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MASTER'S THESIS

BACKTESTING-BASED VALUE INVESTING

Ljubljana, March 2015 GAŠPER SMOLIČ

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INTRODUCTION

This thesis is motivated by research investigating market anomalies. The idea is to investigate some of the anomalies, apply them through the back testing portfolios and investigate what would happen if one would try to exploit them during the past thirteen-year period within the S&P 500 index.

Many authors refer to stocks with high book-to-market as value stocks and stocks with low book-to-market as growth stocks or glamour stocks. Based on empirical observation stocks with higher book-to-market have higher average returns relative to low book-to-market stocks. There is another interesting fact to be noted. Not only do high book-to-market stocks on average outperform low book-to-market stocks they also tend to outperform the so-called growth stocks thus creating the value premium. The value premium created in such a way cannot be explained by the Capital Asset Pricing Model, this interesting fact is named the value premium puzzle. Out of that some authors conclude that the markets are not efficient while others do not take the same view.

Shleifer and Vishny conducted an interesting study of value and glamour stocks in 1994. They evaluated the performance of several value strategies based on several measures of value. They have examined book-to-market, cash-flow-to-price, earnings-to-price, and growth of sales as well as multi-dimensional measures of value. In their paper growth of sales is used as a measure of value which unlike most measures of value is not a function of the price. They used five years of accounting data, formed equally weighted portfolios and reported the buy and hold returns for five years. The first decile of portfolio based on growth of sales returned 19.5 percent per annum over the five year holding period compared to 12.7 percent of the tenth decile. That gave them an annual difference of 6.8 percentage points. The cash flow to price presented the biggest difference in return between first and last decile of about 11 percentage points per annum. Authors show that strategies built with two value measures outperform those using only one variable. They have formed nine groups of stocks and sorted them independently into bottom 30 percent, middle 40 percent and top 30 percent for two measures of value. The high cash flow-to-price and low growth of sales portfolio earned 22.1 percent per annum for five years following the formation period compared to 20.1 percent of the high cash flow to price and 19.5 percent of the low growth of sales decile. The improvements compared to one dimensional strategy are similar for other portfolios. They have also restrict the analysis to only large capitalization stocks and found similar return differences between the value and glamour stocks, suggesting that value strategies are useful for large stocks as well as small stocks (Lakonishok, Shleifer, Vishny, 1994).

Rafael La Porta, Josef Lakonishok, Andrei Schleifer, and Robert Vishny examined the hypothesis that the superior return to the so-called value stocks is the result of expectation errors made by investors. They studied stock price reactions around earnings announcements for value and glamour stocks over the period of 5 years after portfolio formation. The announcement suggested that a significant portion of the return difference

between value and glamour stocks is attributable to earnings surprises that were systematically more positive for value stocks. The analyzed sample consisted of companies listed on the NYSE, AMEX and NASDAQ. Authors note that although a complete and satisfying explanation for the superior return-to-value stocks is beyond the scope of their article evidence suggests that behavioral factors play an important role. The examined period ranges from 1971 to 1993 (La Porta, Lakonishok, Schleifer, & Vishny, 1997). While previously mentioned authors show that value stocks outperform, they also state that the portfolios based on the combination of value measures tend to work even better (Lakonishok et al., 1994). Empirical research shows that both book-to-market ratio and market capitalization tend to be very important ratios for selection of outperforming portfolios (Fama & French, 2012). Some authors show the importance of taking the ROE in consideration when purchasing high book-to-market securities (Wilcox, 1984). Established connection is later confirmed in (Wilcox & Philips, 2005). The research is also supported with more recent studies making the research more up to date (Hou, Xue, & Zhang, 2012). While return on equity is important the price we pay for stock is of all importance (La Porta et al., 1997).

Investors many times work under assumption that volatility is a bad trait, and that high book-to-market as well as small capitalization stocks are inherently riskier. According to Graham common stocks as well as bonds and other instruments are a subject of recurrent and wide fluctuations in their prices. The intelligent investor should be interested in the possibilities of profiting from these swings (Graham, 2006, p. 206).

The goal of this master thesis is to examine some of the above mentioned strategies that worked in the past and inspired the thesis, test them against various benchmarks and present results for the observed period and performance of these strategies within the S&P 500 index. Book-to-market, market capitalization and return on equity strategies are going to be tested separately. Since avoiding losers within the S&P 500 seems like the strategy of beating it, Altman's Z score will also be tested as a separate strategy. Additional goal is to examine whether portfolio based on multiple variables outperforms the benchmarks and whether assuming volatility would be feasible. All portfolios will be benchmarked with risk adjusted returns calculated on the basis of CAPM and Fama French as two most commonly used metrics of risk adjusted returns, as well as against each other in order to find the portfolio strategy that worked out best.

