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# Relevance of higher moments in explaining stock return of growth and value stocks

Master Thesis

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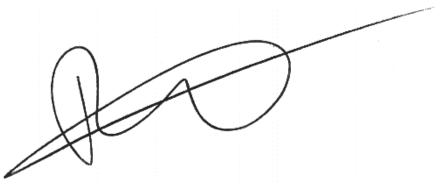

# Abstract

This study researches the relevance of higher moments in describing stock returns of growth and value stocks. Empirical research shows distinct return distributions for growth and value stocks, which could cause different attitudes of investors. Growth and value stocks classified by the book-to-market and price-to-earnings were hand-picked in this study and divided in four groups of 25 stocks. Moreover, four different models were used. Three were already created by prior research, the CAPM, 3-CAPM and 4-CAPM. This study is the first to include an interaction term between co-skewness and co-kurtosis, which resulted in the 4i-CAPM. By running Fama Macbeth regressions, this study finds that co-skewness and co-kurtosis are important in clarifying the variations of expected excess returns of value stocks. The observed results do not provide evidence to conclude the same for growth stocks. Some explanatory power seems to be added to a model by including the interaction term. This study concludes that the influence of investor's utility functions on the pricing of stocks is different for growth versus value stocks. This implies that the utilization of one common model will not lead to the best estimates for the pricing of varying types of stocks. Developments of new and divergent models based on this insight can potentially solve the value anomaly.



Keywords: Asset pricing; Higher moments; Co-skewness; Co-kurtosis; Interaction term; Value anomaly

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# 1. Introduction

The stock market has existed for centuries and although much research has been done on the understanding of this market, still a lot remains a mystery. In July of the year 2015 the market was again amazed. Take the 17th of July for example when the Wall Street record of largest single-day gain was broken by Google (Randewich, 2015). The stock price of Google increased that Friday with 16.26% adding $67 billion to the market value of Google. It is argued that technology stocks are in general very volatile. However, this event was still striking. This incredible day gain of Google could be justified by the fact that the earnings report, which was released the day before, exceeded the expectations of analysts. It remains questionable whether this is sufficient to explain the entire 16.26% stock price increase. A different explanation given is that the company will focus on cost reduction, but so far, not a single dollar has been saved. This relates purely to the expectation that this new path will pay off. In other words, speculation, as this has nothing to do with the fundamental value of the company and investors cannot be sure what the effect will be in the future. Or is there still more behind this stock price increase?

The value of a stock is determined partially by the demand, but on what grounds do investors decide whether or not they want to buy a stock? In general, it is determined by the risk-return framework of a stock and the preferences of an investor. How much return do I want to make and how much risk am I willing to take on for that amount of return is the question investors have to answer on a daily basis. Before investors will accept additional risk, the expected return should have to increase as well (Markowitz, 1952). The CAPM is a model trying to explain the relationship between these two factors and argues that the expected return demanded by investors is equal to the risk-free rate plus the market risk premium times the sensitivity of an asset to the market (Brealey, Myers and Allen, 2011).

Nowadays, the CAPM is (still) a popular risk-return measure commonly adopted by the finance industry, for example in the determination of the valuation of a company, where the cost of equity is calculated on the basis of the CAPM (Koller, Goedhart and Wessels, 2010). However, empirical research shows that the model is not exhaustive as the beta is not able to explain all the variations in expected returns by itself (Da, Guo and Jagannathan, 2012). Therefore, a considerable amount of varying research exists within the asset pricing literature with the aim to find a superior model. One part of this research focuses on the higher moments of a return distribution, particularly, but not exclusively, skewness and kurtosis, as pricing factors in the valuation of assets (e.g. Fang and Lai, 1997; Harvey and Siddique, 2000; Doan, Lin and Zurbruegg, 2010; Zhang, 2013 and Sihem and Slaheddine, 2014). This study is intended to add three valuable insights to the asset pricing literature with respect to the higher co-moments of an asset return distribution.

Firstly, to discover more about the explanatory power of the higher moments of a return distribution and to see how this can potentially clarify (part of) the value anomaly. The value anomaly is a prominent empirical contradiction of the CAPM, which shows that with the appropriate distribution of shares an abnormal return can be obtained (Fama and French, 1993). In the mentioned anomaly, the appropriate distribution of shares is determined by assigning the right amount of growth and value stocks in a portfolio, as value stocks generally tend to outperform growth stocks in terms of excess returns (Cohen, Polk and Vuolteenaho, 2009). The classification of these stocks are inherently important before being able to proceed to the distribution: a value stock is a stock with a high fundamental value compared to the market value, whereas a growth stock has a high market value relative to its fundamental value (Fama and French, 1993). This classification is still under scrutiny, to a certain extent due to the calculation of the fundamental value still being subject to investigation. This research will use two ratios in the classification of growth and value stocks, the book-to-market and the price-to-earnings ratio. The aforementioned outperformance of value stocks is an anomaly, as the calculated expected return, based on the CAPM, does not correspond to the actual returns observed. Zhang (2013) shows that the return distribution of growth and value stocks differ, with more positive skewness in the return distribution of growth stocks, and concludes that this difference can potentially explain part of the value anomaly. In addition, Trigeorgis and Lambertides (2014) show evidence suggesting an explanatory role for the difference in the return distributions of growth and value stocks. The key question of this paper is whether the inclusion of higher co-moments into an asset pricing model can help to uncover more on the value anomaly.

The second contribution to the literature will be the documentation of the interaction effect between co-skewness and co-kurtosis. To the best of my knowledge and belief, the interaction between these moments and the influence, it has as a price factor has so far not been subject to research. Furthermore, Lehnert, Lin and Wolff (2014) indicate that it is difficult to determine the impact of higher moments due to the interactions among them. By combining the theories of skewness and kurtosis and their influence on the variations of returns this paper theoretically underpins why the interaction should have an effect. If the uncovering of the influences and the related significance of this interaction term is supported by the theory it can make an important contribution to the literature.

Lastly, the practical interpretation of the results will be discussed. Prior research has, in particular, been focusing on the expected returns of stocks and whether skewness and kurtosis risk were priced by investors. In my opinion, the practical implementation of these results is given insufficient attention. Capital budgeting is an important decision making process for a firm to determine which project will add the most value and maximize the profits for a company. In 2008, Welch found that 75% of financial professors recommend the CAPM for capital budgeting purposes, making the CAPM the best model available in the eyes of the professors. However, if the results indicate that co-skewness and co-kurtosis risks are priced, does this not mean that extra risk components should be taken into account when calculating the cost of equity? This paper will interpret the results and will explain how including higher moments in an asset pricing model translates to the cost of equity.

In order to reach the mentioned insights, four different models will be tested on divergent groups of shares. Value and growth stocks display dissimilar return distributions and for this reason both groups are separated. Two ratios, the book-to-market and the price-to-earnings ratio, are utilized so that each ratio may identify 25 growth and 25 value stocks. After the identification of 50 growth and 50 value stocks based on these two ratios, several asset pricing models will be tested on these groups of stocks. The testing of identical models on different groups of individual stocks is unique and allows for a comparison of the results. It is also in contrast to previous studies, which, first of all, mainly test the importance of higher moments on diversified portfolios, and secondly, do not test models separately on different groups of portfolios or individual stocks. Depending on the results of the various models tested on growth and value stocks, additional evidence may be provided that answers to the value anomaly can potentially be found in the higher co-moments of stock return distributions.

This paper is organized as follows. In Section 2, the literature review is presented, which will start with a description of the CAPM and its limitations. Additionally, the economic rationale for the inclusion of higher moments into an asset pricing model will be given as well as an explanation of what skewness and kurtosis represent. At the end of Section 2 the value anomaly will be described. Section 3 contains the research design, which elaborates on the methodology applied and presents an overview of the data employed. Section 4 will present the empirical results and a discussion of these results. Section 5 will state the conclusion of this study, the limitations and some implications for further research.

# 2. Literature Review

This section describes and outlines the CAPM and its limitations as well as economic arguments in favor of the inclusion of skewness and kurtosis into the CAPM. Towards the end the value anomaly is explained. First, a small review of portfolio selection and the most widely used asset pricing model, the CAPM, will be given. The performance and limitations of the CAPM will be discussed next, in order to provide an understanding why the literature has taken up higher order moments to explain stock returns. In section 2.3 the moments of interest, skewness and kurtosis, are explained as well as the theories arguing that higher moments should be taken into account in asset pricing models. This study focusses on the value anomaly to research further in correspondence with higher moments. Section 2.4 describes the value premium and explains the basis of this research.

## 2.1 Portfolio Selection

Individuals or institutions invest money in assets in order to make a profit in the future. The return on any investment is uncertain and therefore carries a certain amount of risk for which investors demand a reward. The risk of any asset consists of the idiosyncratic and the systematic risk (Berk and DeMarzo, 2011). The idiosyncratic risk embodies the risk specific to the individual asset, whereas systematic risk translates to the risk that is associated with market wide variations, which affects all stocks simultaneously.

In 1952, Harry Markowitz wrote the paper “Portfolio Selection”, which changed the attitude of investors towards asset selection. Markowitz (1952) created a method to analyze the quality of any portfolio (multiple assets hold together) using only the means and variances of the assets in the portfolio. The quality is determined by the combination of risk and return, so either maximizing return or minimizing risk. Markowitz (1952) showed that the risk of an investment does not consist of its individual variance, but is depended on the covariance with the other assets in the portfolio. For that reason, an investor can reduce the risk of a portfolio without reducing the return of the portfolio by diversification, creating so-called efficient portfolios. By holding a well-diversified portfolio the idiosyncratic risk can be eliminated, leaving only the systematic risk of an asset to consider. Therefore, investors only demand a reward for the systematic risk taken, instead of total risk. With this insight, the risk of a portfolio is a function of three factors: individual systematic risk, asset weights and the interaction, or correlation, between assets (Markowitz, 1952). The theory of Markowitz assumes a normal return distribution and a rational investor who always prefers more to less. The normal return distribution indicates: (1) a portfolio created under a mean-variance approach, where investors only care about the mean and the variance of a portfolio, and (2) investors are indifferent between negative and positive outcomes in terms of risk. In the end, a portfolio is considered efficient when it has the highest expected return given a certain amount of variance or has the lowest variance given a certain expected return.

## 2.2 The Capital Asset Pricing Model

The capital asset pricing model (CAPM) is a formula that explains the relationship between return and systematic risk (Treynor, 1961; Sharpe, 1964; and Lintner, 1965). The CAPM is based on four assumptions (Brealey et al., 2011):

- Investors are assumed to be risk averse, rational and utility-maximizing investors;
- The returns of all assets follow a normal distribution. This implies a portfolio selection based on the expected return and variance only, with higher variance implying higher risk;
- Investors share the same beliefs about the market, so that the expectation and investment horizons of investors are identical, and
- A perfect capital market, where transaction costs, taxes and restrictions on short selling do not exist and where investors have unlimited access (borrowing or lending) to the risk-free rate.

When these assumptions hold, the CAPM concludes that, in equilibrium, investors should invest only in the risk-free rate and the market portfolio. This leads to the following well-known CAPM formula:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] \qquad (1a)$$

Where:

$$\beta_i = \frac{Covariance(R_i, R_M)}{\sigma^2(R_m)} = \frac{E\{[R_i - E(R_i)][R_m - E(R_m)]\}}{E\{[R_m - E(R_m)]^2\}}$$

So, the expected return of an asset, $E(R_i)$, consists of the risk-free rate, $R_f$, plus the sensitivity of an asset to the market, $\beta_i$ , times the market excess return or market risk premium, $[E(R_m) - R_f]$, where $E(R_m)$ gives the expected return of the market. The CAPM is very popular and often implemented by financial managers in practice. Sentana (2009) gives two explanations for this popularity of the CAPM. First of all, the CAPM makes the comparison of performance between assets easy, as the risk and expected return characteristics can be compared in a two-dimensional graph. Secondly, the fact that the CAPM assumes normal distributions makes the model fully compatible with expected utility maximization regardless of investor preferences. Jagannathan and Wang (1996) argue that the survival of the CAPM is due to two additional reasons. First of all, the evidence in favor of other models is not any better and secondly, the evidence against the CAPM is ambiguous.

However, the fact that the CAPM is such a well-known and often applied model does not mean perfection.

### 2.2.1 Limitations of the CAPM

Academic literature has criticized the CAPM for years. Roll (1977) was one of the first authors to find a fault in the CAPM. According to Roll, all implications of the CAPM are dependent on the market portfolio and so a test for the validity of the CAPM will be futile when the market portfolio is not mean-variance efficient. "*The theory is not testable unless the exact composition of the true market portfolio is known and used in the tests. This implies that the theory is not testable unless all individual assets are include in the sample*." (Roll, 1977, p. 130) Unfortunately, a true market portfolio does not exist and is impossible to create, and therefore the CAPM can never be fully accurate.

Other critique is directed to the market beta being a sole risk indicator. Banz (1981) provide evidence in favor of the inclusion of firm size besides the market beta. In the stock market of the UK, Strong and Xu (1997) show results suggesting an insignificant market beta when additional variables are added to their regression. Through empirical research it has been shown that other variables (partly) explain the variation of stock returns (Basu, 1983; Rosenberg, Reid and Lanstein, 1985 and Lakonishok, Shleifer and Vishny, 1994 as examples of past research). Fama and French (1992) created the three-factor model to add two explaining factor to the CAPM. The size and book-to-market factors were added to the regression and the results indicated that these factors describe the cross-section of average stock returns. Due to the strong results, the innovative regression and simple implementation, this three-factor model has had an influential effect in the search toward the understanding of the stock return distribution (Koller et al., 2010).

Another crucial assumption of the CAPM under scrutiny is the assumption of a normal return distribution. A normal distribution implies a symmetrical distribution, so that investors only care about the mean and variance and that the chances of an upside gain or a downside loss are equal. Three measurements of asymmetry are given in Chen, Hong and Stein (2001). Firstly, the chance of a meltdown is higher than the chance of a large increase. Secondly, a negative skewness in the market return is documented by researches. Lastly, the prices of stock options indicate a negatively skewed distribution. Furthermore, empirical evidence shows that stock returns have a more asymmetric distribution including heavier tails (Jondeau and Rockinger, 2006 and Chung, Johnson and Schill, 2006). The degree of asymmetry is measured by the third moment of a distribution, skewness. Kurtosis, the fourth moment, measures the peakedness and heavy tails of a distribution.

Empirical research has exposed the inability of the CAPM to explain stock returns when returns are not symmetric and preferences are not quadratic (Trigeorgis and Lambertides, 2014; Kostakis, Muhammad and Siganos, 2012). So, an asymmetric distribution and fat tails can be considered as fundamental risks of an asset. As this risk is not captured by beta, the CAPM will not be sufficient and an alternative asset pricing model is needed. One strand of literature incorporates higher moments, skewness and/or kurtosis into the traditional CAPM, so that variations in excess returns will not be explained by the first two moments of the distribution alone (Rubinstein, 1973; Kraus and Litzenberger, 1976; Fang and Lai, 1997; Harvey and Siddique, 2000; Dittmar, 2002 as pioneer examples of a larger literature).

## 2.3 Skewness and Kurtosis

The underlying economic rationale for an asset return distribution to be asymmetric and/or leptokurtic is still under debate. Most explanations find themselves in behavioral economics spheres, by trying to clarify the effect that reactions of investors have on an asset's return distribution. A different explanation comes from real options and will be dealt with last.

A different attitude towards information releases was one of the first explanations, provided by Damodaran (1985). The information structure, collecting and spreading information about a company, is an important parameter for determining the return distribution. Three dimensions concerning the information structure are identified and examined by Damodaran (1985): the accuracy, frequency and bias of information. The variance of stock returns is affected by the accuracy of or errors in information releases. The frequency of information provision is argued to have an effect on the probability of jumps implying an effect on kurtosis. Skewness is partly determined by the bias of information, due to the reactions of investors towards good and bad news. As news has an effect on stock returns, the variance is likely to increase for which investors demand a higher risk premium. Therefore, the increase of stock returns caused by good news is diminished by this increase in variance, whereas the decrease of stock returns caused by bad news is amplified by the increase in variance. This interpretation gives an explanation to the commonly negatively skewed return distributions of assets. A piece of critique towards this explanation is that shocks of volatility are mostly not long-term and consequently cannot have a large impact (Poterba and Summers, 1986).

A possible longer-term clarification, stemming from Blanchard and Watson (1982), finds its basis in the existence of bubbles in combination with the prospect theory of Kahneman and Tversky (1979). The prospect theory was developed as an alternative model for decision-making under uncertainty and as critique towards the standard expected utility model. Several inconsistencies with the expected utility model were presented. One of which is the overweighting of low probabilities, causing investors to perceive an event to be more likely to appear than is actually the case. The appeal of gambling and insurance may be justified by this theory. The desire to gamble and the fear of disaster can be represented by a preference for skewness and a kurtosis aversion, respectively (Zhang, 2014). A bubble seldom occurs, but has extreme outcomes when it does occur. The overweighting of probabilities in combination with the existence of bubbles can possibly explain a stock return distribution to become asymmetric and leptokurtic.

