karachi Stock Exchange)	January 2003 to December 2007.
Dennis M. Bulla	CAPM & FF3M	Correlation and Regression analysis	For the study Year end returns of 10 banks were taken from the period of 2010-2015	2010-2015
Yaşar Erdiñç	CAPM, FF3M & FF5M	Regression	263 nonfinancial firms that were listed on the Istanbul Stock Exchange (BIST) between December 31st, 1999 and May 30th, 2017.	June 2000 to May 2017.
Nicklas Rehnby	FF3M And Carhart Four-Factor Model	Regression	106 companies that met the requirement of being listed on Nasdaq OMX's large or mid cap list within the specified timeframe of 2010-2015.	2010-2015
Tatang Ary Gumantil, Bambang Sutrisno, Andreas, Denny Bernardus	FF3M And Carhart Four-Factor Model	Regression	Monthly data was obtained from the 90-day Bank Indonesia Certificates.	July 2005 to June 2015.

*CAPM- Capital Asset Pricing Model

*FF3M- Fama French Three Factor Model

*FF5M-Fama French Five Factor Model

CONCLUSION

The Capital Asset Pricing Model (CAPM) has been a well-liked technique for pricing assets in finance for many years. However, a number of studies have highlighted the model's shortcomings and suggested substitute models, such as the Fama-French three-factor model and the Carhart four-factor model. These models also take into consideration additional factors including momentum, book-to-market equity ratios, and business sizes to more fully account for variations in the average stock return.

The empirical investigations show that when it comes to describing the cross-sectional variation in average stock returns, the Fama-French three-factor model and the Carhart four-factor model perform better than the CAPM. The Fama-French concept has also been examined and approved in other overseas markets. However, it is crucial to understand that the empirical findings are ongoing and not always consistent. However, it is crucial to understand that the empirical findings are not always consistent and that further research is being done to enhance these models. Alternative models that take additional factors into account should be taken into consideration in order to improve the accuracy of stock return forecasts, even though the CAPM is still a useful asset pricing and portfolio management tool.

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