Firstly, we will examine past research behind every strategy and metric used in the thesis. Each metric is described and evaluated for inclusion. After reviewing the literature, research questions are stated. As a second step I explain the methodological approach and the data on which the case is built. After presenting our approach results are stated and benchmarked against commonly used benchmarks. All of the constructed portfolios are explained and interpreted together with calculations and ratios that were taken into consideration. The portfolios are evaluated against the risk free rate of return, the S&P 500, CAPM expected returns, Fama French expected returns as well as against each other. We conclude the thesis with a final evaluation, presenting the final answers to our research questions.

1 LITERATURE REVIEW

Under the following titles we will present some commonly used multiples. These multiples will later be applied and their applicability and relevance will be tested on historical data. Each multiple is going to be described, supported by empirical research and argument for inclusion. In this thesis we will focus on the accounting measures due to the simplicity and comparability of data. Focusing on quantitative GAAP reported measures our results will be comparable and easy to revise.

1.1 Book-to-market multiple

According to Sutton (2004), investors refer to ordinary shareholders' equity as stated in the accounts as book value. Market value, which equals the current price, represents the interest of the same ordinary shareholders measured at current market value. The ratio of these two factors is the ratio of price per share divided by book value per share. Zvie Bodie (2009) explains the interpretation of book-to-market ratio, saying that some analysts view it as a useful measure of value. Some also use the ratio of price-to-book value as an indicator of how aggressively the market values the firm.

According to Sutton the accounting book value is neither the market value nor the fair value of owner's equity. The author defines the book value as the accumulation of accounting inputs and corrections that have occurred through the company history, the shareholders equity is impacted by the following events (Sutton, 2004):

- Issuance of shares for cash,
- payment of dividends,
- transfer of profits to reserves,
- share dividends and share splits,
- write down of capital.

The price-to-book multiple is based on the company's balance sheet. The simplest version of this equation would probably be as follows:

$$\frac{P}{B} = \frac{Current\ Share\ Price}{Book\ Value\ per\ Share} \tag{1}$$

The end period market price of ordinary share divided by its end period book value. Per share book value is ordinary shareholders' equity divided by ordinary shares outstanding. Some consider it a stock market indicator of expected profit growth.

Tim Sutton (2004) comes to the equation (1) through equations explaining the background:

$$\frac{P}{B} = \frac{\begin{array}{c}Share\ capital\ and\ reserves\ attributable\ to\ orddinary \\ shareholders\ (end\ period)\end{array}}{End\ period\ ordinary\ shares\ outstanding} \tag{2}$$

According to Sutton (2004), companies that are profitable and growing have a price-to-book ratio greater than one. This, he claims, is evident when we analyze the price-to-book ratio as the product of return on equity and the price earnings ratio.

$$\frac{P}{B} = \frac{Earnings\ per\ share}{Book\ value\ per\ share\ (end\ period)} X \frac{Current\ market\ price\ per\ share}{Earnings\ per\ share} \tag{3}$$

Sutton (2004) compares the price-to-book multiple with some other popular measures of value:

- Price-to-book ratio is a richer measure then price-to-earnings because it also includes firms' current profitability
- It can be used in a similar way as the price earnings multiple and can serve as an indicator of the company's growth prospects
- P/B tends to be a more reliable measure in the case of companies whose earnings are cyclical or which suffer short-term earnings declines

Factors that influence the ratio as explained by Damodaran follow (Damodaran, 2002). Since the price-to-book metric is equity multiple, the author uses the dividend discount model to explore the determinants.

$$P = \frac{DPS}{k-g} \tag{4}$$

- P – Value of equity per share today
- DPS – Expected dividends per share next year
- k – Cost of equity
- g – Growth rate in dividends

If we substitute the DPS with EPS times the payout ratio, we can write the equation in the following way:

$$P = \frac{EPS*Payout\ ratio}{k-g} \tag{5}$$

If the ROE=EPS/Book value of equity, one can write the value of equity as follows:

$$P = \frac{BV*ROE*Payout\ ratio}{k-g} \tag{6}$$

Rewriting equation (6) yields the following equation:

$$\frac{P}{B} = \frac{ROE*Payout\ ratio}{k-g} \tag{7}$$

Taking growth into consideration:

$$\frac{P}{B} = \frac{ROE*(1+g)*Payout\ ratio}{k-g} \tag{8}$$

If we relate growth to return on equity, the equation is simplified to:

$$g = (1-Payout\ ratio)*ROE \tag{9}$$

Substituting back into the P/B equation:

$$\frac{P}{B} = \frac{(ROE-g)}{(k-g)} \tag{10}$$

We can see that the main factors influencing price-to-book ratio are:

- Return on equity: the higher the ROE, the higher the expected multiple
- The payout ratio: the higher the payout ratio, the higher the price-to-book multiple
- The growth rate: the higher the expected growth, the higher the multiple
- Riskiness: the higher the risk, the lower the expected multiple
- The differential between the return on equity and its cost of equity

The book value may or may not be adjusted to any particular facts. Probably most commonly used is the accounting book value of common stock based on the company's balance sheet at financial year end.

