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# The five-factor asset pricing model – A theoretical review and assessment

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## Abstract

The relation between expected return and risk has long been a topic for discussion and research. In this essay, we discuss the latest Fama and French (2015) five-factor model and its incorporation of the two new factors that are supposed to better explain the variation of the cross-section in expected average stock returns. By outlining recent developments of asset pricing models in general and the underlying valuation theory, we provide insights into the reasons why they augmented their three-factor model.

## 1 Introduction

Up to now, the three-factor model of Fama and French (1993) has been considered the benchmark asset pricing model to explain average stock returns and the relationship between risk and return of stocks at least for the US capital market (Kubota and Takehara, 2018). In their latest research, Fama and French (2015, 2017) propose and apply additional profitability and investment factors, turning it into a five-factor model. They argue that their new five-factor model outperforms their classic three-factor model. Despite their supposed improvements, it remains a conundrum why they added those specific factors and no others (Blitz et al., 2018).

In order to understand their motivation, we begin by reviewing the history of asset pricing models and the background of valuation theory. We describe the challenge of finding adequate risk factors and derive connections between valuation theory and asset pricing models. Ultimately, we conclude with an outlook on the asset pricing debate.

## 2 A brief history of asset pricing models

Throughout history, academic research has tried to identify patterns in average stock returns. The starting point of asset pricing theory was the theoretical result by Sharpe (1964), Lintner (1965) and Mossin (1966) who individually proposed a theory of market risk premium under uncertainty, later called the capital asset pricing model (CAPM). By incorporating the model of portfolio choice developed by Markowitz (1952) the CAPM assumes an efficiency of the market portfolio, where expected returns on stocks are a positive linear function of their market.

Besides estimating the expected return on equity, the CAPM provides a methodology for quantifying risk by regressing the excess returns on the market premium. The resulting slope (beta) of the single factor model illustrated how much a stock moved compared to the market portfolio. In equilibrium, the hypothesis is that the true intercepts (alphas) are zero. Being different from zero, Jensen (1969) argues that this "performance measure" (Jensen's alpha) is due to a portfolio manager's skill to forecast security prices. Following Fama and MacBeth (1973), there are numerous studies that test the CAPM.

Based on the evidence of previous works (Banz, 1981; Basu, 1983; DeBondt and Thaler, 1985; Rosenberg et al., 1985; Chan et al., 1991), Fama and French (1992) subsequently presented empirical evidence that the CAPM fails to explain the cross-sectional variation in expected returns related to size and value (book-to-market). They showed that these two firm characteristics proxy for sensitivity to risk factors in returns, proposing a three-factor model that is consistent with these anomalies (Fama and French, 1993). Although their three-factor model is reliable with a rational-pricing, they admit that size and value remain arbitrary indicator variables that, for unexplained economic reasons, are related to risk factors in average returns (Fama and French, 1995). They only give a vague explanation, in which they state that size and value proxy for risk factors that might capture the risk of financial distress (Fama and French, 1996).

Following Jegadeesh and Titman (1993) who present another anomaly and show that stocks that have done well over the past year tend to continue to do well in the following year, Carhart (1997) proposes to extend the three-factor model with a factor that captures this momentum.

Over time, further anomalies like net share issues (Ikenberry et al., 1995; Loughran and Ritter, 1995), accruals (Sloan, 1996), liquidity risk (Pástor and Stambaugh, 2003), and volatility (Ang et al., 2006) have been discovered. Consequently, it became clear, that the three-factor model and even the four-factor model still had some drawbacks and areas that can be improved (Kosowski et al., 2006). It is argued that these anomalies are either due to (1) omitted variables, (2) an inefficient capital market, or (3) systematic experimental error in the studies.

## 3 Profitability, investment, and valuation theory

Extant literature long had difficulty to explain risk-adjusted returns and capture accounting risk measures especially related to profitability and investment (Frankel and Lee, 1998; Dechow et al., 1999; Piotroski, 2000). Fama and French (2006) argue that expected stock returns are related to profitability and investment based on valuation theory. Indeed, a huge body of literature finds evidence that the capital investment to average return relation is negative (Fairfield et al., 2003; Richardson and Sloan, 2003; Titman et al., 2004) and the profitability to average return relation is positive (Haugen and Baker, 1996; Cohen et al., 2002). Motivated by a more recent study from Novy-Marx (2013), pointing out that profitable firms generate significantly higher returns than unprofitable firms, and the linkage between investment and value (internal rate of return), which is a key economic insight from the investment theory, Fama and French (2015) propose their five-factor model.