Homogeneous expectations are one of the four assumptions for the CAPM to hold. An initially proposed theory of Hong and Stein (2003) adopts the heterogeneity of investors to justify and clarify return asymmetries. This theory was improved and expanded by Chen et al. (2001).[1] Assuming short-sale constraints, bear-investors can only sell a stock, which excludes bear-investors from participating in the market. If large differences of opinion arise, the information of bear-investors may not be adopted correctly, causing an overreaction and a significant decrease in price. A related research by Kirchler and Huber (2007) considers asymmetric information to explain heterogeneous expectations. They created an experimental environment to give answer to the question: is the degree of heterogeneity in fundamental information positively correlated to trading activity, volatility and the emergence of fat tails? Kirchler and Huber (2007) argue that periods with constant dividend payments lead to similar estimates of asset values by investors, opposed to periods of fluctuating dividend payments. Varying dividend payments lead to a different interpretation of information and different estimates of asset values, increasing the possibility of extreme values occurring. Statistically significant evidence indicates higher volatility and the emergence of fat tails, a characteristic of a leptokurtic distribution, due to heterogeneity in fundamental information.

Lastly, real options will be described, a rationale focusing on the actual characteristics of a firm to explain return distributions and which thus not stems from the behavioral economics spheres. Where an option gives the holder the right to buy an asset, but not the obligation, a real option is a term used to describe the right but not the obligation to engage in an actual business opportunity for a company (Smit and Trigeorgis, 2004). This right gives the possibility to enter in a business opportunity when the prospects are appealing, but abandon the opportunity when the prospects are not. The upside of such an option is potentially very high, while the downside is limited to the costs of obtaining the real option. The characteristics of a real option can induce (positive) skewness and kurtosis in an assets

[1] The paper of Hong and Stein (2003) was a working paper at the time the paper of Chen et al. (2001) was published.

return distribution, and can potentially explain the return distributions of growth stocks (Haanappel and Smit, 2007).

Although the economic logic of the effect of skewness and kurtosis on asset pricing is an issue that requires more research, it is observed that stock return distributions are asymmetric and leptokurtic. Since traditional measures of risk based on the mean-variance framework cannot explain all of the variation, the roles of higher moments become increasingly important. The higher moments of an asset return distribution can be separated in a systematic and idiosyncratic component or the conditional and unconditional moments. In the literature the conditional systematic skewness (co-skewness) and conditional systematic kurtosis (co-kurtosis) are used more often as these moments take the correlation with the market into account and cannot be diversified away (Harvey and Siddique, 2000).

### 2.3.1 Skewness

Skewness is the third moment of a distribution and measures the asymmetry or, in other words, the relative sizes of the tails of the distribution. A normal distribution is symmetric and consequently has a skewness of zero. A positive (negative) skewness indicates a longer right (left) tail, which represents the probability of large holding gains (losses).

Kraus and Litzenberger (1976) conducted one of the first researches that incorporated the effect of systematic skewness on valuation. They argue that although the market portfolio is efficient for the utility function of investors, the mean-variance framework is violated. The features of an investor's utility function should include a preference for positive skewness, besides an aversion for variance. Kraus and Litzenberger (1976) extend the CAPM to include systematic skewness as a higher moment to examine the effects. The three-moment CAPM from Kraus and Litzenberger (1976):

$$\bar{R}_i = R_f + \beta_i b_1 + \gamma_i b_2 \qquad (2a)$$

Where the expected return of an asset is represented by $\bar{R}_i$, $\beta_i$ represents the market beta and $\gamma_i$ the market gamma or systematic skewness of an asset. $b_1$ and $b_2$ give the market risk premiums for the corresponding risks, and can be interpreted as market prices for a beta and gamma respectively. Kraus and Litzenberger argue that $b_1$ equals the excess rate of return on the market portfolio $(\tilde{R}_m - R_f)$ and $b_2$ is expressed as $(\tilde{R}_m - \bar{R}_m)$, which equals the excess rate of return on the market portfolio from its expected value. Based on their results, Kraus and Litzenberger (1976) question the validity of the CAPM, argue that other negative empirical findings towards the CAPM were due to the omission of skewness as a factor causing the CAPM to be incorrectly specified and conclude that investors have a preference for positive systematic skewness.

While the research of Harvey and Siddique (2000) is related to Kraus and Litzenberger (1976), their research focuses on conditional skewness instead of unconditional skewness. Conditional skewness (co-skewness) measures whether the return of an asset is more skewed compared to the return of the market. Harvey and Siddique (2000) find that their model is economically important, helpful in explaining variations of asset returns and show a negative premium for skewness risk, consistent with Kraus and Litzenberger. In more recent research, Hung, Shackleton and Xu (2004) provide (weak) evidence for the pricing of higher moments in a market other than the US, namely the UK and also Chung et al. (2006) find that skewness has an effect on the pricing of assets. Moreno and Rodriguez (2009) show that even in a mutual fund environment incorporating co-skewness as a factor increases the explanatory power of a model and is economically and statistically significant.

However, not all research gives consistent results. Post, van Vliet and Levy (2008) give a theoretical explanation and provide empirical evidence that the assumption of risk aversion is violated in research incorporating traditional higher moment asset models and thereby questioning the implied utility function. They further explain that the explanatory power of co-skewness decreases when risk aversion is imposed. These statements lead to the conclusion that research should focus on reliable and different utility functions (Post et al., 2008). Moreover, the underlying theoretical explanation of conducted researches could be false, which could imply that co-skewness proxies for another but omitted factor that actually explains asset prices, the identification of these omitted factors was left for further research (Post et al., 2008 and Poti and Wang, 2010).

In a different economic setting, idiosyncratic skewness might be priced by investors. Barberis and Huang (2008) show that the cumulative prospect theory of Tversky and Kahneman (1992) can help explain the negative skewness premium. Under the cumulative prospect theory investors have an inversed S-shaped utility function, so that the assumption of risk-aversion only holds up to a certain point after which investors become risk seeking. Together with the overweighting of tails, investors develop a preference for positively skewed return distributions. Based on the prospect theory and their research, they conclude that positively skewed stocks are more valuable to investors and consequently earn a lower return. The key insight of their model is that idiosyncratic skewness risk is priced. This insight is also demonstrated by Mitton and Vorkink (2007) who show the negative relation of idiosyncratic skewness in the return distribution on stock prices as well. Zhang (2005) tests this theory on the stock market and finds strong evidence that positively skewed stocks have lower average returns.

In the end, besides the theoretical explanation of known deviations, empirical evidence from the large body of literature confirms the importance of the inclusion of skewness as a higher moment in the traditional CAPM.

### 2.3.2 Kurtosis

Research focusing on the importance of skewness is much greater than the focus on kurtosis, while the inclusion of the fourth moment in asset pricing models can be equally or more important (Doan et al. 2010). Kurtosis measures the degree of peakedness of a distribution, where a normal distribution has a kurtosis of three. A leptokurtic distribution has a higher kurtosis, which is represented by a high peak and fat tails, whereas a platykurtic distribution has a kurtosis lower than three, meaning a less clustered around the mean distribution with thin tails. Leptokurtotic distributions suggest that the outcomes of a distribution are likely to be at the extremes, which result in fat tails.

Fang and Lai (1997) derive a model that includes, besides variance and skewness, the pricing of systematic kurtosis. An investor's preference is a function of the mean, standard deviation, skewness and kurtosis of the terminal wealth (Fang and Lai, 1997). To maximize the preference of the investor a Lagrangian[2] is formed which in the end translates to the following formula to solve an investor's portfolio equilibrium:

$$\bar{R} - R_f = \varphi_1 VX + \varphi_2 Cov\left[\left(X'(R - R_f)\right)^2, R\right] + \varphi_3 Cov\left[\left(X'(R - R_f)\right)^3, R\right] \tag{3a}$$

Where $Cov\left[\left(X'(R - R_f)\right)^i, R\right]$ is the n x 1covariance vector of asset return R with the portfolio return $\left(X'(R - R_f)\right)^i$ for I = 1, 2 ,3. $\varphi_1$, $\varphi_2$, and $\varphi_3$ are the market prices of the systematic variance, skewness, and kurtosis, respectively.

To create a market model from this individual model, Fang and Lai (1997) make similar assumptions as the CAPM and assume that all investors hold the same probability beliefs and have identical wealth coefficients. These assumptions lead to the conclusion that the portfolio held by investors must be the market portfolio, $R_m$. This conclusion leads to the following four-moment CAPM:

[2] For a more elaborate discussion, see Fang and Lai (1997)

$$\bar{R} - R_f = \varphi_1 Cov(R_m, R) + \varphi_2 Cov(R_m^2, R) + \varphi_3 Cov(R_m^3, R) \quad (3b)$$

Where $R_m^2$ and $R_m^3$ represent the square and cube of the standardized market portfolio return $R_m$, respectively.

The linear model below, which is derived from equation (3b) is an extension of the three-moment CAPM of Kraus and Litzenberger (1976):

$$E(R_i) = R_f + \beta_i b_1 + \gamma_i b_2 + \delta_i b_3 \quad (3c)$$

Where:

$$\gamma_i = \frac{Coskewness(R_i, R_M)}{s^3(R_m)} = \frac{E\{[R_i - E(R_i)][R_m - E(R_m)]^2\}}{E\{[R_m - E(R_m)]^3\}}$$

$$\delta_i = \frac{Cokurtosis(R_i, R_M)}{k^4(R_m)} = \frac{E\{[R_i - E(R_i)][R_m - E(R_m)]^3\}}{E\{[R_m - E(R_m)]^4\}}$$

The market premia are given by $b_1$, $b_2$ and $b_3$ with, according to the theory, $b_1 > 0$, $b_2$ should have the opposite sign of market skewness, and $b_3 > 0$. The cubic market model consistent with the four-moment CAPM is:

$$R_{it} = \alpha_i + \beta_i R_{mt} - \gamma_i R_{mt}^2 + \delta_i R_{mt}^3 + \varepsilon_{it} \quad (3d)$$

With $R_{it}$ as the return of an individual asset and $R_m$ the return of the market portfolio. The regression coefficients, $\beta_i, \gamma_i$, and $\delta_i$ are identical to $\beta_i, \gamma_i$, and $\delta_i$ in equation (3c).

Fang and Lai (1997) and Dittmar (2002) both provide intuitive explanations for the aversion of investors for kurtosis and confirm their theories with empirical results. Fang and Lai (1997) find that investors are compensated for holding a portfolio with higher systematic co-kurtosis. Variance measures the deviations from the mean whereas kurtosis is a measure for the extreme deviations. Since investors dislike variation, investors should also dislike kurtosis. Zhang (2014) explains that despite the fact that high kurtosis measures both good and bad extreme events, investors demand a kurtosis premium due to the fact that investors overweight the extreme loss to the extreme gain. Another reasoning, stemming from Dittmar (2002), is a more utility-based explanation. Kimball (1993) argues that the two sufficient conditions for standard risk aversion to hold are decreasing absolute risk aversion, an investor dislikes risk, and decreasing absolute prudence, precautionary actions of an investor. Dittmar (2002) links decreasing absolute prudence to kurtosis and shows an aversion. More recent research provides evidence in favor of the pricing of co-kurtosis in stock portfolios as well. Doan et al. (2010) test whether higher co-moments are present on the Australian stock market and compare them with the US market. They find evidence suggesting a positive (negative) relation of stock returns with co-kurtosis (co-skewness), although the strength of the relation is dependent on firm characteristics and the risk preferences of investors. According to their research, the Australian stock market is more skewed and less leptokurtic, whereas the US market shows characteristics of higher kurtosis. Therefore, co-skewness is more influential in explaining stock variations on the Australian market and co-kurtosis is more significant for the US market. The previously mentioned research of Poti and Wang (2010) confirms the importance of co-kurtosis besides co-skewness. Both factors are found to explain at best part of the stock returns, and, similar to co-skewness, Poti and Wang (2010) question whether co-kurtosis does not act as an intermediary for another factor.

To sum up, an investor with a non-quadratic utility and a decreasing absolute risk aversion should prefer positive skewness and less kurtosis in the return distribution. Assets with negative skewness and larger kurtosis should therefore be related to higher risk premia. Or, to put it differently, unfavorable movement of higher moments to the risk preferences of investors requires compensation in the form of additional returns. So, if skewness and kurtosis are taken into account in an asset pricing model, the trade-off for portfolio selection should consist of maximizing the expected return and (positive) skewness and minimizing the variance and kurtosis.

## 2.4 The Value Anomaly

Research shows that the CAPM does not always hold in practice and often gives an expected result that deviates from the actual result. According to the Merriam-Webster dictionary a deviation from the common rule, or an irregularity, is defined as an anomaly. In asset pricing there are four well researched anomalies: the size, value, momentum and reversal effect (Hartley, 2006). These effects are anomalous because there is a structural and replicable pattern where the actual outcomes cannot be explained by the CAPM alone. The relationship of stock returns with beta is simply not as strong as the CAPM predicts and other explanations are needed. Although all four anomalies still need to be researched, this paper examines the value effect.

### 2.4.1 Returns of value and growth stocks

Value stocks are generally represented by undervalued stocks or stocks with low prospects for growth, represented by, for example the book-to-market ratio, a book value of stocks close to (or higher than) their market values (Fama and French, 1993). Growth stocks have more growth opportunities, generally meaning a (much) higher market price than the stocks fundamentals indicate (Fama and French, 1993). Historically, value stocks seem to earn an excess return superior to growth stocks. The outperformance of value stocks to growth stocks is called the value effect or value premium. Following the CAPM, growth stocks should have a lower beta than value stocks and would consequently earn a lower return. However, even though value-minus-growth betas covariate positively with the market excess return, the result of the combination is too small to explain all of the return observed in the value effect (Petkova and Zhang, 2005). So, the value premium exists even after corrections for beta have been made, causing the CAPM to be insufficient to explain this difference.

#### *2.4.1.1 A rational explanation*

Fama and French (1993) created a three-factor model that should capture the value (and size) anomaly, by adding the corresponding factor to the CAPM. The third, and relevant, factor is the high minus low (HML) factor and shows the difference between the return of a portfolio containing value stocks versus a portfolio containing growth stocks. Fama and French (1993) justify the inclusion of the high minus low factor by their financial distress hypothesis. This hypothesis argues that book value should be close to market value if a firm does not have any valuable growth opportunities. This would make a (value) stock more risky, which in turn raises the required return. Although the literature reached consensus on whether the factors of Fama and French are relevant, the interpretation of the factors are still controversial. For example, Lettau and Ludvigson (2001) find that value is riskier than growth, but especially in bad times. Cohen et al. (2009) show that the expected value premium is even higher when the value spread is wide. More recently, Choi (2013, p. 25) concludes “*neither asset risk nor leverage alone drives the value premium. It is the dynamic interaction […] that makes value stocks riskier […] and that explains, at least in part, the return differences between these stocks and growth stocks.*

#### *2.4.1.2 A behavioral explanation*

Not all literature finds evidence for value strategies to be riskier than glamour strategies and reject the financial distress hypothesis as justification. Instead, a behavioral point of view, considering errors in the reaction and interpretation of investors, is put forward as explanation. In line with this view, Lakonishok et al. (1994) conclude that the contrarian strategy is more likely to explain the value anomaly. Naïve investors might expect past earnings growth to uphold in the far future, even though evidence does not suggest this growth to persist. This judgment error leads to investing in growth stocks instead of value stocks, causing growth stocks to be overpriced and value stocks to be underpriced. The contrarian strategy lets investors bet against these overreactions by buying the underpriced value stocks instead, consequently earning a superior return. Piotroski (2000) implements a simple accounting based fundamental analysis strategy to test this view empirically, and finds results supporting the view that the market does not incorporate information correctly.

Concluding, it is important to capture the underlying dynamics in order to provide meaningful analysis and so long as the economic rationale behind the factor is unclear it is possible that they only represent a proxy for the true factor.