Company shareholders are sometimes called "residual claimants" which means that the value of their stake is what is left over when the liabilities of the firm are subtracted from its assets. Shareholder's equity is the net worth that remains. However, the values of both assets and liabilities recognized in financial statements are based on historical, not current values. Authors present an example and saying that the book value of an asset equals original cost of acquisition, less some depreciation charges, even if the market price of an asset changed over time. Depreciation does not include the loss of actual value (Bodie, Kane, & Marcus, 2011).

According to Benjamin Graham the balance sheet deserves more attention than Wall Street has been willing to accord it. Graham goes further and says that the book value of a common stock was originally the most important element of its financial exhibit. It supposed to show the value of the shares in the same way as a merchant's balance sheet shows him the value of his business (Graham & Dodd, 2006).

1.1.1 Advantages and shortcomings

There are several reasons for investors to use the price-to-book ratio as a tool. Damodaran argues that when accounting standards vary widely across firms the price-to-book metric might not be comparable. We are most probably going to face that issue when comparing price-to-book ratios on the international level. The book value might not be as relevant when valuing firms that do not have significant tangible assets. The author's third point is

that we might face an issue of valuing a firm with negative book value (Damodaran, 2002). Examples of advantages and shortcomings are presented below.

Advantages:

- A useful measure where tangible assets are the source of value generation (Suozzo, Cooper, Sutherland, & Deng, 2001)
- The book value provides a relatively stable and intuitive measure of value that can be compared to the market price (Damodaran, 2002)
- For investors that instinctively mistrust discounted cash flow estimates of value the book value makes a much simpler benchmark for comparison (Damodaran, 2002)
- It is a fact that there are reasonably consistent accounting standards across firms which makes price-to-book ratios reasonably comparable (Damodaran, 2002)
- The book value makes valuation possible even when the firm has negative earnings (Damodaran, 2002)
- According to Fama and French the price-to-book is strongly connected with future returns (Fama & French, 1992)

Shortcomings:

- Using this measure with industrial companies requires care because net assets are based on the historical cost book value which is an unreliable indicator of economic value (Suozzo P. et al., 2001)
- With acquisitions, the effect on price-to-book ratios can vary dramatically depending on how the acquisition is accounted for (Damodaran, 2002)
- To compare the price-to-book ratios across firms, when some firms in the sample buy back stocks and some do not, can be problematic (Damodaran, 2002)

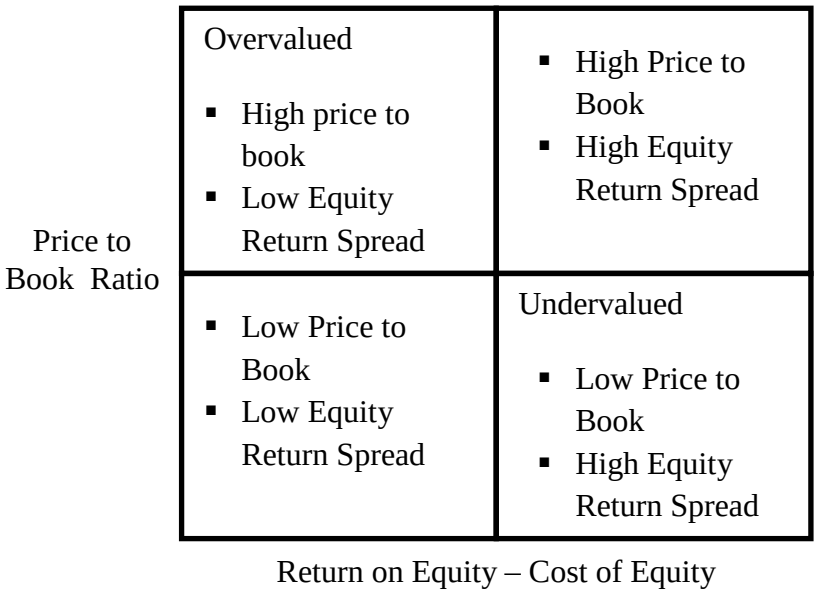
1.1.2 Applications

According to Damodaran at least three potential applications are possible when looking for undervalued firms (Damodaran, 2002):

- Comparisons across firms in a sector
- Matrix approach
- Regression approach

Comparison of price-to-book value ratios would have to take into account different expected growth, different payout ratios, different risk levels and different returns on equity among firms. The firms that should draw attention from investors are those that provide mismatches of price book ratios and returns on equity according to Damodaran. If we assume that firms within a sector have similar costs of equity, we could replace the equity return spread with the raw return on equity (Damodaran, 2002). We provide an example presented in the book mentioned below.

Figure 1. Price-to-book & ROE



Source: A. Damodaran, *Investment Valuation*, 2002, p. 524.

One can also use a regression approach were the following regression equation is suggested by Damodaran (2002):

$$PBV = a + b*ROE \tag{11}$$

One could also expand the regression and include other independent variables. Later in the thesis we will do a similar thing in BtoM + ROE portfolio and The Four Variables portfolio. The price-to-book multiple that represents the true value of a business supposed to vary due to different factors that come with a business, but everything else held constant, buying companies with the same average ROE at lower multiples of their book value supposed to lead an investor to superior results.