## 4 From a three-factor to a five-factor model

Prior to the three-factor model, there are a large number of studies that have observed abnormal patterns in average stock returns (DeBondt and Thaler, 1985; Stattman, 1980; Banz, 1981; Basu, 1983; Bhandari, 1988; Keim, 1983; Jegadeesh and Titman, 1993). Fama and French (1992) argued that these anomalies necessitate a reevaluation of the existing capital asset pricing model. They examined size, leverage, book-to-market ratio, and earnings-price ratio. Fama and French (1996) showed that small stocks (in terms of the company's market capitalization) have significantly higher average returns than large stocks and stocks with high Book-to-Market ratios (value stocks) outperform those with low Book-to-Market ratios (growth stocks). They further conclude that a combination of size and book-to-market factors absorbs the effects of leverage and earnings-price ratio (Fama and French, 1992).

Therefore, Fama and French (1992) proposed a three-factor model containing additional the two factors size and book-to-market ratio to the beta of the CAPM.

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + S_iSMB + h_iHML + e_{it} \quad (1)$$

SMB (small minus big) models the size-related risk and represents the difference in returns between small and big-stock portfolios, whereas HML (high minus low) covers the risk related to book-to-market equity and is calculated as the difference in average returns between stocks with high and low book-to-market ratios (Fama and French, 1993).

Fama and French (1993, 2004) provided evidence that their three-factor model outperforms the CAPM both in terms of the mean absolute value of the alphas and in the explanation of the cross-sectional variance in returns. However, when regarding the Gibbons, Ross and Shanken-Test (Gibbons et al., 1989) testing the joint significance of zero alphas, the Fama French three-factor model has to be rejected (Fama and French, 1996). Further shortcomings of the three-factor model concerning the failure of the model to explain short-term return continuation were reported by Jegadeesh and Titman (1993), Carhart (1997) and Asness (1994). In the three-factor model, the value factor and momentum are negatively correlated. Both shortcomings were openly explicated by Fama and French. They argue that the characteristic of momentum is a matter of horizon and changes with the observed period (Fama and French, 1996). Additionally, they argue that their three-factor approach is indeed just a model and does not work perfectly but rather helps to explain anomalies and "solving the puzzle" of asset pricing factors (Fama and French, 1996). The deficit in explaining continuing returns later led Fama and French to further analyze momentum (Fama and French, 2012). They investigated 5x5 portfolios based on size and past year returns with global and local factors (North American, European, Japanese, and the Asia Pacific). Evidence of momentum was only found in microcaps and global portfolios. Furthermore, Fama and French observed reverse momentum effects in stocks with a high market capitalization, implying that stocks with previous negative performance showed positive performance in the future periods (Fama and French, 2012).

The upcoming evidence of the explanatory power of profitability on average returns (Novy-Marx, 2013; Titman et al., 2004) motivated Fama and French to reconsider their three-factor model for other factors (Fama and French, 2015). The selection of the two additional factors size and book-to-market ratio for the three-factor model was motivated by "empirical experience" (Fama and French, 1993). Contrary, Fama and French (2015) derive their basic assumptions about the inclusion of profitability and investment factors from a modified dividend discount model (Gordon and Shapiro, 1956) in combination with the Miller-Modigliani valuation model (Miller and Modigliani, 1961). Fama and French state that the Miller-Modigliani valuation formula explains basic assumptions about the relationship between stock returns, book-to-market ratio, expected profitability and investment (Aharoni et al., 2013; Fama and French, 2006). The dividend discount model describes that a stock's market value equals the sum of their expected dividends per share divided by the assets' internal rate of return (the long-term average expected stock return).

$$m_t = \sum_{\tau=1}^{\infty} E\,(d_t - \tau) \,/\, (1+r)^{\tau} \quad (2)$$

Where $m_t$ equals the assets share price at time $t$ and $E\,(d_t - \tau)$ is the expected dividend per share for period $t + \tau$. $r$ is the long-term average expected stock return. The equation is modified to include the relationship between expected return, profitability, investment and book-to-market equity ratio based on Miller and Modigliani (1961).

$$M_t = \sum_{\tau=1}^{\infty} E\,(\,Y_{t+\tau} - dB_{t+\tau}) \,/\, (1+r)^{\tau} \quad (3)$$

$Y_{t+\tau}$ represents the total equity earnings for period $t + \tau$ and $dB_{t+\tau} = B_{t+\tau} - B_{t+\tau-1}$ is the change in total book equity. Dividing the second equation by the book equity at time $t$ $(B_t)$ gives the final equation which serves as the basis of the five-factor model:

$$\frac{M_t}{B_t} = \frac{\sum_{\tau=1}^{\infty} E(\,Y_{t+\tau} - dB_{t+\tau}) \,/\, (1+r)^{\tau}}{B_t} \quad (4)$$

Fama and French further strengthen their model by relating to both the Miller-Modigliani model and equation one being approved as a tautology (Ohlson, 1990; Aharoni et al., 2013; Campbell and Shiller, 1988). Under the assumption of clean surplus accounting – meaning a stock's price is determined by the company's earnings, expected returns and change in book equity (Ohlson, 1995; Feltham and Ohlson, 1995) – Fama and French (2015) state that their model should be seen as a tautology. Therefore, they continue to make five essential assumptions from the above equation:

A) If everything is fixed, except the current value of the stock ($M_t$) and the expected stock return, a lower value of $M_t$ (or a higher book-to-market ratio $B_t/M_t$) implicates a higher expected return $E(\ Y_{t+\tau} - \ dB_{t+\tau})$.