### 2.4.2 The higher moments of growth and value stocks

The market value of a firm can be seen as the sum of the assets in place plus the value of growth opportunities and this mix of growth options and assets in place has been suggested to affect stock returns (Berk, Green and Naik, 1999). Growth opportunities are more volatile than assets in place, but with a high potential for a large valuable upside. An investor can walk away from a growth opportunity when the conditions are unfavorable, but can pursue when the future is bright. This flexibility provides an investor with unlimited upside potential whereas the downside stays limited (Smit and Trigeorgis, 2004). In the end, a company has a collection of different kinds of options that create skewness and imply an asymmetric return distribution for growth stocks, whereas a value stock should have a more symmetric distribution (Del Viva, Kasanen and Trigeorgis, 2013). Investors seem to favor a positively skewed risk-return profile and may rationally accept a lower return for stocks that offer such a distribution, because of the possibility for large gains. This skewness risk can potentially explain the value premium. Consider for example Chung et al. (2006) who find that the Fama-French factors become insignificant when higher-order co-moments are included in their models. Based on their results they conclude that the Fama-French factors merely proxy for higher-order co-moments. Trigeorgis and Lambertides (2014) find similar results suggesting a stand-in role for the book-to-market ratio substituting growth options, based on the believe that the higher moments of the return distribution of growth options are more favorable for investors. Zhang (2013) finds excess positive skewness in the return distributions of growth stocks compared to value stocks, thereby revealing that a significant portion of the value premium is driven by the preference for skewness. The author also shows that the book-to-market ratio has significant predictive power towards future skewness. Based on these results, Zhang (2013) argues that trading strategies based on market anomalies can expose investors unintentionally to more skewness risk. The effect of growth options on the skewness in return distributions has been subject of intensive research and seems to even partly explain the value premium. This study will explore if including higher moments as pricing factors can clarify the difference in excess returns between growth and value stocks and will provide a conclusion on whether or not evidence has been found to further explain the value premium.

The aversion of investors for kurtosis and the resulting kurtosis premium has been well documented (see above), as well as the excess kurtosis showing in the return distributions of growth stocks

(Trigeorgis and Lambertides, 2014). However, so far, this combination has not been further explored.[3] Kurtosis measures probabilities of both good and bad extreme events and normally more weight is put on the loss in relation to the gain, resulting in the aversion. The theory suggests that excess kurtosis should, due to the aversion, annul part of the premium investors are willing to pay for growth stocks. The fact that an interaction term for the higher moments is not included in many previous studies may have resulted in the overstatement of the significance of the individual factors. This analysis provides an alternative reasoning towards kurtosis, suggesting that the positively skewed return distributions of growth stocks can result in a preference for kurtosis. The interaction of the higher moments has the potential to provide additional evidence for the value anomaly.

In conclusion, this chapter has explained why the CAPM seems to be insufficient in explaining variations in stock returns and that the inclusion of higher moments can potentially improve this insufficiency. Furthermore, this section described the value anomaly and the search for the right factor. The basis for this research is to add higher moments as pricing factors to the CAPM and test these asset pricing models on growth and value stocks in order to discover more about the value anomaly and potentially clarify the differences in excess returns, not explained by beta.

[3] To the best of my knowledge and belief

# 3. Research Design

This section will describe the methodology and data employed to examine whether the first two moments are enough to explain the risk-return characteristics of growth and value stocks or if the higher moments, skewness and kurtosis, should be incorporated in modeling asset pricing as well. First, a detailed explanation of the models and the tests performed is presented, after which a description of the data will be given.

## 3.1 Methodology

This research uses three models to study find the best asset pricing model for value and growth stocks. The traditional CAPM, the 3-CAPM, the 4-CAPM and the 4i-CAPM. This section explains the methodology behind every model and the tests that are performed.

### 3.1.1 Test for normality

The assumption of a normal risk-return distribution is essential for the CAPM to hold. This paper examines the ability of the CAPM to explain variations of stock returns when skewness and kurtosis are included. A test for normality is therefore crucial in the analysis. When evidence indicates that the mean and the variance are not sufficient to justify variations in stock returns, skewness and kurtosis might be important to include in an asset pricing model. To test the normality of the portfolios the Jarque-Bera (JB) test for normality will be conducted.

The JB test is based on two measures, skewness and kurtosis. In a normal distribution, skewness is equal to zero and kurtosis is equal to three, excess kurtosis (kurtosis minus three) is then zero. The JB test tests the null hypothesis that the sample has a normal distribution.

*$H_0$: The individual stocks have a normal distribution, skewness of zero and excess kurtosis of zero*

*$H_a$: The individual stocks do not have a normal distribution*

The JB test is based on a chi-squared test with two degrees of freedom. Therefore, $H_0$ is rejected when the probability of the test does not exceed the 5 percent significance level. The null hypothesis is expected to be rejected. The CAPM will, in that case, not be sufficient as the mean-variance criterion does not hold. (Hill, Griffiths and Lim, 2008)

The output of the JB test will be obtained from EViews.

### 3.1.2 Extending the CAPM

When the null hypothesis is rejected it is essential to assess whether the higher moments of stocks play a role in the pricing of growth and value stocks.

To find an answer to this question, the following hypothesis will be tested:

*$H_0$: Higher moments, skewness and kurtosis, are **not** statistically significant and do **not** contribute significantly to the difference in expected stock returns between value and growth stocks*

*$H_a$: Higher moments are statistically significant and do contribute significantly to the differences in expected stock returns*

To assess the role of higher moments, this research extends the CAPM by incorporating the conditional skewness (co-skewness) and conditional kurtosis (co-kurtosis) into the model. By adding these factors the 3- and 4-moment CAPMs are created, following Fang and Lai (1997), Harvey and Siddique (2000) and Dittmar (2002). Whether this model provides additional explanation must be tested empirically.

#### *3.1.2.1 Fama Macbeth two-step procedure*

In the finance literature the standard practice in testing an asset pricing model empirically is to adopt the Fama MacBeth (1973) two-step estimation procedure (Sylvain, 2013). The Fama Macbeth regression is a procedure to estimate the betas and risk premium (gammas) for any risk factors that are expected to determine asset prices. As the name suggests, two steps are required. The first step is to determine the betas for each risk factor by regressing each asset against the expected risk factors. Before step two can be carried out, the assumption will be made that the estimated betas from the first step agree with the actual unknown betas. In the second step these estimated betas are then implemented to determine the gamma for each factor cross-sectionally, in order to test whether the supposed factors have a significant effect on the returns on average. A factor is considered to be of influence when the corresponding gammas are significantly different from zero. (Sylvain, 2013; Bai and Zhou, 2015) The output of this test will be obtained from EViews.

Unfortunately, the assumption about the betas raises concerns, as the truthfulness of the gammas is affected by the degree of uncertainty related to the betas. When the estimated betas from step one include errors, this introduces errors-in-variables in the second step. The errors-in-variables can cause the precision of the gammas to be overstated. Although this concern should not be taken lightly, without correction, the factors will possibly retain their significance as pricing factors. (Doan, 2011;

Brooks, 2014; Vogelsang, 2012) Therefore, the attempt to correct for the errors-in-variables problem will be left for further research.

So, the risk premia are estimated in two steps. First a time-series regression is conducted to estimate the betas, followed by a cross-sectional regression to estimate the significance of the factors. When the time-series are run for each single sock after which a single cross-sectional regression has to be performed, the specification of the models come into play. The validity of a model can only be trusted when the few required assumptions are true. The first assumption is that the mean of the error term needs to be zero, but because a constant term was included in the model, this assumption is automatically not violated (Brooks, 2014). The second assumption capable of questioning the validity of the model when not met is the assumption of autocorrelation or serial correlation, which means that evidence is found indicating a correlation between the residuals in the regressions. A third important assumption concerns the assumption of homoscedasticity, the assumption that the variance of the error terms over time needs to be zero. Fortunately, the Fama Macbeth two-step procedure ensures that these two assumptions are not violated, by averaging the cross-sectional results (Vogelsang, 2012; Brooks, 2014; Fama and French, 2004). Besides, EViews automatically incorporates Newey-West (HAC) standard errors to correct any additional problems towards heteroskedasticity and autocorrelation (HIS EViews, 2014). Also the independence between the independent variable and the error term, or endogeneity assumption, can be maintained with the used procedure (Lee, Lee and Lee, 2010).

#### *3.1.2.2 'Traditional' CAPM*

The 'traditional' CAPM (CAPM) describes the relation between the expected return and risk of an asset with the formula below:

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f] \tag{1a}$$

Where:

$$\beta_i = \frac{Covariance(R_i, R_M)}{\sigma^2(R_m)} = \frac{E\{[R_i - E(R_i)][R_m - E(R_m)]\}}{E\{[R_m - E(R_m)]^2\}}$$

The expression from equation (1a) can be transformed to a time-series regression (equation 1b) in order to estimate the coefficient $\beta_i$:

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + \epsilon_{it} \tag{1b}$$

With $R_{it} - R_{ft}$ being the excess return or risk premium of asset $i$, $R_{mt} - R_{ft}$ the market excess return, $\beta_i$ the systematic risk, and $\alpha_i$ and $\varepsilon_{it}$ are assumed to be zero according to the model, equation (1b) expresses the excess return of an asset as a combination of the asset's beta and the market risk premium. With the estimated beta it is possible to proceed to the second step, the estimation of the risk premia, or slope, of $\beta_i$. To estimate the risk premia, the regression see below is needed:

$$r_i = \Upsilon_0 + \Upsilon_1 \beta_i + \epsilon_{it} \quad (1c)$$

Where $r_i$ refers to the average excess return of company $i$, $\beta_i$ is the obtained systematic risk from equation 2 and $\Upsilon_0$ and $\Upsilon_1$ are the parameter estimates. The estimated value of $\Upsilon_1$ should be positive and significant, as this indicates a significant role for beta to explain the excess return on the left-hand side of the regression (Bartholdy and Peare, 2005). $\Upsilon_0$ should be zero if the pricing factors are fully able to explain the excess return.

#### *3.1.2.3 Three-moment & Four-moment CAPM*

When evidence indicates that the excess return is not exclusively explained by $\beta_i$, an alternative model should be build, which incorporates other factors. In this paper, following Fang and Lai (1997), Harvey and Siddique (2000) and Dittmar (2002) the 'traditional' two-moment CAPM is augmented by incorporating co-skewness and co-kurtosis, thereby assuming a quartic and cubic stochastic discount factor in the market return.

Taking in mind the co-skewness, the three-moment CAPM (3-CAPM) is given by equation (2a). Considering both the co-skewness and co-kurtosis, the four-moment CAPM (4-CAPM) is given by equation (3c):

$$E(R_i) = R_f + \beta_i b_1 - \gamma_i b_2 \quad (2a)$$

$$E(R_i) = R_f + \beta_i b_1 - \gamma_i b_2 + \delta_i b_3 \quad (3c)$$

Where:

$$b_1 = [E(R_{mt}) - R_{ft}]$$
$$b_2 = [E(R_{mt}) - R_{ft}]^2$$
$$b_3 = [E(R_{mt}) - R_{ft}]^3$$

And:

$$\gamma_i = \frac{Coskewness(R_i, R_M)}{s^3(R_m)} = \frac{E\{[R_i - E(R_i)][R_m - E(R_m)]^2\}}{E\{[R_m - E(R_m)]^3\}}$$

$$\delta_i = \frac{Cokurtosis(R_i, R_M)}{k^4(R_m)} = \frac{E\{[R_i - E(R_i)][R_m - E(R_m)]^3\}}{E\{[R_m - E(R_m)]^4\}}$$

The dependent variable in equation (2a) and (3c) is the expected return, where the parameters $\beta_i$, $\gamma_i$ and $\delta_i$, indicating the co-variance, co-skewness and co-kurtosis risk respectively, represent the independent variables. To estimate the sensitivity of asset returns to the factors related to the market, the co-skewness risk and the co-kurtosis risk, a time-series regression is run:

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i}(R_{mt} - R_{ft}) - \beta_{2i}(R_{mt} - R_{ft})^2 + \varepsilon_{it} \quad (2b)$$

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i}(R_{mt} - R_{ft}) - \beta_{2i}(R_{mt} - R_{ft})^2 + \beta_{3i}(R_{mt} - R_{ft})^3 + \varepsilon_{it} \quad (3e)$$

$R_{it}$, $R_{ft}$ and $R_{mt}$ indicate the return for asset $i$, risk free rate and the return on the market portfolio, respectively. $\beta_{1i}$, $\beta_{2i}$ and $\beta_{3i}$ depict, respectively, the systematic variance, systematic skewness and the systematic kurtosis and are time series regression coefficients of equation (2b) and (3e).

It is important to mention that a caveat is in order as to the signs for the prices of co-skewness and co-kurtosis. Chang, Christoffersen and Jacobs (2010) explain that the guidance from economic theory on the independent variables is poor. Different forms of risk premia are implemented in the asset pricing literature in order to explain the explanatory value of higher moments. In this paper, the risk premia used in the first step of the Fama Macbeth procedure, which is also adopted by recent literature (e.g. Poti and Wang, 2010; Messis and Zapranis, 2014), is based upon older research (Fang and Lai, 1997). That being said, Doan et al. (2010) captures the risk premium related to co-skewness (and co-kurtosis) by taking the difference of the return with the highest co-skewness (co-kurtosis) portfolio and the lowest co-skewness (co-kurtosis) portfolio. Kostakis et al. (2012) also takes a spread return between different skewness and kurtosis portfolios as factors. Another approach is taken by Chang et al. (2010) who take the difference of the skewness of a portfolio and subtract the expected skewness of the previous period. Of course the independent variables chosen to be implemented to estimate the betas for the cross-sectional regression influence the outcome. Choosing a different measure can yield different outcomes and insights regarding the explanatory value of higher moments.

The estimated values of the slope coefficients from equation (2b) and (3e) are implemented as explanatory variables to run the cross-sectional regression below (equation (2c) and (3f) to see whether a factor is significant for the returns.

$$r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \varepsilon_{it} \quad (2c)$$

$$r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \varepsilon_{it} \quad (3f)$$

At equilibrium, the expected excess return, $r$, on any security $i$ is then a function of the parameters $\beta_{1i}$, $\beta_{2i}$ and $\beta_{3i}$. The coefficients $\Upsilon_1$, $\Upsilon_2$ and $\Upsilon_3$ can be interpreted as systematic risk market premia for, respectively, an increase in systematic variance, a decrease in systematic skewness, and an increase in systematic kurtosis. $\Upsilon_0$ represents the constant term, which should be zero in the case of a sufficient model.

Previous empirical research suggests that investors demand a higher risk premium for negative skewness and higher kurtosis. Therefore, if, consistent with previous research, differences in expected returns can be explained by the parameters $\beta_{1i}$, $\beta_{2i}$ and $\beta_{3i}$ the average coefficient estimates of $\Upsilon_1$, $\Upsilon_2$ and $\Upsilon_3$ should be significantly different from zero. In other words, a significant condition for the market, co-skewness and co-kurtosis to be considered pricing factors and the model to be of any use, the hypothesis for $\Upsilon_1$, $\Upsilon_2$, and $\Upsilon_3$, representing the risk premia for the market, co-skewness and co-kurtosis, respectively. The hypothesis for the constant term should not be rejected, as this would imply that the model does not explain all of the returns.

$$H_0\text{: } \Upsilon_0 = 0$$

$$H_0\text{: } \Upsilon_1 = 0$$

$$H_0\text{: } \Upsilon_2 = 0$$

$$H_0\text{: } \Upsilon_3 = 0$$

*3.1.2.4 Interaction effect*

The impact of skewness and kurtosis on asset returns will be determined with the methodology above. However, it is possible that the effect of kurtosis on a stock's return can vary depending on the amount of skewness in the return distribution. Investors have a preference for skewness as this indicates a higher probability of obtaining large gains. Excess kurtosis indicates, through fat tails, the possibility of extreme events, positively or negatively. It may be that the impact of kurtosis on stock returns is depended on the level of skewness. If two independent variables affect the outcome of the dependent variable in a non-additive way, an interaction term needs to be included in the model to capture this effect (Field, 2009). To test whether an interaction is significant, an additional term is added to the regression in which the two interaction variables are multiplied, creating an Interactive 4-CAPM (4i-CAPM). The corresponding regression will be:

$$R_{it} - R_{ft} = \alpha_i + \beta_{1i} b_1 - \beta_{2i} b_2 + \beta_{3i} b_3 + \beta_{4i}(b_2 * b_3) + \varepsilon_{it} \qquad (5a)$$

Where:

$$b_1 = [E(R_{mt}) - R_{ft}]$$
$$b_2 = [E(R_{mt}) - R_{ft}]^2$$
$$b_3 = [E(R_{mt}) - R_{ft}]^3$$

The cross-sectional regression that follows (equation 9):

$$r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \Upsilon_4\beta_{4i} + \varepsilon_{it} \tag{5b}$$

Of course the implementation of an interaction term changes the manner in which all coefficients should be interpreted. In the 4-CAPM, all coefficients had a unique and individual effect on the excess return of stocks. In equation (9) two coefficients lose their unique qualities and are instead (partly) depended on each other, only when one of the variables is zero, the uniqueness returns. This paper expects that fat tails should increase the chance of large gains more for a positively skewed stock return distribution than for a symmetrical return distribution, indicating less kurtosis-averse investors or possibly even investors who prefer kurtosis when a stock return distribution exhibits positive skewness. To check the use of this model and the effect of the pricing factors, the following hypothesis will be tested:

$$H_0\colon \Upsilon_0 = 0$$
$$H_0\colon \Upsilon_1 = 0$$
$$H_0\colon \Upsilon_2 = 0$$
$$H_0\colon \Upsilon_3 = 0$$
$$H_0\colon \Upsilon_4 = 0$$

### 3.1.3 CAPM vs. 3-CAPM vs. 4-CAPM vs. 4i-CAPM

Theoretically, the 4i-CaPM should outperform the 4-CAPM, which should in turn perform better than the 3-CAPM and the CAPM in explaining stock returns of growth and value stocks. The evaluation of the models will be based on the adjusted $R^2$ and the Akaike Information Criterion (AIC).