The value premium is the empiric observation that stocks with high book-to-market have on average higher average returns whereas stocks with low book-to-market have on average lower returns. In the following text we try to show some examples of how authors discovered that correlation.

Quite some research has been done in this field. Rosenberg, Reid, and Lanstein (1984), Chan, Hamao, and Lakonishok (1991), Fama and French (1992), Chui, Titman and Wei (2010) as well as Fama and French (2012) are only some examples confirming that stocks with low price-to-book multiples outperform the market. Across the world the empirical relation between stock returns and fundamental variables has been extensively studied as well as widely used in practice. One could say that the majority of studies have been performed in the Unites States, while that might be true, there are studies that confirm that at the international level as well.

Rosenberg, Reid, and Lanstein studied and evaluated the performance of the book-to-market strategy in their article named Persuasive Evidence of Market Inefficiency from 1985. They have created a monthly hedge portfolio based upon data available at the prior month's close, based on 1,400 securities from the HICAP universe, NYSE large capitalization stocks. Their time span used was from January 1973 to September 1984. The hedge portfolio was created to have equal long and short positions. They have attempted to control a number of factors. Among them size, earnings yield, share turnover as well as industry classification. Their hedge portfolio of long high book-to-market stocks and short low book-to-market stocks had an average monthly return of 0.36 percent during the 12 year time span of their study. The portfolio was positive 38 out of the 54 studied months. They have also noted strong seasonality in the returns. The average January return is 1.7% and a downward trend from the early months to the late months is documented by the Fama and French as well (Rosenberg, Reid, & Lanstein, 1985).

This has also been proven outside the United States. Louis K.C. Chan, Yasushi Hamao, and Josef Lakonishok demonstrated the performance of high book-to-market stocks in the Japanese market in their paper from May 1990. Their paper examines returns on Japanese stocks based on four variables: earnings yield, size, book-to-market ratio, and cash flow yield. They have based their research on the data ranging from 1971 to 1988 and their sample includes manufacturing and non-manufacturing companies from Tokyo Stock Exchange as well as delisted stocks. Their findings show a significant relationship between the fundamental factors and expected returns. Among four considered factors, the book-to-market ratio was one with the most significant positive impact on expected return. Monthly data on stocks listed on Tokyo stock exchange was used. The data was collected from 1971 to 1988. The database used has been set up by the Hamao and Daiwa Securities. The constructed portfolios were formed on the basis of fundamental variables known to investor as of the end of June. They have performed regression analysis on the data and find out that the BtoM variable has the expected positive sign and that the coefficient is strongly significant, at least two standard deviations away from zero in all models. They have find out that firms with large positive book-to-market ratios earn a premium of 1.10% over firms with low, positive book-to-market ratios. Among the examined variables, the book-to-market ratio consistently has the largest coefficient and the highest t-statistic.

Fama and French did a study on intersection of NYSE, AMEX, NASDAQ and COMPUSTAT in which they have examined the data in time span from July 1963 till December 1990. The authors documented a success of using value characteristics when explaining average portfolio returns compared to market returns. One hundred equally weighted portfolios have been created. Portfolios were formed based on the rank intersection of company's size, market capitalization and book-to-market ratio. Fama and French have shown that the difference in the average monthly returns for the highest book-to-market decile and the lowest book-to-market decile is 0.99 percent, compared to size decile difference of 0.58 percent. The book-to-market effect exists even when controlling for size as well as vice versa. In each size class, the average returns generally increase as the book-to-market increases and the effect is stronger for the smaller stocks. The high

minus low book-to-market portfolio difference is over 1 percent for smaller size classes, 0.25 percent for the largest size class. Authors have also shown that controlling for size and book-to-market diminishes the relationship between earnings to price and average returns (Fama & French, 1992).

More recent study performed by Chui, Titman and Wei examines the market using CRSP and DataStream international database. The data range is from February 1980 to June 2003. Among other things the authors have evaluated the returns of high and low book-to-market portfolios. The data was available for 22 countries and is based on Ken French's website. Portfolios were sorted into three groups from bottom 30 percentage to top 30 percentage. The average monthly book-to-market effect for the low, medium and high group, were the following: 0.53%, 0.43% and 0.09%. The difference in the book-to-market effect between the low and the high groups is 0.43% per month with a t-statistic of 1.87 (Chui, Titman, & Wei, 2010).

Not only that there has been proved that so-called "cheaper, value" stocks tend to yield higher results both in U.S. markets and internationally, they also tend to yield higher result than growth stocks on average (Fama & French, 2012).

Value stock defined as a stock with high ratios fundamental like book value. The logic behind including this ratio is supported by the previously reviewed literature. While literature supports our claim, our view is that we want to buy business as cheap as possible. However, we do not believe that the price of business book equity necessarily has any connection to the risk assumed. To the contrary, we strongly believe that buying businesses at lower prices brings lower risk.