B) If everything is fixed except the expected future earnings ($Y_{t+\tau}$) and the expected stock return ($r$), then higher expected earnings lead to higher expected returns.

C) If $B_t$, $M_t$ and the expected earnings ($Y_{t+\tau}$) are fixed, then a higher expected growth in book equity ($dB_{t+\tau}$) results in lower expected returns.

$D$) $B_t/M_t$ acts as an imperfect proxy for expected returns due to $M_t$ being influenced by forecasts of earnings and investment.

E) A stock's expected return has to be set by the given factors. Meaning that any change in a stock's expected return is determined by either a change in its price-to-book ratio, the expectations of future investments or the expectations of future profitability.

Two statements are of particular importance. Assumption C implies that growth in book equity (in other words investment) leads to lower future earnings. The negative relationship between these two factors is later criticized by Hou et al. (2017) who found evidence for a contrary relationship.
The latter statement implies that – under the assumption of the completeness of the model – any other factors that contribute to the explanation of returns cannot have a direct impact. Fama and French state that factors like momentum and size have an impact on returns by rather affecting the prognosis of future investments or future profitability.

Fama and French (2015), therefore, extend their three-factor model by adding investment (CMA – Conservative minus aggressive) and profitability (RMW – Robust minus weak) resulting in the following model:

$$R_{it} - R_{Ft} = a_i + b_i(R_{Mt} - R_{Ft}) + S_iSMB + h_iHML + r_iRMW + c_iCMA + e_{it} \quad (5)$$

The five-factor model corrects some of the shortcomings from the three-factor model, like microcap stocks with extreme growth while other problems of the three-factor model, like microcap portfolios which have negative linkage to profitability and investment factors, continue to persist in the five-factor model (Fama and French, 2015, 1993). Further, when including profitability and investment, Fama and French find that the book-to-market (HML) shows patterns of redundancy. They assumed that this could be due to anomalies in their specific sample (US 1963 – 2013). Later they could prove their assumption and observe the importance of HML in Global and local portfolios from 1990 – 2015 (Fama and French, 2017). Tests with various portfolios based on size, book-to-market ratio, investment, and profitability show that the five-factor model outperforms the three-factor model in explaining cross-sectional variance in average returns and produces close to zero unexplained average returns for individual portfolios. Despite that, the five-factor model still is rejected by the Gibbons, Ross and Shanken-Test (Fama and French, 2015; Kubota and Takehara, 2018).

# 5 Implications

Despite its weak theoretical underpinnings and empirical concerns, the three-factor model (as well as the CAPM) still is a centerpiece of university investment courses and is commonly used to estimate the cost of capital for firms and to evaluate portfolio performance of mutual funds (Carhart, 1997; Kosowski et al., 2006; Fama and French, 2010).

As we show, the dividend discounting model cannot rule out that the factor premiums may still be due to mispricing but working within the confines of valuation theory Fama and French (2015) filled the economic void and proved that the five-factor model is consistent with the predictions of the valuation equation. Blitz et al. (2018) therefore postulate that the five-factor model will most likely become the new benchmark for empirical asset pricing studies. However, they mainly criticize that Fama and French (2015) ignore momentum factors despite its high recognition in academic literature. Fama and French (2004) justify the absence of the momentum effect's short-term nature, which makes it relatively irrelevant for estimates of the cost of equity capital.

Like Fama and French (2004) further stated, risk-based factors also won't satisfy behavioralists that regard the violation of asset pricing models as mispricing. Building on the principal-agent theory (Jensen and Meckling, 1976) they argue that the anomalies are more likely the result of information asymmetry and irrational investor behavior, such as overconfidence. It's therefore important to point out that asset pricing factor models are only one approach to evaluate the returns of stock returns. Besides behavioral finance research, literature has developed approaches like event studies (Chopra et al., 1992) to calculate abnormal average returns.
Since the value factor of the five-factor becomes redundant, the work of Fama and French (2015, 2017) raises more questions than it answers. Furthermore, it still can't explain whether the outperformance tendency is due to market efficiency or market inefficiency. To conclude, the inclusion of the two new factors is not going to end the main asset pricing debate and it is most likely going to foster more research in this area as well as in behavioral research.

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