The $R^2$ is a simple statistical measure that tells us how well a model fits the data. The more this number approaches to 1, the more variability is accounted for. So, the model with the highest $R^2$ explains the most and is superior to the other. A limitation of the $R^2$ is that it automatically increases when more parameters are added to a model. The adjusted $R^2$ can fix this problem as it is a measure of goodness of fit derived from $R^2$, but adjusted for the number of predictors in the model. A negative $R^2$ indicates that the model does not fit the data well. (Field, 2009)

Another goodness-of-fit measure is the AIC, based on the residual variance. Unfortunately, the residual variance has a negative correlation with the number of parameters used. This measure takes the complexity of a model into account, giving a penalty for the amount of parameters estimated. The smaller the value of AIC, the better a model fits. It should be noted that the AIC is not a test to see whether a model is significant or significantly better than another model. The AIC is only useful as a way of comparing models. (Field, 2009 and Vogelvang, 2005)

## 3.2 Data

The data is constructed based on growth and value stocks traded on NYSE, AMEX and NASDAQ from the period of April 2009 to March 2014, and thus covers most of the recent financial crisis. The data will be extracted from CRSP/COMPUSTAT database because of the large amount and completeness of the data available and because it automatically excludes companies not listed on the stock exchanges during this period. This implies that the empirical analysis will be based on secondary data, as it is collected by someone else.

The large literature engaged in asset pricing, specifically the literature incorporating skewness and kurtosis, sort stocks into portfolios in order to test the risk-return relationship. The motivation behind portfolios stems from the estimation errors in betas, which can be diversified away by aggregating stocks. A huge amount of research follows the method of Fama and French (1996) and creates for example book-to market deciles portfolios. Ang, Liu and Schwarz (2008) show and confirm empirically that this motivation is false, by arguing that information is lost with the aggregation of stocks which results in larger standard errors of the risk premia. Another approach in testing asset pricing models is to use individual stocks. Tests become more efficient in answering whether factors are priced when working with individual stocks (Ang et al., 2008).

In this study, 50 value and 50 growth stocks will be picked, identified the companies book-to-market (BM) ratio and price-to-earnings (PE) ratio. The reason for the use of two different ratios is to create additional groups so that the consistency of the results can be checked. In order to calculate these ratios, the annual accounting data from companies listed in America is necessary, the data is obtained from COMPUSTAT, a database consisting of annual data of listed American companies.

The BM is a ratio that divides the book value of equity by the market value, thereby creating a ratio for the separation of value from the growth stocks, and is often used in the literature (Zhang, 2013). The economic logic behind this ratio lies in the valuable growth options a company has relative to its assets-in-place. Growth options raise a company's stock price, so relatively more (less) growth options will result in a low (high) BM (Harris and Marston, 1994). The lowest (highest) ratio acts as a proxy for growth (value) stocks. The BM ratio is calculated following the Fama methodology[4] which calculates the book value of equity as book equity + deferred taxes and investment credit -/- preferred stock, the market value equals the outstanding shares * closing price at fiscal year-end.

The PE ratio is another ratio that can distinguish the value from the growth stocks. By comparing the stock price of a company with its earnings per share, this ratio represents the perceptions of investors towards a company's current and future earnings. A high PE ratio can be interpreted as a positive indication for the future earnings and growth prospects of a company. Consequently, growth (value) stocks can be identified by a high (low) PE ratio. (Bodie, Kane and Marcus, 2009). Both components, price close and earnings per share, of the PE ratio can be obtained directly from CRSP/COMPUSTAT.

The financial firms will be excluded from both the BM data set and the PE data set, as a healthy balance sheet from a financial firm probably does not resemble a healthy balance sheet from a nonfinancial firm (Fama and French, 1992). Besides, in the BM data set, the book value of equity may not be negative, whereas the earnings may not be negative in the PE data set. The negative values will make it difficult to identify a growth from a value company and will distort the statistics of the data sets. A company with a negative book value of equity may have got many growth options in the future, but it is also possible that this company is in distress without any growth options. The same reasoning holds for negative earnings. Furthermore, to reduce the impact of the extreme ratios due to the misalignment of the measurement dates of book value and market value or due to indications of potential distress or exceptional growth, as well as the effect of accounting conservatism, the ratios are winsorized at the top and the bottom 5 percent.

After the necessary adjustments are completed, the top and bottom 25 stocks of 2012 in each database are selected to represent growth and value stocks. The stocks selected in this paper have to satisfy a number of conditions, each company not fulfilling a condition will be removed from the top or bottom:

- The fiscal year must end in December due to comparability reasons;
- Following Zhang (2013), a gap of four months is demanded between fiscal end and the first returns taken into account to make sure that the accounting information was incorporated by the market. Therefore, the stock returns from the end of April 2009 will be the first ones considered;
- All accounting information must be available during the entire period.

[4]Kenneth R. French - Data Library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html

- The standard frequency and time period used in the literature for the estimation of asset pricing models is monthly data dating back 5 years (60 months) (Bartholdy and Peare, 2005). A stock should have return data available for 60 consecutive months.

This paper will extract monthly returns by using end of month prices including dividends. The return of each stock is calculated by the following formula:

$$R_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \qquad (6)$$

The CAPM is clear on the market portfolio, which should consist of all assets in the world. As it is impossible to create such a portfolio a proxy should be used. The most commonly considered proxy for the market return is the value-weighted Standard and Poor's Composite Index (S&P Composite) (Bartholdy and Peare, 2005). To proxy for the risk-free rate, the 1 month US Government Treasure Bill yield will be adopted.

### 3.2.1 Descriptive statistics

A summary of the statistics with regard to the individual stocks for the entire sample period is presented in tables 3.1 to 3.4. Table 3.1 can be found below, whereas tables 3.2 to 3.4 are in the Appendix.

#### *3.2.1.1 Book-to-market ratio*

Table 3.1 and 3.2 show the statistics for respectively the growth and value stocks based on the BM ratio. The industries, based on the two-digit SIC codes, containing the growth and value stocks immediately stand out. Most of the growth stock, no less than 80% (20 out of 25), finds their primary business in the manufacturing industry. The value stocks are more spread across various industries, with 20% in the mining industry, an industry not found within the growth stocks. The tables show an average return for growth stocks, which is higher than the average return of value stocks, 3.28% and 1.45% respectively. This is remarkable as, according to the value anomaly, value stocks should outperform growth stocks. Furthermore, both the minimum and the maximum average are larger for value stocks, even the biggest increase in a monthly return comes from a value stock with an incredible 245% increase in one month. Stocks with positively skewed distributions are, according to the theory, preferred by investors who should be willing to pay more for such stocks. The theory also states that growth stocks should possess such distributions. From the tables 1 and 2 you can conclude that nearly all stocks have positively skewed distributions, consistent with the findings of Zhang (2013). However, the skewness is more than twice as big for value stocks compared to growth stocks, 0.910 and 0.437

correspondingly. These averages are inconsistent with Zhang (2013), who finds that the mean return of growth stocks is lower with higher positive skewness than value stocks. The positive skewness is only 0.15 compared to 0.11, which is substantially lower than the skewness found in Table 3.1 and 3.2, but the difference is significant in the research of Zhang (2013). The skewness averages are, on the other hand, much lower than the averages from Trigeorgis and Lambertides (2014), who report an average of 2.056. Also Larson (2005) reports significantly higher skewness for growth stocks compared to value stocks. Additionally, other papers form portfolios based on the BM ratio and although the value anomaly is not the primary subject of those researches, the statistics can potentially reveal additional valuable information. The skewness found in the different portfolios is not higher for portfolios with a lower BM ratio, consistent with the statistics from this paper (Lin and Wang, 2003; Harvey and Siddique, 2000; Heaney, Lan and Treepongkaruna, 2011). When looking at the average kurtosis, the tables show higher kurtosis for value stocks compared to growth stocks, with kurtosis as high as 27.386. Nearly all stocks show excess kurtosis, indicating peaked distributions with fat tails. The higher skewness for value stocks could potentially explain the lower returns, although the larger excess kurtosis could nullify this effect.

In order to answer the first hypothesis of this paper, whether the distributions are normally distributed, the results of the JB tests are presented. Less than half of the growth stocks have a nonnormal return distribution whereas only 9 value stocks have a normal return distributions. It can be concluded that for 27 out of the 50 stocks the CAPM is insufficient as a pricing model as the assumption of normal return distributions is violated. This violation provides the necessary grounds to test whether the inclusion of higher moments help to explain variations of asset returns.

#### *3.2.1.2 Price-to-earnings ratio*

The statistics of the growth and value stocks classified on the PE ratio are presented in Table 3.3 and 3.4. The average PE ratios of growth stocks, 90.961, and value stocks, 5.667, are in line with other research (Chahine, 2008). Furthermore, although less conspicuously, also for these growth stocks, more than half (13 out of 25) work in the manufacturing industry. Where the growth stocks based on the BM ratio did not find a single company in the mining industry, four growth stocks classified on the PE ratio are mining companies primarily engaged in the oil & gas extraction. The identification of growth stocks in this industry is unexpected, as this industry has been around for a long time and is generally considered a mature industry, which is characterized by few growth opportunities (Johnson, Kerr and Side, 2013). Here the average returns are, in accordance to the value anomaly, higher for value stocks, 3.72%, than for growth stocks, 2.79%. Consistent with the BM stocks, the positive skewness and excess kurtosis is higher for the value stocks compared to the growth stocks. For the value stocks classified on PE, both the skewness and kurtosis are substantially larger, 89.3% and 53.1% respectively. Considering the preference for skewness and the aversion for kurtosis, this can potentially explain the average returns close to each other. Evidence in favor of the theory of the interaction effect between positive skewness and kurtosis has not been found so far.

The hypothesis of the JB test is only rejected for 7 growth stocks as opposed to 16 for the value stocks. Although less stocks do not have a normal return distribution for the stocks classified on the PE ratio, the testing of the higher moments CAPM can be justified.

#### *3.2.1.3 Equal-weighted Portfolios*

Table 3.5 presents the statistics of the four equal-weighted portfolios, which show interesting results. With the Welch t-test, the equality of means was tested between the two different value and growth portfolios. The Welch t-test is preferred above the standard t-test as the equality of variances is unexpected (Field, 2009). The statistics show that the null hypothesis of equal means cannot be rejected and as a result it can be assumed that for the portfolios created there is no substantial and statistical difference in the means between growth and value portfolios. However, a value effect was expected, indicating a higher return for value portfolios. On the other hand, it is not inconsistent with other research, as , for example, Doan et al. (2010) created portfolios based on the BM ratio and do not find noteworthy differences between the high and low portfolios. The standard deviations are much lower for the portfolios than the averages of the individual stocks, indicating a lower variation of returns. Besides, the skewness is higher for both growth portfolios compared to the value portfolios, which is consistent with the theory and the literature. An additional interesting outcome is presented by the JB tests. Three of the four portfolios show normal return distributions, and the only portfolio not matching a normal return distribution is the growth portfolio classified by the PE ratio, the same portfolio with the most amount of stocks exhibiting normal return distributions.

These statistics demonstrate the importance in the decision whether to test an asset pricing model with portfolios or with individual stocks.

In summary, four models will be tested using the Fama Macbeth procedure: the CAPM, 3-CAPM, 4-CAPM and the 4i-CAPM, where co-skewness is added as a pricing factor in the 3-CAPM, co-skewness and co-kurtosis are added in the 4-CAPM and the 4i-CAPM includes an interaction term compared to the 4-CAPM. The Fama Macbeth procedure will calculate the coefficients for the corresponding risk factors, which should be significantly different from zero for a factor to be of influence on the stock returns. The performance of the different models will be tested using two tests: the $R^2$ and the AIC.

The models will be tested on individual stocks, specifically chosen for this study and divided into 4 groups of 25 stocks: 25 growth and 25 value stocks based on the BM ratio, and 25 growth and 25 value stocks classified by the PE ratio. Although the null hypothesis of the JB test cannot be rejected for all stocks as not all stocks show a nonnormal return distribution, the descriptive statistics of the four groups of stocks suggest that the mean and variance might not be enough to justify variations in all stock returns. This provides the necessary reasoning to assess whether the higher moments can potentially fill this gap.

# Table 3.1 - Characteristics of BM growth stocks

This table reports the 25 handpicked growth stocks, the industry and their statistics based on their BM ratio. The period is from April 2009 to March 2014. The normality test is based on the Jarque-Berra statistics. The symbols ** and *** referrer respectively to the levels of significance of 5% and 1%.

## Growth stocks - BM

| Company name | Industry | | Ratio | Mean | Median | Maximum | Minimum | Std Dev | Skewness | Kurtosis | Jarque-Bera | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Achillion Pharmaceuticals | Manufacturing | Chemicals | 0.113 | 3.40% | 0.22% | 24.60% | -17.43% | 0.210 | 0.245 | 3.062 | 0.609 | |
| Alexion Pharmaceuticals | Manufacturing | Chemicals | 0.109 | 3.86% | 4.75% | 48.10% | -53.18% | 0.080 | -0.239 | 4.291 | 4.738 | |
| Alliance Data Systems Corp | Services | Business | 0.112 | 3.67% | 2.66% | 25.96% | -21.00% | 0.077 | 0.111 | 2.937 | 0.133 | |
| AmBev | Manufacturing | Food and Kindred | 0.111 | 3.30% | 3.32% | 23.82% | -15.77% | 0.082 | -0.269 | 2.580 | 1.167 | |
| Apricus Biosciences | Manufacturing | Chemicals | 0.111 | 4.66% | -0.64% | 19.91% | -15.68% | 0.318 | 1.053 | 4.591 | 17.407 | *** |
| ARM Holdings | Manufacturing | Electronics | 0.113 | 4.63% | 5.27% | 94.92% | -60.42% | 0.092 | -0.110 | 2.716 | 0.324 | |
| AtriCure | Manufacturing | Measuring Instruments | 0.107 | 5.88% | 5.04% | 98.36% | -17.59% | 0.182 | 2.319 | 12.382 | 273.830 | *** |
| CEB Inc | Services | Engineering/Accounting | 0.111 | 3.34% | 3.38% | 40.58% | -28.24% | 0.097 | -0.033 | 3.229 | 0.141 | |
| Cepheid | Manufacturing | Measuring Instruments | 0.110 | 4.01% | 3.44% | 72.06% | -26.75% | 0.113 | 0.365 | 4.345 | 5.853 | |
| Cerus Corp | Manufacturing | Chemicals | 0.108 | 4.90% | 1.75% | 62.42% | -43.50% | 0.192 | 1.166 | 5.027 | 23.864 | *** |
| Cleveland Biolabs | Manufacturing | Chemicals | 0.106 | -0.37% | -0.64% | 19.02% | -22.80% | 0.187 | 0.169 | 4.478 | 5.749 | |
| CPSI Inc | Services | Business | 0.106 | 1.78% | 2.51% | 28.06% | -19.02% | 0.083 | -0.509 | 3.331 | 2.862 | |
| Cypress Semiconductor | Manufacturing | Electronics | 0.116 | 1.47% | 0.69% | 28.26% | -23.03% | 0.110 | 0.022 | 2.491 | 0.653 | |
| Endologix Inc | Manufacturing | Measuring Instruments | 0.107 | 4.03% | 1.97% | 51.58% | -23.90% | 0.146 | 0.772 | 4.430 | 11.070 | *** |
| Glaxosmithkline | Manufacturing | Chemicals | 0.106 | 1.45% | 1.32% | 13.67% | -9.04% | 0.046 | 0.258 | 3.173 | 0.740 | |
| Loral Space & Communications | Manufacturing | Electronics | 0.113 | 3.64% | 3.02% | 33.14% | -18.72% | 0.110 | 0.687 | 3.788 | 6.274 | ** |
| Masco Corp | Manufacturing | Fabricated Metal | 0.111 | 2.84% | 2.03% | 46.19% | -19.73% | 0.123 | 0.839 | 4.859 | 15.679 | *** |
| Microvision Inc | Manufacturing | Electronics | 0.105 | 0.13% | -5.33% | 70.59% | -39.25% | 0.254 | 0.976 | 3.613 | 10.463 | *** |
| Newmarket Corp | Manufacturing | Chemicals | 0.114 | 4.47% | 3.65% | 42.21% | -21.39% | 0.104 | 0.697 | 5.188 | 16.831 | *** |
| Pain Therapeutics Inc | Manufacturing | Chemicals | 0.110 | 3.01% | 3.53% | 39.77% | -61.11% | 0.173 | -0.741 | 5.198 | 17.568 | *** |
| Rollins Inc | Services | Business | 0.110 | 1.91% | 1.67% | 16.41% | -10.52% | 0.054 | 0.363 | 3.068 | 1.330 | |
| Sherwin-Williams | Manufacturing | Chemicals | 0.113 | 2.52% | 2.21% | 15.35% | -9.71% | 0.053 | 0.023 | 2.703 | 0.226 | |
| Sinclair Broadcast Group | Transportation | Communications | 0.114 | 7.38% | 4.58% | 58.56% | -19.98% | 0.175 | 1.046 | 3.777 | 12.445 | *** |
| Sturm, Ruger & Co. | Manufacturing | Fabricated Metal | 0.109 | 3.89% | 3.28% | 39.20% | -31.15% | 0.131 | 0.081 | 3.206 | 0.172 | |
| Xoma Corp | Manufacturing | Chemicals | 0.108 | 2.31% | 0.69% | 115.55% | -46.65% | 0.269 | 1.648 | 7.803 | 84.836 | *** |
| **Average** | | | 0.110 | 3.28% | 2.17% | 45.13% | -27.02% | 0.139 | 0.437 | 4.251 | | |

# 4. Empirical Results and Discussion

This section presents and discusses the empirical results based on the methodology described above. The methodology of Fama and Macbeth (1973) was conducted to determine the significance of the different moments on a return distribution by performing four cross-sectional regressions. The most important question to answer when different asset pricing models are being tested is whether the beta risk of a factor is priced, or, in other words, if the risk premium linked to a certain factor is significantly different from zero (Kan and Zhang, 1999). The regressions are based on 100 stocks, each with 60 monthly returns, split into 4 different groups. Two groups of growth stocks and two groups of value stocks, identified by the BM and the PE ratio. After the 4 groups of stocks are tested, 4 additional tests are being performed to test the consistency of the results. The first two tests will be performed on all the growth combined and all the value stocks combined. Next, the stocks with a normal distribution are removed from the database, where after the final tests will be carried out.