Seth A. Klarman believes that the reason for their low price is that they are unheralded or just ignored. In depressed financial markets according to the author's words some securities are so out of favor that you cannot give them away. These stocks might be sling with a significant discount to their book value. As with any value investment, the greater the undervaluation, the greater the margin of safety to investors (Klarman, 1991). If we consider the book value to be on average a proxy for intrinsic value, we employ a margin of safety by buying at prices that represent low price to book, or high book-to-market for selected corporations. If we buy at considerable discounts from underlying value, we provide ourselves with room for imprecision, bad luck, or analytical error, while avoiding sizable losses. We will test the performance of that individual strategy as well as the combination with other metrics. According to Damodaran the ratio of price-to-book value is strongly influenced by the return on equity (Damodaran, 2002). In that light we would like to proceed to the next chapter.

1.2 Return on Equity

The ratio of price-to-book value is strongly influenced by the return on equity. A lower return on equity affects the price-to-book value ratio directly as well as indirectly by lowering the expected growth or payout. According to theory the price-to-book value ratio of a stable firm is supposed to be determined by the differential between the return on equity and its cost of equity. Damodaran states that if the return on equity exceeds the cost of equity the price is supposed to exceed the book value of equity (Damodaran, 2002). The ROE in itself shows how many cents of profit each euro of shareholders' capital has yielded in the financial year. It is an indicator of the success with which managers have used owners' funds (Sutton, 2004).

When investors speak of equity in the context of profitability, they are usually referring to the capital provided by a company's ordinary, common shareholders. The ROE is designed to measure the return the owners earned on their investment. The investment consists of their contributions and the cumulative profits attributable to them that were reinvested in the firm on their behalf.

Return on equity is one of the basic measures of employing capital. Return on equity reveals the rate at which shareholders are earning income on their employed capital. According to Tim Sutton return on equity is designed as follows (Sutton, 2004):

$$Return\ on\ equity = \frac{Net\ income\ attributable\ to\ ordinary\ shareholders\ in\ period}{Share\ capital\ and\ reserves\ attributable\ to\ ordinary\ shareholders\ (period\ average)} \quad (12)$$

Whereas preference share capital is not included in the denominator ROE and income attributable to these shareholders is excluded from the numerator. Since treasury stock is deducted from equity, the denominator represents the capital attributable to outstanding shares.

The author states that the ROE can be viewed as the sum of two components: the firms operating performance and the benefit to shareholders from the firm financing (Sutton, 2004):

$$ROE = Return\ on\ net\ operating\ assets + Gain\ (-Loss)\ from\ net\ financial\ leverage \quad (13)$$

The gain from net financial leverage is further broken down to:

- Difference between the firm's operating returns and its net borrowing cost (spread)
- The leveraging of that difference through use of debt (net financial leverage effect or ″netflev″)

$$\begin{aligned} &Gain\ from\ the\ financial\ leverage = SPREAD * NETFLEV \\ &= \left[\begin{array}{c}Return\ on \\ net\ operating\ assets\end{array} - Net\ borrowing\ cost\ (NBC)\right] * Net\ financial\ leverage\ effect \\ &= \left[\frac{NOPAT}{Av.NOA} - \frac{NFE}{Av.net\ debt}\right] * \frac{Av.net\ debt}{Av.SE} \end{aligned} \quad (14)$$

Company can raise the rate of return on its shareholders' funds by (Sutton, 2004):

- Improving its operating performance (higher margins, faster turnover ratio or both)
- Reducing its net borrowing cost
- Increasing its net financial leverage

The ROE relates the earnings left over for equity investors after debt service costs have been factored in to the equity invested in the asset (Damodaran, 2002).

In order to understand what the key factors determining the ROE are the Du Pont system is most commonly used. Bodie, Kane, and Marcus show the following decomposition of the ROE:

$$ROE = \frac{Net\ pofits}{Pretax\ Profits} * \frac{Pretax\ profits}{EBIT} * \frac{EBIT}{Sales} * \frac{Sales}{Assets} * \frac{Assets}{Equity} \quad (15)$$

Authors go further and describe each component separately:

- Factor one is the ratio of net income to pretax profits tells us how many units of generated profit there are to reinvest after corporate taxes are paid
- Factor two is the ratio of pretax profits to EBIT. The pretax profits will be generated when there are no interest payments to debt holders, namely when I equals zero.
- Factor three is known as the operating profit margin or return on sales. It tells us what the operating profit per unit of sales is
- If we focus on factor four, we can see that we are actually looking at the asset turnover ratio. This ratio tells us something about the efficiency of the firm's use of assets. It measures the annual sales generated by each dollar of assets
- Factor five measures the degree of financial leverage and is equal to 1 plus the debt to equity ratio (Bodie, Kane, & Marcus, 2011)

The return on equity, as a profitability measure, measures profitability for contributors of equity capital. One of important disadvantages would be using the ROE on its own without considering the capital structure of a firm behind it. There are also disadvantages that come

with GAAP shortcomings. The ROE used also might not be a good predictor of future ROE. Net income might not be the category we would like to look at. There is a question of how the equity is calculated, especially how the securities on balance are treated and so on. Despite these and other shortcomings we believe that the ROE used is a reasonably good indicator or proxy of profitability we wish to measure. The metric is also widely accessible and fairly easy to calculate and understand. The fact that we used a quantitative factor is an advantage for the purpose of this thesis.