## 4.1 Asset Pricing Models BM ratio

Table 4.1 shows the regression results for the different asset pricing models based on individual growth and value stocks classified by the BM ratio. The left side reports the averages of the $\Upsilon$coefficients for four cross-sectional regressions of the growth stocks, whereas the right side reports the $\Upsilon$coefficients of the value stocks. A summary of the coefficients can be found in Table 4.3 and of the measurement statistics in Table 4.4.

### 4.1.1 Constant term

The first row shows the constant, or $\Upsilon_0$, for the different asset pricing models. It is expected that the excess returns of individual assets can be fully explained by the pricing factors obtained in the different asset pricing models. Therefore, according to the theory of an asset pricing model, this constant should be zero, as it otherwise indicates an incomplete model. From Table 4.1 it can be deduced that for the growth stocks all constant terms are significantly different from zero, whereas the coefficient is not significantly different from zero for the value stocks. This result implies that some part of the return of growth stocks in excess of the risk-free rate is not explained by any of the four asset pricing models. The direct opposite applies for value stocks.

*The null hypothesis of the $\Upsilon_0$ coefficient is not rejected for any of the growth stock models, but is rejected for all value stock models.*

The outcomes on the intercept obtained from the growth stocks are inconsistent with Messis, Iatridis and Blanas, (2007), Fang and Lai (1997), Javid (2009) and Doan and Lin (2012). Doan et al. (2010) even run regressions for both the US and the Australian market and for both markets the authors report mostly insignificant intercepts. The results, which mostly indicate insignificant constants, imply complete models. However, not all the constants are insignificant in those researches and the results from Sihem and Slaheddine (2014) tell a different story, as the constants in their research are all significantly different from zero. The opposite results for the intercept of growth stocks compared to value stocks in this research are abnormal, especially considering the non-existence of differences in the means between the two portfolios. Even more, constant terms significantly different from zero are predicted for the CAPM, as empirical research showed that the mean-variance framework was violated as well as the incapability of the beta to explain the value effect. The findings in table 4.1 display differences, but also, based on the zero value of the value stocks constant term, a complete explanatory CAPM.

#### 4.1.2 Beta

The risk premium for the second moment, co-variance, should, according to the theory, be positive and significant. Although insignificant for most of the models for growth and value stocks, for all models the risk premium show a positive relation. Aforementioned, this indicates that the higher the variance is in comparison to the market, the higher the perceived risk and the more return is demanded by investors.

*The null hypothesis of the $\Upsilon_1$ coefficient cannot be rejected for all growth stock models, and can only be rejected for the 4i-CAPM of value stock models.*

The results are consistent with other literature (Fama and French, 1992; Doan et al., 2010; Fang and Lai, 1997; among others). However, as stated by Kan and Zhang (1999), for a one-factor asset pricing model (e.g. the CAPM), the primary interest is focussed on whether the hypothesis $\Upsilon_1 = 0$, can be rejected. The hypothesis cannot be rejected for the CAPM or the other models, from which can be concluded that the pricing of systematic risk may not explain variations of stock returns in these models.

#### 4.1.3 Third moment

The quadratic market model, the 3-CAPM, includes the third moment in the regression, assuming that investors take co-skewness into account. The risk premia for co-skewness $\Upsilon_2$, is, in line with the theory, negative for all models. This suggest a preference for positively skewed stocks, were it not that the only significant coefficient, at the 1% significance level, is in the 3-CAPM for value stocks. This observation indicates that co-skewness is not priced in any of the growth stock models as well as the 4-and 4i-CAPM of value stock models.

*The null hypothesis of the $\Upsilon_2$ coefficient cannot be rejected for all growth stock models, and can only be rejected for the 3-CAPM of value stock models.*

The insignificance of skewness risk premia also occurs in other research. For example Fang and Lai (1997) report, in consistence with even older research, a risk premium for co-skewness not significantly different from zero. Javid (2009) finds significant co-skewness risk premia for half of the periods in the 3-CAPM, both for monthly and daily returns, for 5 out of 7 periods in the monthly 4-CAPM and only for 3 periods in the daily 4-CAPM. Except for one, all of the risk premia in those results are positive, implying that "*an investor is rewarded with positive premium for coskewness risk"* (Javid, 2009, p. 9). The regression results of Doan and Lin (2012), which are in consistence with Doan et al. (2010), lead them to conclude that the most important role in explaining variations in returns of stocks listed in Australia is reserved for systematic skewness. Harvey and Siddique (2000) estimate risk premia with cross-sectional regressions using individual stock returns and find the risk premia signs to be as predicted and significant for the whole sample. Upon a closer look, in the unreported estimates, the premium becomes insignificant for the sample with returns between 60 and 90 months. Their results suggest that skewness does not appear to be useful in the explanation of stock returns when the length of return history is considered.

#### 4.1.4 Fourth moment

The next asset pricing model is the 4-CAPM, which extends the 3-CAPM by including co-kurtosis as a pricing factor in the model. A different sign can be observed between growth and value stocks, showing a positive and negative sign respectively. In the trade-off for portfolio selection the minimizing of kurtosis in the return distribution is anticipated, so that a positive sign for the risk premia is expected. Given the fact that this is not the case for value stocks while the co-kurtosis coefficient in the 4i-CAPM is the only significant coefficient of the four co-kurtosis premia, it contradicts the expectation on the relationship between returns and kurtosis. On the other hand, considering the fact that nearly all value stocks are characterized by positive skewness, excess kurtosis could be considered as positive by investors. This presumption will be further tested in the 4i-CAPM. In the end, the result do confirm, partly, that the co-kurtosis factor has a significant explanatory ability, as it implies that an increase of one in co-kurtosis translates to a monthly decrease in stock return of 0.0033% or 0.040% per annum.

*The null hypothesis of the $\Upsilon_3$ coefficient cannot be rejected for all growth stock models, and can only be rejected for the 4i-CAPM of value stock models.*

The results concerning co-kurtosis are both consistent and in contrast with findings of other researches. In the paper of Kostakis et al. (2012) results of co-kurtosis are presented, also with opposite coefficients for different portfolios. On the other hand, the signs forecasted by the theory are in this case the significant ones. Poti and Wang (2010) find significant but negative co-kurtosis betas and Doan et al. (2010) report weak evidence in favour of the anticipated co-kurtosis effect, especially for the Australian market. A lot of research finds a positive co-kurtosis coefficient, although not all of the coefficients are significant (Fang and Lai, 1997; Javid, 2009; and Sihem and Slaheddine, 2014). Interestingly, Doan and Lin (2012) find evidence suggesting systematic kurtosis to be a robust risk measure for Australian stocks, thereby directly contradicting Doan et al. (2010).

#### 4.1.5 Interaction term

The final model regressed is the 4i-CAPM, which includes the interaction between co-skewness and co-kurtosis as a factor. Table 4.1 shows the results, indicating a negative premium for the interaction term in case of value stocks. This result was predicted as the sum of a negative premium for skewness and the positive premium for kurtosis should equal a negative premium. Also, the coefficient is highly significant with a p-value of 0.001, suggesting a prominent role for the interaction effect as a risk measure for value stocks listed on the US stock market. Furthermore, the co-kurtosis coefficient decreases by 0.0006% compared to the 4-CAPM for value stocks and becomes significant. The effect of co-skewness becomes higher as the coefficient decreases from -0.036% to -0.063%, although the explanatory power continues to be insignificant.

*The null hypothesis of the $\Upsilon_4$ coefficient cannot be rejected for the growth stock model, but is rejected for the value stock model.*

#### 4.1.6 Model performance

So far, the results of the different factors have been discussed individually. In order to explain what in the end the superior model is, the four different models have to be discussed as well. The selection of the best model will be based on two measures: the adjusted $R^2$ and the Akaike Information Criteria (AIC). The adjusted $R^2$ is used more often in the comparison of performances (Doan and Lin, 2012; Bartholdy and Peare, 2005; Harvey and Siddique, 2000; Fang and Lai, 1997), although the AIC is also considered to be a popular measure (Chaibi and Ben Naceur, 2010; Chen, 2003; Başçi and Zaman, 1998).

The two bottom lines in Table 4.1 show the mentioned fitness measures. Published research find evidence in favour of the increasing power of a model when higher moments are included. Fang and Lai (1997) report the highest adjusted $R^2$ for the 4-CAPM in all three time periods, in one period even showing an increase of over 20% compared to the CAPM. Similar to Fletcher and Kihanda (2005), Doan and Lin (2012), Doan et al. (2010) and Ditmar (2002) the table reports, for value stocks, a higher adjusted R2 and lower AIC measure for the 4-CAPM, indicating superiority over the 3-CAPM and

CAPM. Where the CAPM even has a negative adjusted $R^2$, the measure increases with 20% with every higher moment. For value stocks the results are in line with expectations, as the highest $R^2$ and lowest AIC are reserved for the 4i-CAPM. The goodness-of-fit measures of growth stocks are entirely different, with the negative $R^2$ values jumping out. These negative values imply that none of the four factors contribute in the explanation of returns and so all of the models do not fit the data. Besides, consistent with Chaibi and Ben Naceur (2010), the AIC is lowest for CAPM compared to the 3-and 4-CAPM. For growth stocks based on the BM ratio it can be concluded that including moments does not improve the explanatory power of an asset pricing model.

Overall, the findings suggest that co-skewness, co-kurtosis and the interaction term have an explanatory ability for the variations of value stocks. The results further suggest that the higher moment factors do not seem to matter in the pricing of growth stocks.

## 4.2 Asset Pricing Models PE ratio

The regression results for the monthly returns of value and growth stocks classified by the PE ratio are presented in Table 4.2. Similar to Table 4.1, the gammas of the growth stocks can be found on the left side and the gammas of the value stocks on the right side of the table. A summary of the coefficients can be found in Table 4.3 and of the measurement statistics in Table 4.4.

### 4.2.1 Constant term

Consistent with the results of the BM based stocks, the growth and value stocks based on the PE ratio display significantly and insignificantly different from zero constant terms, respectively. This result implies that for all four asset pricing models some part of the return of growth stocks in excess of the risk-free rate is not explained. However, the $\Upsilon_0$ of PE based growth stocks are less insignificant and the coefficients are smaller than for BM based growth stocks for every model. For this reason, the models seem to provide better descriptions of the returns. The constant terms of value stocks are not significantly different from zero indicating good descriptive models for the returns of value stocks.
*The null hypothesis of the $\Upsilon_0$ coefficient is not rejected for any of the growth stock models, but is rejected for all value stock models.*

### 4.2.2 Beta

The systematic risk factor is highly significant, all at the 1% significance level, and seems to be important in every model of value stocks, consistent with the expectations, and even showing a higher premium and higher significance when factors are added. This is in contrast to the $\Upsilon_1$ coefficients of growth stocks, which show the exact opposite. In the CAPM the $\Upsilon_1$ coefficient has a value of 0.8% and is significant, at the 10% significance level, but adding higher moments causes the term to become smaller and insignificant. Only for the CAPM evidence can be found in favour of the explanatory value for the returns of growth stocks by the systematic risk.

*The null hypothesis of the $\Upsilon_1$ coefficient can only be rejected for the CAPM growth stock model, and can be rejected for all value stock models.*

#### 4.2.3 Third moment

The risk premia of co-skewness, or $\Upsilon_2$, is negative and in line with expectations for value stocks. Nevertheless, the coefficients are not significantly different from zero suggesting a minor role for the third moment of a return distribution. In fact, the only time a coefficient of co-skewness is significant, at the 10% significance level, for value and growth stocks classified by the PE ratio is in the 4i-CAPM of growth stocks. This significant and positive coefficient implies an aversion towards positive skewness, which is in contrast with the theory. Lehnert et al. (2014) provide a potential explanation for this result, by concluding that investors can substantially weaken the trade-off between skewness and return when they find themselves in periods of low risk aversion. Besides, they show a negative correlation between jump sizes and the skewness risk premium. This could indicate that positive jump sizes in growth stocks go hand in hand with a negative skewness risk premium, or a positive skewness coefficient. Unfortunately, this is only a theory, which cannot be verified by the results displayed.

*The null hypothesis of the $\Upsilon_2$ coefficient can be rejected for the 4i-CAPM of growth stock models, and cannot be rejected for the three value stock models.*

#### 4.2.4 Fourth moment

The results for the asset pricing models including the fourth moment, co-kurtosis, show that the expected excess return is not only explained by the second moment. The results further indicate that investors receive compensation for carrying a higher level of kurtosis risk. Besides, the pricing of kurtosis seems to be very consistently priced, with a premium between the 0.065% and 0.078% per annum.

*The null hypothesis of the $\Upsilon_3$ coefficient is rejected for all models.*

This result is in contrast to the results of Doan and Lin (2012) who find that skewness is more consistently priced. Interesting to note are the opposed signs for the different classifications of value and growth stocks. Where the sole significant risk premium of co-kurtosis for BM based stocks was negative, the coefficients for co-kurtosis for PE based stocks are, in line with the theory, positive and significant.

### 4.2.5 Interaction term

In the 4i-CAPM column of Table 4.2, in explaining return differences explained by the interaction term, the results are displayed. The theory suggested a negative premium, but both of the coefficients are positive and insignificant, implying that an interaction between co-skewness and co-kurtosis is rejected based on these models.

*The null hypothesis of the* $\Upsilon_4$ *coefficient cannot be rejected for any of the two models.*

Actually, the theory of the interaction term suggests a sign similar to the sign of the co-skewness coefficient. Although this is true for BM based value stocks and PE based growth stocks, the interaction term coefficient has the same positive or negative sign as all co-kurtosis coefficients. This observation is surprising as this insinuates that the effect of co-kurtosis exceeds the effect of co-skewness when interacted. In other words, in the case of excess kurtosis, a premium will always be demanded, whether a stock return distribution exhibits positive or negative skewness.

### 4.2.6 Model performance

At the bottom of Table 4.2, the two measures used to identify the best performing model are shown. Considering growth stocks, both the measures worsen with the inclusion of higher moments, although the measures of the adjusted $R^2$ remain largely unchanged. The adjusted $R^2$ decreases from 8.6% for the CAPM to 6.5% for the 4-CAPM and the AIC increases going from the CAPM to the 4-CAPM displaying -5.442 to -5.350, respectively. Interestingly, looking at the adjusted $R^2$ measure, the 4i-CAPM seems to explain nearly four times as much as the second best model, which is the CAPM. The large increase in the adjusted $R^2$ as well as the lowest AIC demonstrates that the addition of the interaction term to the model is desired. The values of the goodness-of-fit measures are different for the value stocks and may tell a different story. The systematic risk is very significant in all of the models and the inclusion of the higher conditional moments seem to increase the explanatory power of the CAPM as the adjusted $R^2$ increases with an amount of 12% to 17.9%. The best model is in this case the 3-CAPM. Comparing the performances of models tested on growth and value stocks classified by the PE ratio, both show the importance of including higher moments in an asset pricing model.

Below are Tables 4.3 and 4.4 presented. These tables show both a summary of the results found. Table 4.3 shows a summary of the coefficient results, whereas Table 4.4 displays the findings of the measurement statistics $R^2$ and AIC.

## Table 4.3 - Summary table of data obtained by regressions

A visualization of the data is presented in this table. The expected and actual coefficient results are given for all 5 factors for every group of stocks.

| Pricing factor | Expected by theory | Growth | | Value | |
|---|---|---|---|---|---|
| | | BM | PE | BM | PE |
| Constant | Coefficient should be zero | Positive<br>Sig | Positive<br>Sig | Positive<br>Insig | Positive<br>Insig |
| Co-variance | Coefficient should be positive<br>and significantly different from zero | Positive<br>Insig | Positive<br>Only sig CAPM | Positive<br>Only sig 4i-CAPM | Positive<br>Sig |
| Co-skewness | Coefficient should be negative<br>and significantly different from zero | Negative<br>Insig | Positive<br>Only sig for 4i-CAPM | Negative<br>Only sig for 3-CAPM | Negative<br>Insig |
| Co-kurtosis | Coefficient should be positive<br>and significantly different from zero | Positive<br>Insig | Positive<br>Sig | Negative<br>Sig except for 4i-CAPM | Positive<br>Sig |
| Interaction term | Coefficient should be the same as the co-skewness sign<br>and be significantly different from zero | Positive<br>Insig | Negative<br>Insig | Positive<br>Sig | Positive<br>Insig |

## 4.3 Robustness Checks

This section will complement the results presented by running additional regressions to check the robustness, or correctness, of the results. A robustness check is an examination of the behavior of the regression coefficients when the tests are being altered (Lu and White, 2014). The outcomes of a test are said to be robust when the outcomes of the check provide similar insights into the problem as before. The value of a dataset only becomes apparent after the right tests are carried out, meaning that they are jointly responsible for the empirical results found (Heckman, 2005). This paper will check for robustness by altering the datasets used. The Fama Macbeth procedure is repeated with a dataset containing all of the returns of either the growth companies or the value companies from the different ratios. Finally, a last test will be performed on only the growth or value stocks exhibiting nonnormal return distributions. The reasoning behind this alteration is that the main theory followed in this paper is based on the difference between growth and value stocks with respect to the higher moments in the return distributions. Therefore, assuming the ratios for the classification of growth and value stocks do not provide very different companies, the coefficients should not change when a database contains all of the growth or value companies together. Besides, the removal of companies with a normal return distribution from the dataset will leave only companies which return variations should be more depended on higher moments.

### 4.3.1 Combining datasets

Combining the growth stocks will lead to a database containing 50 different companies, whereas the combination of value stocks will provide a database with 49 different companies, due to the fact that Stealthgas Inc. is present in both value stock samples. Excluding companies exhibiting normal return distributions from the databases leaves 18 growth companies and 32 value companies. The coefficients of the regressions are presented in Table 4.5 and 4.6, for the whole and nonnormal databases, respectively.

After the evaluation of the newly presented coefficients (Tables 4.5 and 4.6), the results seem to come across as robust. The performances of the asset pricing models do not seem to improve for growth stocks, as the estimated risk premia are nearly all insignificant, besides the constant term, which should be insignificant. Furthermore, the adjusted $R^2$ measures do not show improvements and the AIC measures reveal that, consistent with the results for BM based growth stocks, the CAPM appears to be superior to the other models. This applies to both the models on all growth stocks as well as all the nonnormal growth stocks. In conclusion can be said that the results for the growth stocks are not in line with the expectations outlined by the theory. According to the results obtained in this study, one can assume that variations in the stock returns of growth companies are not influenced by the higher moments, co-skewness and co-kurtosis or the interaction term.

On the other hand, in contrast of the outcome for growth companies, the variations of value stock returns seem to depend, in particular, on the second and the fourth moment, co-variance and co-kurtosis respectively. The systematic risk component, or beta, is significant (at the 10% significance level) in nearly all, 13 out of 16, models and the inclusion of the fourth moment seems to improve the fitness of the data as illustrated by the values of the adjusted $R^2$ and AIC. In fact, the results of the goodness-of-fit measures indicate that adding higher moments to an asset pricing model improves the explanatory power towards variations in stock returns. This leads to the belief that, consistent with other literature, higher moments are important for investors when pricing value stocks. However, it has to be kept in mind that the regressed models do not perfectly explain all of the expected returns. Various reasons can have an influence on this imperfection. Firstly, poor guidance from economic theory on higher moments has led to the implementation of different risk premia (Chang et al., 2010). Other forms of risk premia can potentially lead to better measurement values. Secondly, additional factors besides the market could potentially be important in capturing risks to explain variations in stock returns.[5]

## Table 4.4 - Summary table of statistical measures

Summary evaluation table showing the results of the statistical measures for every model: adjusted $R^2$ and AIC.

| | **Expected by theory** | | | | **Best** |
|---|---|---|---|---|---|
| | **CAPM** | **3-CAPM** | **4-CAPM** | **4i-CAPM** | |
| $R^2$ | n/a | Higher than CAPM | Higher than CAPM and 3-CAPM | Highest | **4i-CAPM** |
| AIC | n/a | Lower than CAPM | Lower than CAPM and 3-CAPM | Lowest | **4i-CAPM** |
| | **BM - Growth** | | | | |
| | **CAPM** | **3-CAPM** | **4-CAPM** | **4i-CAPM** | |
| $R^2$ | -0,043 | Lower | Highest | Lowest | **4-CAPM** |
| AIC | -5,195 | Higher | Higher than both | Highest | **CAPM** |
| | **BM - Value** | | | | |
| | **CAPM** | **3-CAPM** | **4-CAPM** | **4i-CAPM** | |
| $R^2$ | -0,018 | Higher | Higher than both | Highest | **4i-CAPM** |
| AIC | -5,294 | Lower | Lower than both | Lowest | **4i-CAPM** |
| | **PE - Growth** | | | | |
| | **CAPM** | **3-CAPM** | **4-CAPM** | **4i-CAPM** | |
| $R^2$ | 0,086 | Lower | Lower than both | Highest | **4i-CAPM** |
| AIC | -5,442 | Higher | Higher than both | Lowest | **4i-CAPM** |
| | **BM - Value** | | | | |
| | **CAPM** | **3-CAPM** | **4-CAPM** | **4i-CAPM** | |
| $R^2$ | 0,264 | Higher | Higher than CAPM, lower than 3-CAPM | Higher than CAPM, lower than 4-CAPM | **3-CAPM** |
| AIC | -4,620 | Lower | Lower than CAPM, higher than 3-CAPM | Lower than CAPM, higher than 4-CAPM | **3-CAPM** |

[5] E.g. the factors in the Fama-French three-factor model (Fama and French, 1992)

## 4.4 Practical Implications

The CAPM calculates the expected excess return of an asset by multiplying the systematic risk with the market risk premium. The expected return of an asset is also known as the cost of equity, which indicates the theoretical return investors get when investing their money in the equity of a company. One of the assumptions for the CAPM to hold is the assumption of normality, implying that the risk of an asset is measured by its variance. This paper shows that exactly 50 companies violate the normality assumption for the time period measured, implying that for 50% of the companies the calculated cost of equity based on the beta as a sole risk indicator will not be reliable. The rejection of the normality assumption in this paper is not unique, as many empirical studies found results not supporting the normality hypothesis. It now appears that the beta does not suffice to determinate the cost of equity, thus an alternative approach should be constructed. Among the possibilities is the inclusion of higher moments in the CAPM, which is researched in this paper. With this approach, a cost of equity can be calculated by the square and cube of the market excess return, or market risk premium, in addition to the excess market return to the first power. The results displayed in this paper indicate explanatory roles for higher moments in an asset pricing model. But what does that look like in practice?

Consider the value stock StealthGas Inc. (Stealthgas), a marine transporter of liquefied petroleum gas for producers and users[6], with a nonnormal stock return distribution (see Table 3.2). To determine the pricing factors of StealthGas, the monthly returns have been regressed against the market risk premium to the power one, two and three. The outcomes using the four models can be found in Table 4.7. The expected monthly returns are close together ranging from 1.16% to 2.84%. At this moment it is difficult to calculate the cost of equity for Stealthgas as it is unsure what the required market risk premium should be. On the one hand, looking at the outcomes, all four models seem fit to be used in practice, but, on the other hand, the signs for kurtosis in the 4- and 4i-CAPM go against the higher moment theory. The sign for skewness is even, in line with the theory, negative for the 3-CAPM, but changes when kurtosis is added.

Now consider the growth stock Apricus Biosciences (Apricus), a biotechnology company[7], with a nonnormal stock return distribution (see Table 3.1). The same procedure is used for Apricus as for Stealthgas. The outcomes are displayed in Table 4.8. The calculated expected monthly returns lie in the range of -1.71% to 2.71%, which does not seem to be inappropriate. However, a negative cost of equity is of course not applicable in capital budgeting. The signs are in line with the theory except for

[6] Source: Bloomberg
[7] Source: Bloomberg

the 4i-CAPM, where the sign of kurtosis has switched and the sign of the interaction term should be negative.

The two examples show that the outcomes do not deviate much from each other and that the price factors do not assume impossible values. For example Bennaceur and Chaibi (2010), show costs of equity for different industries ranging from 4.33% to 8.55%. Consequently, the results seem to support the view that adding higher moments to the CAPM can produce reliable estimates of the cost of equity and that the theory might work in practice. Naturally, it is not possible to make any empirical conclusions based on these findings, so it is difficult to make any recommendations. Besides, quoting Koller et al. (2010, p. 261): "*It takes a better theory to kill an existing theory, and we have yet to see the better theory. Therefore, we continue to use the CAPM while keeping a watchful eye on new research in the area."*

In the end, the findings suggest that the 4i-CAPM is superior in the calculation of value stock returns, whereas the CAPM should be chosen for growth stocks. Moreover, the findings from this section show ambiguous results for the explanatory power of all pricing factors: the market beta, the higher moments, co-skewness and co-kurtosis, and the interaction term. Where the pricing factors are strong in explaining value stock returns, they are weak for the growth stocks. According to the theory, higher moments should improve the explanatory value of an asset pricing model, and where the results are in line with the theory for value stocks, the results for growth stocks are in sharp contrast with the theory. The presented results are consistent with previous literature, as they also show mixed results but conclude that higher moments seem to be helpful in explaining stock returns. Towards the end of the section, the practical implications of the results are given, showing potentially reliable estimates for the higher moments CAPMs.

## Table 4.7 - Calculation of the Cost of Equity of Stealthgas Inc.

The cost of equity will be calculated using the betas obtained from the first step in the Fama Macbeth procedure.

**Cost of Equity - Stealthgas**

**4i-CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 2,11 | 3,06% |
| Co-skewness | 0,18% | 3,18 | 0,58% |
| Co-kurtosis | 0,01% | -132,49 | -0,79% |
| Interaction term | 0,00% | -6601,95 | -0,07% |
| Premium over risk-free rate | | | 2,78% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | 2,84% |

**4-CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 2,26 | 3,28% |
| Co-skewness | 0,18% | 2,80 | 0,51% |
| Co-kurtosis | 0,01% | -207,79 | -1,25% |
| Premium over risk-free rate | | | 2,54% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | 2,60% |

**3-CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 1,38 | 2,00% |
| Co-skewness | 0,18% | -4,97 | -0,91% |
| Premium over risk-free rate | | | 1,10% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | 1,16% |

**CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 1,29 | 1,87% |
| Premium over risk-free rate | | | 1,87% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | 1,93% |

## Table 4.8 - Calculation of the Cost of Equity of Apricus Biosciences

The cost of equity will be calculated using the betas obtained from the first step in the Fama Macbeth procedure.

**Cost of Equity - Apricus Biosciences**

**4i-CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 2,02 | 2,93% |
| Co-skewness | 0,18% | -24,99 | -4,55% |
| Co-kurtosis | 0,01% | -51,94 | -0,31% |
| Interaction term | 0,00% | 14955,64 | 0,16% |
| Premium over risk-free rate | | | -1,77% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | -1,71% |

**4-CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 1,69 | 2,45% |
| Co-skewness | 0,18% | -24,13 | -4,39% |
| Co-kurtosis | 0,01% | 118,64 | 0,71% |
| Premium over risk-free rate | | | -1,23% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | -1,17% |

**3-CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 2,19 | 3,18% |
| Co-skewness | 0,18% | -19,69 | -3,58% |
| Premium over risk-free rate | | | -0,41% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | -0,35% |

**CAPM**

| Pricing factor | Average monthly premium | Regression coefficient | Contribution to expected return |
|---|---|---|---|
| Systematic risk | 1,45% | 1,83 | 2,65% |
| Premium over risk-free rate | | | 2,65% |
| | | Average risk-free rate | 0,06% |
| | | Cost of Equity | 2,71% |

# 5. Conclusions

This study concludes that the influence of investor's utility functions on the pricing of stocks is different for growth versus value stocks. This implies that the utilization of one common model will not lead to the best estimates for the pricing of varying types of stocks. Developments of new and divergent models based on this insight can potentially solve the value anomaly.

This study finds that co-skewness and co-kurtosis are important in clarifying the variations of expected excess returns of value stocks. In addition, the interaction term appears to add some explanatory power to the models, even though the results give the impression of being inconclusive about the importance of the interaction term by itself. For growth stocks, the results do not provide evidence to reach a similar conclusion. All three added pricing factors do not seem to be helpful in explaining growth stock returns. This is inconsistent with the theory, as the theory declares that due to the more positively skewed risk-return profile of growth stocks, the higher moments, especially co-skewness, should have explanatory power.

Furthermore, the measurement statistics revealed that distinct asset pricing models should be employed in the calculation of the expected stock returns for growth and value stocks. The 4i-CAPM should be selected to provide the most reliable results for value stocks, whilst the CAPM should perform the best for growth stocks. If this is the case, the value premium can probably be detected by relying on different models.

The main conclusion presented above reveals that valuable insights have been added to the existing asset pricing literature: First of all, additional evidence has been provided in favor of including higher moments as pricing factors to the CAPM. Secondly, prior research mostly tests models on all stocks and does not make a distinction between stocks. Therefore, any conclusion on the significance of a model will be for stocks in general. In this study, models were tested on separated growth and value stocks. It appears that the explanatory power of factors in a model is different for growth and value stocks, which could help clarify the value anomaly. Thirdly, based on two quality measures, the 4i-CAPM model seems to be the superior model most of the times, indicating a desire for the inclusion of the interaction term.

This section will continue with describing how the results were obtained followed by some limitations of this study and some recommendations for further research.

## 5.1 Summary

The first step of this research was the expounding of the CAPM as asset pricing model and the main limitations of this model. One of the underlying assumptions of the CAPM to produce reliable estimates is the normal distribution of stock returns. However, previous empirical research illustrated that stock return distributions are asymmetric and leptokurtic. The rationale provided for this observation is either the influence of real options on an asset's return distribution or lies more in the behavioral economic spheres. This study follows the theory that looks at the influence of co-skewness and co-kurtosis, as well as the interaction effect between the two, on the pricing of assets. Co-skewness is the third moment and responsible for asymmetry in a return distribution, co-kurtosis, the fourth moment, can cause peakedness and fat tails. After the explanation of the value anomaly, which is the inability of the beta as a sole risk factor to clarify all of the differences in the excess returns of growth and value stocks, the higher co-moments were introduced to potentially clarify this particular anomaly.

Following the methodology of prior literature, four asset pricing models were adopted in this study. Three models already existed: the CAPM, 3-CAPM and the 4-CAPM. The CAPM calculates the excess expected return of an asset by multiplying the beta of the asset by the market risk premium. The 3-CAPM is an extension of the CAPM that adds co-skewness as a price factor, where the 4-CAPM incorporates co-skewness as well as co-kurtosis. The addition of the interaction term between co-skewness and co-kurtosis to the 4-CAPM resulted in a newly created model: the 4i-CAPM.

This study uses 60 monthly returns of stocks listed on the US stock exchanges NYSE, AMEX and NASDAQ for the period April 2009 to March 2014. The stocks in the final sample were handpicked based on the book-to-market (BM) and the price-to-earnings (PE) ratio. First, 25 value and 25 growth stocks were picked based on the BM ratio, whereupon the same number of growth and value stocks were chosen classified by the PE ratio. This resulted in four different groups of 25 stocks. To check the consistency of the results, four new groups were created by merging the value and growth stocks into two new groups. The removal of the stocks exhibiting normal return distributions created the two remaining data sets. In the end, four models were tested on eight different data sets, four containing growth stocks and four with value stocks.

Following the Fama Macbeth methodology, a two-step procedure to obtain the risk premia of the pricing factors, the results display that important roles are observed for the higher moments in pricing stocks. The results displayed by this study are in consistency with prior research. However, the regression models show mainly significant results for the pricing factors tested on value stocks, but mainly insignificant results for tests on growth stocks. Therefore, the higher co-moments appear to add explanatory power for value stocks while they appear to be impotent for growth stocks. Also, the precision of the models was examined using the adjusted $R^2$ and the AIC measures. Both statistics show superior performance for models including higher order co-moments. The best seems to be the 4i-CAPM. Nonetheless, it must be kept in mind that the highest $R^2$ found in this research shows a value of 44.5%, meaning that the models in this study do not entirely clarify all of the variations in stock returns.