Regardless of all negative and positive sides the ROE metric and the way we calculate it is meant to show us the amount of income returned on shareholders equity over a certain period of time. As such everything else held constant higher the ROE on our investment yields higher results and is preferable. The reasoning goes the business that can steadily grow intrinsic value at the rate of say 12% is worth much more than the business that is growing its value at say 4% annually ceteris paribus. In the real world things get a bit more complicated but that should not change our philosophy. "A business obtains the best financial results possible by managing both sides of its balance sheet well. This means obtaining the highest-possible return on assets and the lowest possible cost on liabilities" (Buffett, 1987).

In his letter to shareholders Buffett also mentions the study performed by Fortune that supports his view. In this test 25 out of 1,000 businesses had a return on equity of over 20% in ten years, from 1977 to 1986, and no year less than 15%. He goes on and says that during the decade 24 out of 25 outperformed the S&P 500. In addition most of them had very low leverage (Buffett, 1987).

Investors often distinguish between good firms and good investments. A good firm might be highly profitable and have correspondingly high ROE, but if its stock price is selling at extremely high price-to-book multiples, the earnings yield to investors are supposed to diminish. High ROE in itself does not imply that the stock is a good investment. Firms with low ROEs can be even better investments if their prices are low enough (Bodie, Kane, & Marcus, 2009). This thought has been taken into consideration with one of the portfolios as well. Following research confirms the before mentioned.

1.2.1 Research

Wilcox developed the price-to-book ratio, return on equity approach to stock valuation in 1984. The model approach is shown to be a surprisingly effective tool for a broad variety of uses, including the explanation of current prices and the prediction of future differences. Wilcox (1984) posited a strong relationship between the price-to-book value ratio and the return on equity. He based his research on Value Line Stocks (Wilcox, 1984).

In 2005 the P/B-ROE Valuation Model Revisited was published. The authors have enhanced the model for predicting both individual stocks as well as market indices. The model includes three assumptions: (1) constant growth rate in the stock's book value, (2) constant expected return on equity, (3) and constant expected dividend yield. The data they used was from Value Line, and the study period from 1984 through 2003. The sample size

ranges from 700 firms in 1988 to about 1,900 in 2003. Authors discover the following. The average forecast horizon for abnormal ROE is 3.66 years. Sensitivity ranges from 2.37 to 6.47 years. The model explanatory power improves if the ROE is less volatile. The authors state simplicity, widespread applicability, and adaptability for empirical estimation as the main advantages (Wilcox & Philips, 2005).

Kewei Hou, Chen Xue and Lu Zhang in their paper titled "*Digesting anomalies: an investment approach"* among other things also examine the effect of the ROE. They sorted all stocks into deciles based on the NYSE breakpoints of the ranked values of ROE each month. Data is based on the Compustat database. Their portfolios are rebalanced monthly. Their high minus low decile returns earned on average return of 0.81% per month, more than three standard errors from zero. The CAPM, Fama-French model and the Carhart all failed to explain the ROE effect. High minus low alphas with these models were 0.97%, 1.19% and 0.86% (Hou, Xue, & Zhang, 2012).

A firm's capacity to earn excess returns in the business is an important determinant of the company value. The size and expected duration of these excess profits should be examined. There is a variety of frameworks on how to do that. One of the better known is the five forces competition framework developed by Porter. According to Porter's framework, a firm is able to maintain high return on equity because there are significant barriers for new firms to enter or because the firm has significant advantages over its competition (Damodaran, 2002).

Applying the previous paragraph, the firm that has higher returns on equity employing the same or similar amount of capital should be worth more ceteris paribus. In order to come close or at least close to assessment of that kind of special value of the firm we employed the five year average return on equity as one of the selective metrics to look at. With all limitations we expect that with that kind of assumption we acquired a quantitative factor which should be a reasonably good proxy for finding firms with greater potential of being above average performers.

The idea behind this metric is that one would rather have a business that earns high return on capital than one that earns low return on capital ceteris paribus. This factor would necessarily be combined with the price-to-book metric, since we want to buy a great business at a bargain price. Buying a share of good business is better than buying a share of a bad business. One way to do this is to purchase a business that can invest its own money at high rates of return rather than purchasing a business that can only invest at lower ones. If we consistently continue to do this, we should crush the stock market indexes. We will also perform a calculation of portfolio returns based solely on this metric.

Investors may simply have a preference for investing in "good" companies with high levels of profitability and superior management. Unsophisticated investors may equate a good company with a good investment irrespective of the price. They may even perceive such stock to be less risky (La Porta et al., 1997). The BtoM +ROE portfolio will be constructed within this context.

1.3 Market Capitalization

If we multiply the total number of outstanding shares with their current market price, the result is market capitalization. The portfolio strategy based on market capitalization is perhaps one of most simple strategies. Banz (1981) and Reinganum (1981a, 1981b) established that on average small firms earned higher rates on return than large firms.

Rolf W. Banz examined the empirical relationship between the return and the total market value of NYSE common stocks. He had found out that the smaller firms have had higher risk adjusted returns on average than large firms. He went further and determined that the size effect is not linear. The main effect occurs for very small firms while there is little difference in return between average sized and large firms. The author based the empirical tests on a generalized asset pricing model which allows the expected return of a common stock to be a function of risk β and an additional factor, the market value of the equity. All common stocks quoted on the NYSE for at least five years between 1926 and 1975 were included in the sample. In his paper the author finds out that on average small NYSE firms had significantly larger risk adjusted returns than large NYSE firms over a forty year period (Banz, 1980).

In his paper titled Earnings' yield and the size effect from 1983, Basu examined the size effect. He had examined the sample of companies traded on the NYSE between December 1962 and March 1980. He used NYSE and COMPUSTAT database. Basu examined whether the high return associated with stocks that have high earning yields is related to the high return attributed to stocks with small market capitalizations. In other words, he had examined the size effect. The firms the author examined are ranked by years using earnings yield and size. Five equally weighted portfolios are constructed. The high earnings yield portfolios perform better than the low earnings yield portfolios within each market value class. The raw returns are highest for high earnings yield small stocks. The high minus low spread varies between 0.3 percent and 0.5 percent per month. The common stocks of small NYSE firms appear to have earned substantially higher returns than the common stock of large NYSE firms (Basu, 1983).

Debond and Thaler worked on monthly data for New York Stock Exchange common stocks compiled by the University of Chicago to look into this puzzle. Their data span was between January 1926 and December 1982. They used an equally weighted arithmetic average rate of return on all Center for Research in Security Prices listed securities. Authors confirm the small firm effect. They also notice the interaction between the small firm and January effects. Their findings redefine the small firm effect as a losing firm effect around the turn of the year. Persistently losers earn exceptionally large January returns, while winners do not (De Bondt & Thaler, 1985).

Lakonishok, Shleifer and Vishny evaluated the performance of several value strategies based on several measures of value in the NYSE, AMEX and COMPUSTAT database universe. The sample stars in April 1963 and ends in April 1990. Among other things authors restricted their analysis only to large stocks and found similar return differences

between the value and glamour stocks suggesting that the value strategies are useful for large stocks as well as for small stocks (Lakonishok, Shleifer, & Vishny, 1994).

In their paper authors used international stock returns and accounting data primarily from Bloomberg but supplemented it by DataStream and Worldscope. The sample period they have used is November 1989 to March 2011. They have examined 23 countries. In their research paper Fama and French confirm that there is a standard size effect, the small extreme value portfolios have higher average returns than the big extreme value portfolios. Evidence that international value premiums are larger for small stocks seems contrary to the results from their 2006 paper. They suggest that that is due to thinness of the small stocks examined in the earlier paper. Their more complete sample from the 2012 paper suggests that for small stocks larger value premiums are typical (Fama & French, 2012).

1.4 Altman's Z Score

Altman's Z-score is a simple formula that only requires quantitative input. The Z-score formula is built to predict bankruptcy within two years. It was first published by Edward I. Altman in 1968. The model is built exclusively for industrial corporations.

The formula is based on empirical research. In his paper from 1968 Edward I. Altman describes the Z-score in the following way:

$$Z=0.012X^1 + 0.014X^2 + 0.033X^3 + 0.006X^4 + 0.999X^5 \quad (16)$$

$$X^1 = Working\ capital/Total\ assets \quad (17)$$

A frequently used measure of the net liquid assets of the firm relative to its total assets. Working capital is defined as a difference between current assets and current liabilities. The author used that measure because he discovered that a firm experiencing consistent operating losses will have shrinking current assets in relation to its total assets.

$$X^2=Retained\ earnings/Total\ assets \quad (18)$$

A relatively young firm will probably show a low ratio because it has not had the time to increase its profits. Ceteris paribus the probability of bankruptcy against an older firm is relatively higher.

$$X^3=Earnings\ before\ interest\ and\ taxes/Total\ assets \quad (19)$$

According to the author of the Z-score, this ratio is a measure of true productivity of the firm's assets eliminating the tax or leverage factor. Taking into account that bankruptcy

occurs when total liabilities exceed fair valuation of the firm's assets, while the value is determined by the earning power of the assets.

$$X^4 = Market\ Value\ Equity/Book\ Value\ of\ Total\ Liabilities \quad (20)$$

In the original measure equity is measured by the combined market value of all shares of the stock, namely preferred and common, while debt includes both current and long-term. This measure is used to show how much a firm's assets can decline in value before the liabilities exceed the assets and the firm becomes insolvent. The author claims that this tends to be a more effective indicator of bankruptcy than a similar Net worth/Total debt ratio based on book values (Altman, 1968).