Finally, a practical implementation was provided by the interpretation of the results. The cost of equity was estimated for two companies, one value and one growth company. The range between the outcomes does not appear to vary more than other research. However, empirical conclusions cannot be provided due to the lack of empirical testing.

## 5.2 Limitations and Future Research

This section will go in deeper on the limitations of this study, as some caution in the interpretation of the results presented is advised. In addition, some suggestions for further research will be provided.

First of all, the sample size and the sample period might have a negative effect on the generalizability of this study. The standard number of observations was considered, which led to 5940 monthly returns in total. On the other hand, only 99 different companies listed in the US were taken into account in this research out of the thousands available. It is most certainly possible that other results will be obtained when the research expands the number of companies or looks attentively at other companies. Also, to state conclusions for the financial market as a whole, based on these results, may lead to legitimate critique. Be that as it may, the sample size is not smaller compared to other papers examining individual stocks (Peiro, 2002; Hui and Chan, 2014) and is larger than papers examining portfolios where a sample size of 10-25 portfolios is standard (Ang et al., 2008). Moreover, because the sample period of April 2009 to March 2014 captures part of the financial credit crisis (2007-2010) the period is perhaps not generalizable. The only way to verify this is with additional research. Besides, it could be possible that the recovery of the economy, following the downturn, could have divergent effects on growth and value stocks. For that reason, the actual returns observed for the sample utilized in this study could be incomparable to the returns for another period.

A limitation of the Fama Macbeth two-step procedure is the potential noise in the estimation of the betas. As these estimated betas could contain errors, the independent variables used in the cross-sectional regressions for the estimation of the risk premia could cause errors-in-variables. This is a tremendous limitation of the Fama Macbeth procedure as it can potentially lead to an overstated significance of the coefficient results. Despite the fact that this procedure is still used in the asset pricing literature, it caused researchers to either use other estimation methods or to correct the problem (Lee et al., 2010). Empirical literature investing the importance of higher moments tries to avoid the errors-in-variables issue, see for example Fang and Lai (1997), Kostakis et al. (2012) or Doan and Lin (2012). On the other hand, the emergence of measurement errors in the independent variables is merely a possibility, and even if these errors existed they may not lead to an overstatement of significance (Jagannathan and Wang, 1998). Besides, both Fang and Lai (1997) and Doan and Lin (2012) reach conclusions based on the results found with the Fama Macbeth procedure and the results of other estimation methods, which do not deviate from one another.

Ultimately, the conclusions based on the significance of the pricing factors are assumed to be correct and not overstated as the existence as well as the potential impact of the errors-in-variables issue is uncertain and might not even distort the findings of this paper. A great extension of this study would be to examine whether potential test bias affected the results of this research by using other estimation methods.

Another potential interesting extension is to test the methods from this study on portfolios in order to provide additional evidence towards the value anomaly. Tests on individual stocks are not the most common in the asset pricing literature, as most tests are conducted on portfolios.

Additionally, this study heavily leans on previous research with respect to the methodology used. However, the risk premia representing the independent variables are not the same in different prior studies. Besides, the importance of the higher co-moments has not been checked when additional pricing factors are added to the models. The significance should remain the same, while the goodness-of-fit measures should show improvements of the power of the model. A natural extension of this research is to inspect whether different risk premia lead to similar results and secondly to test the performance of the models from this research to alternative models that take other pricing factors into account.

Furthermore, where the CAPM is still the preferred model in practice, empirical research illustrates that other models should produce more reliable estimates. Consequently, the translation to corporate valuation should be investigated, to determine whether the extra work of collecting additional data is in fact justified by better estimates.

In the end, the findings on higher moments contribute heavily to the literature and expose novel issues in the area of asset pricing worth exploring.

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# Appendix

# Table 3.2 - Characteristics of BM value stocks

This table reports the 25 handpicked value stocks, the industry and their statistics based on their BM ratio. The period is from April 2009 to March 2014. The normality test is based on the Jarque-Berra statistics. The symbols ** and *** referrer respectively to the levels of significance of 5% and 1%.

## Value stocks - BM

| Company name | Industry | | Ratio | Mean | Median | Maximum | Minimum | Std Dev | Skewness | Kurtosis | Jarque-Bera | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Advantage Oil & Gas | Mining | Oil and Gas | 1.996 | 2.17% | -0.23% | 60.30% | -35.85% | 0.148 | 1.156 | 6.471 | 43.496 | *** |
| Aegean Marine Petroleum | Wholesale Trade | Nondurable Goods | 2.048 | 0.68% | 0.34% | 64.92% | -44.97% | 0.177 | 0.594 | 4.992 | 13.452 | *** |
| Airmedia Group | Services | Business | 2.067 | 0.37% | -1.29% | 62.19% | -36.97% | 0.168 | 0.860 | 4.827 | 15.748 | *** |
| ArcBest Corp | Transportation | Motor Freight | 2.061 | 2.39% | 1.66% | 41.51% | -28.87% | 0.166 | 1.623 | 10.226 | 156.862 | *** |
| Arcelormittal | Manufacturing | Primary Metal | 2.006 | 0.75% | -0.46% | 81.92% | -32.72% | 0.129 | 0.352 | 3.828 | 2.955 | |
| Cal Dive International | Mining | Oil and Gas | 2.098 | -0.80% | 1.33% | 33.78% | -47.85% | 0.162 | -0.639 | 3.796 | 5.670 | |
| Continental Materials Corp | Manufacturing | Industrial Machinery | 2.189 | 1.52% | 0.34% | 45.84% | -23.22% | 0.146 | 0.953 | 4.270 | 13.113 | *** |
| Diana Shipping | Transportation | Water | 2.110 | 0.68% | -0.75% | 33.16% | -26.12% | 0.111 | 0.411 | 3.402 | 2.092 | |
| Euro Tech Holdings | Wholesale Trade | Durable Goods | 2.069 | 2.47% | -2.29% | 90.00% | -37.72% | 0.226 | 1.622 | 6.874 | 63.811 | *** |
| Highpower International | Manufacturing | Electronics | 2.228 | 4.12% | -0.97% | 131.33% | -26.30% | 0.291 | 2.563 | 10.010 | 188.506 | *** |
| Imation Corp | Manufacturing | Electronics | 2.085 | 0.07% | -1.86% | 33.06% | -21.22% | 0.107 | 0.724 | 4.198 | 8.823 | ** |
| International Shipholding Corp | Transportation | Water | 2.209 | 1.61% | -0.30% | 25.23% | -19.79% | 0.095 | 0.508 | 2.996 | 2.585 | |
| James River Coal | Mining | Bituminous Coal | 2.212 | -1.88% | -5.31% | 73.61% | -49.55% | 0.239 | 0.999 | 4.821 | 18.270 | *** |
| Jinpan International | Manufacturing | Electronics | 2.066 | 1.17% | -0.86% | 51.14% | -31.37% | 0.163 | 0.761 | 3.776 | 7.297 | ** |
| Kindred Healthcare | Services | Health | 2.196 | 1.75% | 1.40% | 35.15% | -33.38% | 0.140 | 0.078 | 3.184 | 0.146 | |
| Knightsbridge Tankers | Transportation | Water | 2.165 | 1.25% | 2.09% | 30.79% | -23.93% | 0.115 | 0.049 | 3.004 | 0.024 | |
| Metalico Inc | Manufacturing | Primary Metal | 2.057 | 1.50% | -0.78% | 84.92% | -25.30% | 0.191 | 1.477 | 7.431 | 70.907 | *** |
| Penn West Petroleum | Mining | Oil and Gas | 1.975 | 1.03% | 0.91% | 29.57% | -24.04% | 0.112 | 0.180 | 3.203 | 0.427 | |
| Perma-Fix Environmental | Transportation | Electric and Gas | 2.221 | -0.04% | -1.92% | 52.90% | -46.66% | 0.151 | 0.725 | 6.296 | 32.427 | *** |
| StealthGas Inc | Transportation | Water | 2.091 | 2.07% | 2.23% | 56.50% | -19.87% | 0.127 | 1.328 | 7.115 | 59.968 | *** |
| Telephone & Data Systems | Transportation | Communications | 2.038 | 0.65% | 1.79% | 18.00% | -18.28% | 0.088 | -0.076 | 2.298 | 1.291 | |
| Thompson Creek Metals | Mining | Metal Mining | 2.198 | 0.61% | -2.07% | 69.77% | -42.16% | 0.189 | 1.123 | 5.226 | 24.998 | *** |
| Tutor Perini | Construction | Building Construction | 1.924 | 2.50% | 5.75% | 40.65% | -26.10% | 0.142 | -0.125 | 2.889 | 0.186 | |
| Vimicro International | Manufacturing | Electronics | 2.196 | 3.22% | -1.28% | 67.91% | -35.44% | 0.184 | 1.148 | 5.114 | 24.352 | *** |
| Zhone Technologies | Manufacturing | Electronics | 2.170 | 6.47% | -0.40% | 245.00% | -30.14% | 0.379 | 4.367 | 27.386 | 1677.429 | *** |
| **Average** | | | 2 | 1.45% | -0.12% | 62.37% | -31.51% | 0.166 | 0.910 | 5.905 | | |

# Table 3.3 - Characteristics of PE growth stocks

This table reports the handpicked 25 growth stocks, the industry and their statistics based on their PE ratio. The period is from April 2009 to March 2014. The normality test is based on the Jarque-Berra statistics. The symbols ** and *** referrer respectively to the levels of significance of 5% and 1%.

## PE - Growth stocks

| Company name | Industry | | Ratio | Mean | Median | Maximum | Minimum | Std Dev | Skewness | Kurtosis | Jarque-Bera | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atmel Corp | Manufacturing | Electronics | 93.571 | 2.09% | 1.55% | 37.18% | -24.71% | 0.120 | 0.418 | 3.346 | 2.046 | |
| Bel Fuse Inc | Manufacturing | Electronics | 97.750 | 1.73% | -0.24% | 43.25% | -24.77% | 0.129 | 0.531 | 3.305 | 3.055 | |
| Biodelivery Sciences | Manufacturing | Chemicals | 86.200 | 4.66% | 1.29% | 157.11% | -67.75% | 0.279 | 2.587 | 16.538 | 525.081 | *** |
| Cabot Oil & Gas | Mining | Oil & Gas | 78.952 | 3.50% | 3.93% | 28.09% | -18.39% | 0.104 | 0.035 | 2.621 | 0.372 | |
| Deltic Timber | Manufacturing | Lumber and Wood | 96.740 | 1.29% | 1.39% | 26.78% | -20.14% | 0.090 | 0.311 | 3.204 | 1.073 | |
| Dominion Resources | Transportation | Electric & Gas | 90.877 | 1.81% | 1.87% | 8.39% | -8.32% | 0.035 | -0.411 | 3.488 | 2.286 | |
| Earthlink Holdings | Services | Business | 92.286 | -0.38% | -0.47% | 15.37% | -20.73% | 0.072 | -0.287 | 3.156 | 0.882 | |
| Equinix Corp | Services | Business | 75.255 | 2.35% | 2.95% | 25.08% | -17.69% | 0.084 | 0.050 | 2.947 | 0.032 | |
| Fairchild Semiconductor | Manufacturing | Electronics | 75.789 | 3.20% | 1.22% | 65.15% | -26.88% | 0.150 | 1.266 | 6.456 | 45.900 | *** |
| Genomic Health | Manufacturing | Chemicals | 100.889 | 0.67% | -0.29% | 30.30% | -16.80% | 0.107 | 0.603 | 3.008 | 3.641 | |
| Harvard Biosciences | Manufacturing | Measuring Equipment | 87.600 | 1.58% | 0.97% | 30.73% | -18.75% | 0.088 | 0.493 | 3.855 | 4.252 | |
| Healthstream Inc | Services | Business | 83.828 | 5.06% | 2.46% | 46.43% | -13.68% | 0.121 | 0.949 | 4.130 | 12.208 | *** |
| Idex Corp | Manufacturing | Industrial Machinery | 103.400 | 2.40% | 3.22% | 19.20% | -16.19% | 0.068 | -0.231 | 3.319 | 0.786 | |
| Louisiana-Pacific Corp | Manufacturing | Lumber and Wood | 84.000 | 5.02% | 2.90% | 82.51% | -27.72% | 0.197 | 1.722 | 8.087 | 94.360 | *** |
| Nanometrics | Manufacturing | Measuring Equipment | 75.895 | 5.94% | 1.06% | 71.66% | -23.21% | 0.182 | 1.775 | 6.719 | 66.079 | *** |
| Natus Medical | Manufacturing | Measuring Equipment | 85.878 | 2.44% | 2.69% | 39.14% | -23.89% | 0.110 | 0.443 | 3.846 | 3.748 | |
| Neurocrine Biosciences | Manufacturing | Chemicals | 93.500 | 3.79% | 1.37% | 82.98% | -27.21% | 0.173 | 1.818 | 8.977 | 122.355 | *** |
| PROS Holdings | Services | Business | 101.611 | 4.11% | 4.22% | 38.92% | -27.36% | 0.134 | -0.009 | 3.192 | 0.093 | |
| Pioneer Natural Resources | Mining | Oil & Gas | 96.900 | 4.71% | 4.10% | 40.38% | -16.51% | 0.111 | 0.427 | 3.717 | 3.111 | |
| Rackspace Hosting | Services | Business | 95.218 | 3.33% | 1.14% | 36.69% | -25.87% | 0.133 | 0.293 | 3.149 | 0.912 | |
| Skechers USA Inc | Manufacturing | Leather | 97.368 | 4.14% | 1.19% | 75.41% | -31.33% | 0.173 | 1.467 | 6.913 | 59.806 | *** |
| Talisman Energy | Mining | Oil & Gas | 94.417 | 0.55% | -1.02% | 29.90% | -26.53% | 0.099 | 0.191 | 3.644 | 1.402 | |
| Unit Corp | Mining | Oil & Gas | 93.854 | 2.52% | 1.81% | 32.88% | -22.58% | 0.112 | 0.285 | 3.440 | 1.298 | |
| United Parcel Service | Transportation | Motor Freight | 87.774 | 1.50% | 0.92% | 14.26% | -9.37% | 0.048 | -0.014 | 3.278 | 0.195 | |
| Viad Corp | Services | Business | 104.462 | 1.87% | 0.73% | 35.13% | -23.62% | 0.115 | 0.238 | 3.400 | 0.964 | |
| **Average** | | | 90.961 | 2.79% | 1.64% | 44.52% | -23.20% | 0.121 | 0.598 | 4.710 | | |

# Table 3.4 - Characteristics of PE value stocks

This table reports the 25 handpicked value stocks, the industry and their statistics based on their PE ratio. The period is from April 2009 to March 2014. The normality test is based on the Jarque-Berra statistics. The symbols ** and *** referrer respectively to the levels of significance of 5% and 1%.

## PE - Value stocks

| Company name | | | Ratio | Mean | Median | Maximum | Minimum | Std Dev | Skewness | Kurtosis | Jarque-Bera | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Acco Brands | Manufacturing | Printing/Publishing | 5.919 | 5.06% | 3.42% | 113.27% | -30.06% | 0.222 | 2.107 | 10.949 | 202.383 | *** |
| Adams Resources & Energy | Wholesale Trade | Nondurable Goods | 5.371 | 3.57% | 2.71% | 37.88% | -41.63% | 0.142 | -0.225 | 3.722 | 1.809 | |
| Cambrex Corp | Manufacturing | Chemicals | 5.343 | 4.46% | 3.49% | 54.51% | -29.93% | 0.138 | 0.690 | 5.025 | 15.016 | *** |
| Cellcom Israel | Transportation | Communications | 5.790 | 0.62% | 1.44% | 24.10% | -42.03% | 0.116 | -0.554 | 4.947 | 12.539 | *** |
| Columbia Laboratories | Manufacturing | Chemicals | 5.777 | 1.28% | -0.22% | 69.40% | -66.36% | 0.198 | 0.510 | 6.689 | 36.613 | *** |
| Copel | Transportation | Electric & Gas | 5.749 | 1.20% | 0.60% | 24.39% | -20.23% | 0.098 | 0.056 | 2.735 | 0.206 | |
| Core Molding Technologies | Manufacturing | Rubber & Plastics | 5.757 | 4.74% | 1.70% | 71.43% | -16.40% | 0.157 | 2.081 | 8.918 | 130.867 | *** |
| Delek US Holdings | Manufacturing | Petroleum Refining | 5.445 | 2.78% | 2.45% | 35.50% | -23.90% | 0.132 | 0.320 | 3.386 | 1.397 | |
| Gray Television | Transportation | Communications | 5.238 | 10.37% | 2.65% | 217.81% | -36.00% | 0.378 | 3.151 | 16.868 | 580.086 | *** |
| Hollyfrontier Corp | Manufacturing | Petroleum Refining | 5.535 | 3.55% | 4.12% | 25.38% | -26.68% | 0.107 | -0.621 | 3.692 | 5.054 | |
| International Shipholding | Transportation | Water | 5.403 | 1.61% | -0.30% | 25.23% | -19.79% | 0.095 | 0.508 | 2.996 | 2.585 | |
| Nevsun Resources | Mining | Metal | 5.863 | 3.29% | 2.40% | 40.68% | -37.50% | 0.157 | -0.077 | 2.913 | 0.078 | |
| Ninetowns Internet Tech | Services | Business | 6.000 | 1.28% | -0.59% | 56.33% | -14.60% | 0.103 | 2.827 | 15.408 | 464.825 | *** |
| Patrick Industries | Manufacturing | Lumber and Wood | 5.850 | 10.77% | 6.14% | 164.33% | -43.02% | 0.298 | 2.836 | 14.286 | 398.913 | *** |
| Perfect World | Services | Business | 5.868 | 2.27% | 0.23% | 34.97% | -48.02% | 0.160 | -0.178 | 3.469 | 0.865 | |
| Realnetworks | Services | Business | 5.860 | 0.77% | -0.56% | 36.13% | -22.23% | 0.104 | 0.789 | 4.313 | 10.535 | *** |
| Republic Airways | Transportation | Air | 5.358 | 2.25% | -1.72% | 80.59% | -33.74% | 0.200 | 1.617 | 6.792 | 62.076 | *** |
| SMTC Corp | Manufacturing | Electronics | 5.280 | 4.64% | 1.66% | 49.67% | -16.19% | 0.139 | 0.936 | 3.903 | 10.810 | *** |
| Sirius XM Holdings | Transportation | Communications | 5.255 | 4.39% | 1.33% | 100.72% | -35.58% | 0.208 | 2.002 | 9.547 | 147.272 | *** |
| StealthGas Inc | Transportation | Water | 5.624 | 2.07% | 2.23% | 56.50% | -19.87% | 0.127 | 1.328 | 7.115 | 59.968 | *** |
| TGS | Transportation | Electric & Gas | 5.677 | 1.93% | 1.12% | 72.91% | -31.43% | 0.117 | 0.498 | 3.805 | 4.102 | |
| Tor Minerals | Manufacturing | Chemicals | 5.978 | 5.11% | 0.53% | 39.11% | -23.64% | 0.190 | 1.344 | 5.310 | 31.408 | *** |
| Unisys Corp | Services | Business | 5.864 | 5.09% | 0.73% | 130.19% | -25.08% | 0.241 | 2.636 | 13.735 | 357.600 | *** |
| Wabash National | Manufacturing | Transportation | 5.863 | 7.84% | 1.68% | 191.57% | -44.00% | 0.348 | 3.353 | 17.177 | 614.906 | *** |
| Yahoo | Services | Business | 6.012 | 2.06% | 1.87% | 22.31% | -12.90% | 0.083 | 0.354 | 2.628 | 1.600 | |
| **Average** | | | 5.667 | 3.72% | 1.56% | 71.00% | -30.43% | 0.170 | 1.132 | 7.213 | | |

## Table 3.5 - Summary statistics of equal-weighted portfolios

This table reports the statistics of four equal-weighted portfolios based on the 25 growth and value stocks picked from the BM ratio and the 25 growth and value stocks picked from the PE ratio. The difference of means between the growth and value portfolios is calculated by the Welch's test.

**Equal-Weighted Portfolios**

| | Mean | Median | Maximum | Minimum | Std. Dev. | Skewness | Kurtosis | Jarque-Bera | | Difference of means - Welch's test |
|---|---|---|---|---|---|---|---|---|---|---|
| BM - Growth | 3.28% | 3.84% | 17.03% | -8.05% | 0.063 | 0.020 | 2.224 | 1.510 | | 0.1832 |
| BM - Value | 1.45% | 1.35% | 17.88% | -19.95% | 0.085 | -0.258 | 2.916 | 0.681 | | |
| PE - Growth | 2.79% | 2.94% | 25.52% | -13.33% | 0.064 | 0.456 | 4.758 | 9.802 | *** | 0.4805 |
| PE - Value | 3.72% | 3.06% | 25.49% | -13.71% | 0.078 | 0.454 | 3.628 | 3.043 | | |

# Table 4.1 - Results of Fama Macbeth regressions for BM stocks

This table reports the regression coefficients of the different asset pricing models for growth and value stocks based on the book-to-market ratio. Four models are regressed:

**CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \varepsilon_{it}$ **3-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \varepsilon_{it}$ **4-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \varepsilon_{it}$ **4i-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \Upsilon_4\beta_{4i} + \varepsilon_{it}$

In all models the $\Upsilon_0$ coefficient is the constant. In the CAPM model, the $\Upsilon_1$ coefficient represents the excess returns of the market or the systematic risk. In the 3-CAPM, the $\Upsilon_1$ coefficient represents the excess returns of the market portfolio and $\Upsilon_2$ refers to the excess returns of the market portfolio squared. In the 4-CAPM the $\Upsilon_1$ coefficient represent the excess returns of the market and the $\Upsilon_2$ and $\Upsilon_3$ coefficents represent the excess returns of the market squared and cubic, respectively. The $\Upsilon_1$, $\Upsilon_2$ and $\Upsilon_3$coefficients in the 4i-CAPM represent the same as in the 4-CAPM. The $\Upsilon_4$ coefficient represent the interaction term between the excess market return squared and cubic.

The S&P Composite is used as a proxy for the market portfolio, whereas the one-month treasury bill proxies for the risk-free rate. The last three rows on the bottom show the $R^2$, the adjusted $R^2$ and the AIC measure. Note, in the column referred to as prob, the probabilities of the coefficients are given.

| | **BM - GROWTH STOCKS** | | | | | | | | **BM - VALUE STOCKS** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAPM** | | **3-CAPM** | | **4-CAPM** | | **4i-CAPM** | | **CAPM** | | **3-CAPM** | | **4-CAPM** | | **4i-CAPM** | |
| | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob |
| $\Upsilon_0$ | 0.032 | 0.000 | 0.030 | 0.000 | 0.029 | 0.000 | 0.029 | 0.000 | 0.007 | 0.501 | 0.000 | 0.968 | 0.002 | 0.792 | 0.000 | 0.979 |
| $\Upsilon_1$ | 0.000 | 0.965 | 0.002 | 0.687 | 0.003 | 0.463 | 0.003 | 0.457 | 0.004 | 0.592 | 0.006 | 0.273 | 0.006 | 0.191 | 0.006 | 0.082 |
| $\Upsilon_2$ | | | -0.00040 | 0.248 | -0.00044 | 0.212 | -0.00042 | 0.203 | | | -0.00099 | 0.007 | -0.00036 | 0.341 | -0.00063 | 0.144 |
| $\Upsilon_3$ | | | | | 0.0000262 | 0.386 | 0.000025 | 0.395 | | | | | -0.000027 | 0.138 | -0.000033 | 0.030 |
| $\Upsilon_4$ | | | | | | | 0.00000022 | 0.423 | | | | | | | -0.00000062 | 0.001 |
| Adj $R^2$ | -0.043 | | -0.041 | | -0.012 | | -0.058 | | -0.018 | | 0.223 | | 0.408 | | 0.445 | |
| AIC | -5.195 | | -5.162 | | -5.156 | | -5.080 | | -5.294 | | -5.528 | | -5.767 | | -5.800 | |

# Table 4.2 - Results of Fama Macbeth regressions for PE stocks

This table reports the regression coefficients of the different asset pricing models for growth and value stocks based on the price-to-earnings ratio. Four models are regressed:

**CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \varepsilon_{it}$ **3-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \varepsilon_{it}$ **4-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \varepsilon_{it}$ **4i-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \Upsilon_4\beta_{4i} + \varepsilon_{it}$

In all models the $\Upsilon_0$ coefficient is the constant. In the CAPM model, the $\Upsilon_1$ coefficient represents the excess returns of the market or the systematic risk. In the 3-CAPM, the $\Upsilon_1$ coefficient represents the excess returns of the market portfolio and $\Upsilon_2$ refers to the excess returns of the market portfolio squared. In the 4-CAPM the $\Upsilon_1$ coefficient represent the excess returns of the market and the $\Upsilon_2$ and $\Upsilon_3$ coefficents represent the excess returns of the market squared and cubic, respectively. The $\Upsilon_1$, $\Upsilon_2$ and $\Upsilon_3$coefficients in the 4i-CAPM represent the same as in the 4-CAPM. The $\Upsilon_4$ coefficient represent the interaction term between the excess market return squared and cubic.

The S&P Composite is used as a proxy for the market portfolio, whereas the one-month treasury bill proxies for the risk-free rate. The last three rows on the bottom show the $R^2$, the adjusted $R^2$ and the AIC measure. Note, in the column referred to as prob, the probabilities of the coefficients are given.

| | **PE - GROWTH STOCKS** | | | | | | | | **PE - VALUE STOCKS** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAPM** | | **3-CAPM** | | **4-CAPM** | | **4i-CAPM** | | **CAPM** | | **3-CAPM** | | **4-CAPM** | | **4i-CAPM** | |
| | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob |
| $\Upsilon_0$ | 0.016 | 0.034 | 0.017 | 0.030 | 0.018 | 0.032 | 0.022 | 0.010 | 0.012 | 0.176 | 0.001 | 0.833 | 0.001 | 0.892 | 0.002 | 0.765 |
| $\Upsilon_1$ | 0.008 | 0.055 | 0.007 | 0.137 | 0.006 | 0.333 | 0.000 | 0.973 | 0.016 | 0.005 | 0.022 | 0.000 | 0.023 | 0.000 | 0.022 | 0.000 |
| $\Upsilon_2$ | | | 0.00055 | 0.317 | 0.00039 | 0.539 | 0.00070 | 0.052 | | | -0.00065 | 0.145 | -0.00060 | 0.296 | -0.00051 | 0.427 |
| $\Upsilon_3$ | | | | | 0.000060 | 0.006 | 0.000054 | 0.019 | | | | | 0.000065 | 0.004 | 0.000064 | 0.004 |
| $\Upsilon_4$ | | | | | | | 0.00000028 | 0.194 | | | | | | | 0.00000026 | 0.355 |
| Adj $R^2$ | 0.086 | | 0.083 | | 0.065 | | 0.331 | | 0.264 | | 0.433 | | 0.409 | | 0.384 | |
| AIC | -5.442 | | -5.403 | | -5.350 | | -5.653 | | -4.620 | | -4.844 | | -4.770 | | -4.697 | |

# Table 4.5 - Results of Fama Macbeth regressions for all stocks

This table reports the regression coefficients of the different asset pricing models for the combined growth and combined value stocks based on the book-to-market and price-to-earnings ratio. Four models are regressed:

**CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \varepsilon_{it}$ **3-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \varepsilon_{it}$ **4-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \varepsilon_{it}$ **4i-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \Upsilon_4\beta_{4i} + \varepsilon_{it}$

In all models the $\Upsilon_0$ coefficient is the constant. In the CAPM model, the $\Upsilon_1$ coefficient represents the excess returns of the market or the systematic risk. In the 3-CAPM, the $\Upsilon_1$ coefficient represents the excess returns of the market portfolio and $\Upsilon_2$ refers to the excess returns of the market portfolio squared. In the 4-CAPM the $\Upsilon_1$ coefficient represent the excess returns of the market and the $\Upsilon_2$ and $\Upsilon_3$ coefficents represent the excess returns of the market squared and cubic, respectively. The $\Upsilon_1$, $\Upsilon_2$ and $\Upsilon_3$coefficients in the 4i-CAPM represent the same as in the 4-CAPM. The $\Upsilon_4$ coefficient represent the interaction term between the excess market return squared and cubic.

The S&P Composite is used as a proxy for the market portfolio, whereas the one-month treasury bill proxies for the risk-free rate. The last three rows on the bottom show the $R^2$, the adjusted $R^2$ and the AIC measure. Note, in the column referred to as prob, the probabilities of the coefficients are given.

| | ALL GROWTH STOCKS | | | | | | | | ALL VALUE STOCKS | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | CAPM | | 3-CAPM | | 4-CAPM | | 4i-CAPM | | CAPM | | 3-CAPM | | 4-CAPM | | 4i-CAPM | |
| | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob |
| bo | 0.024 | 0.000 | 0.024 | 0.000 | 0.024 | 0.000 | 0.024 | 0.000 | 0.010 | 0.215 | 0.003 | 0.681 | 0.003 | 0.663 | 0.005 | 0.491 |
| b1 | 0.004 | 0.106 | 0.005 | 0.097 | 0.004 | 0.120 | 0.004 | 0.205 | 0.009 | 0.075 | 0.013 | 0.018 | 0.013 | 0.014 | 0.012 | 0.017 |
| b2 | | | -0.00003 | 0.923 | -0.00013 | 0.692 | -0.00013 | 0.684 | | | -0.00048 | 0.279 | -0.00030 | 0.619 | -0.00008 | 0.892 |
| b3 | | | | | 0.000037 | 0.025 | 0.000036 | 0.027 | | | | | 0.000022 | 0.378 | 0.000023 | 0.352 |
| b4 | | | | | | | 0.00000028 | 0.108 | | | | | | | 0.0000001 | 0.692 |
| Adj R2 | 0.009 | | -0.009 | | 0.017 | | -0.001 | | 0.072 | | 0.131 | | 0.135 | | 0.154 | |
| AIC | -5.337 | | -5.300 | | -5.308 | | -5.272 | | -4.566 | | -4.613 | | -4.599 | | -4.603 | |

# Table 4.6 - Results of Fama Macbeth regressions for all nonnormal stocks

This table reports the regression coefficients of the different asset pricing models for the combined nonnormal growth and combined nonnormal value stocks based on the book-to-market and price-to-earnings ratio. Four models are regressed:

**CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \varepsilon_{it}$ **3-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \varepsilon_{it}$ **4-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \varepsilon_{it}$ **4i-CAPM** - $r_i = \Upsilon_0 + \Upsilon_1\beta_i + \Upsilon_2\beta_{2i} + \Upsilon_3\beta_{3i} + \Upsilon_4\beta_{4i} + \varepsilon_{it}$

In all models the $\Upsilon_0$ coefficient is the constant. In the CAPM model, the $\Upsilon_1$ coefficient represents the excess returns of the market or the systematic risk. In the 3-CAPM, the $\Upsilon_1$ coefficient represents the excess returns of the market portfolio and $\Upsilon_2$ refers to the excess returns of the market portfolio squared. In the 4-CAPM the $\Upsilon_1$ coefficient represent the excess returns of the market and the $\Upsilon_2$ and $\Upsilon_3$ coefficents represent the excess returns of the market squared and cubic, respectively. The $\Upsilon_1$, $\Upsilon_2$ and $\Upsilon_3$coefficients in the 4i-CAPM represent the same as in the 4-CAPM. The $\Upsilon_4$ coefficient represent the interaction term between the excess market return squared and cubic.

The S&P Composite is used as a proxy for the market portfolio, whereas the one-month treasury bill proxies for the risk-free rate. The last three rows on the bottom show the $R^2$, the adjusted $R^2$ and the AIC measure. Note, in the column referred to as prob, the probabilities of the coefficients are given.

| | **ALL NONNORMAL GROWTH STOCKS** | | | | | | | | **ALL NONNORMAL VALUE STOCKS** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **CAPM** | | **3-CAPM** | | **4-CAPM** | | **4i-CAPM** | | **CAPM** | | **3-CAPM** | | **4-CAPM** | | **4i-CAPM** | |
| | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob | Coeff | Prob |
| bo | 0.044 | 0.000 | 0.044 | 0.000 | 0.046 | 0.000 | 0.046 | 0.000 | 0.010 | 0.182 | -0.001 | 0.881 | -0.001 | 0.931 | 0.002 | 0.643 |
| b1 | -0.002 | 0.556 | -0.002 | 0.567 | -0.002 | 0.472 | -0.002 | 0.593 | 0.011 | 0.014 | 0.017 | 0.001 | 0.017 | 0.001 | 0.016 | 0.000 |
| b2 | | | -0.00006 | 0.801 | -0.00021 | 0.559 | -0.00022 | 0.563 | | | -0.00074 | 0.179 | -0.00062 | 0.442 | -0.00036 | 0.612 |
| b3 | | | | | 0.000020 | 0.326 | 0.000019 | 0.390 | | | | | 0.000038 | 0.098 | 0.000040 | 0.050 |
| b4 | | | | | | | 0.00000024 | 0.365 | | | | | | | 0.0000003 | 0.2427 |
| Adj R2 | -0.055 | | -0.125 | | 0.020 | | -0.055 | | 0.091 | | 0.222 | | 0.199 | | 0.254 | |
| AIC | -5.280 | | -5.170 | | -5.265 | | -5.155 | | -4.244 | | -4.370 | | -4.312 | | -4.357 | |