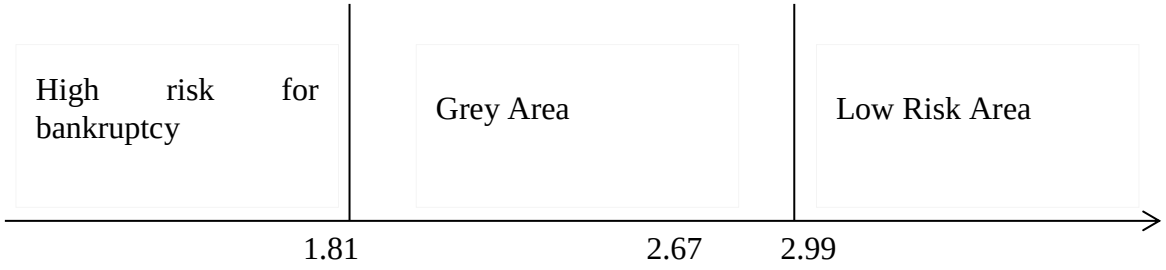
$$X^5 = Sales/Total\ Assets \quad (21)$$

The capital turnover ratio is included as a measure of the management's capability in dealing with competitive conditions.

$$Z = overall\ index \quad (22)$$

The model is one of most well-known distress prediction models. In addition to the stock market variable the study showed four balance sheet and income statement variables. Liquidity, profitability, leverage, solvency and activity were examined. Each company was given a Z-Score. The examined companies were listed on the Stock Exchange. The study showed that companies with a Z-Score of less than 1.81 were high risk and likely to go bankrupt. Companies with a score exceeding 2.99 were healthy, while scores between 1.81 and 2.99 represent a grey area and have less predictable outcomes (Altman, Danovi, & Falini, 2013).

Figure 2. Z Score Classification Areas



The Z-score was developed and tested for the first time by Edward I. Altman in 1968. He tested it on a sample of sixty-six corporations with thirty-three firms in each of the two groups. One group was a group of bankrupt firms, while the other group consisted of randomly selected corporations. Based on the previous studies he determined that there is a list of twenty two potentially helpful ratios. The author proved that the discriminant ratio model tends to be extremely accurate in predicting bankruptcy correctly in 94 percent of

firms in the initial sample. The discriminant function was also accurate in several secondary samples. The author concludes that the bankruptcy can be accurately predicted up to two years prior to actual failure with accuracy diminishing rapidly after the second year (Altman, 1968).

The author tested the model on a different sample in another period. He performed three tests and examined 86 distressed companies from 1969 to 1975, 110 from 1976 to 1995 and 120 from 1997 to 1999. He found that the Z-Score model, using a cut of score of 2.675, was between 82 percent and 94 percent accurate. In repeated tests up to 1999, the accuracy of the Z-Score model on a sample of distressed firms ranged from 80 to 90 percent. He based his research on data from one financial period prior to bankruptcy. In his paper the author suggests the use of a lower bond, namely 1.81, as a more realistic cutoff Z- Score than 2.675, since it has resulted in the lowest overall error in the original tests (Altman, 2000).

June Li examined the prediction of corporate failures in the U.S. during 2008 to 2011 using Z-Score model. His sample consists of all publicly traded companies that filed for Chapter 11 and Chapter 7 bankruptcies in the U.S. between 2008 and the first quarter of 2011. The companies were identified from two sources: COMPUSTAT and BankruptcyData.com. There were 106 companies and 66 companies that filed for Chapter 11 and Chapter 7 bankruptcies. Firms with incomplete or missing data were eliminated. The final sample size was 70. For each bankrupt firm a solvent firm in the same industry and of the closest asset size in the bankruptcy year was identified. A random sample of 20 out of 70 was selected in order to test the model accuracy. Altman's model based on data gathered from COMPUSTAT yields gave consistent results and performed well in predicting bankrupt firms, with accuracy rates ranging from 80 to 94 percent. The model yields even better prediction accuracy from one year prior to bankruptcy (Li, 2012).

Numerous other recent studies document similar positive evidence of Altman's Z- Score in predicting corporate financial distress. To name a few: (Gutzeit, 2011), (Li & Miu, 2012), (Satish, 2011), (Wang, 2010), (Lugovskaya, 2010) and (Gerantonis, 2009).

1.5 Combination of variables

Eugene F. Fama and Kenneth R. French found that in multivariate tests negative correlation between size and average return is robust to inclusion of other variables, however the positive relation between book-to-market equity and average return also persist in competition with other variables (Fama & French, 1992). Mohanram shows that traditional combination of earnings and cash flows with earnings stability and other factors tailored for growth firms earns significant excess returns (Mohanram, 2005). Some authors suggest including new variables to summarize the state of the economy, such as surplus consumption ratio (Campbell & Cochrane, 1999), consumption-to-wealth ration (Duffe, 2005), or the labor income-to-consumption ration for example (Santos & Veronesi, 2006). It is frequently stated that companies with a high book-to-market value are assigned a

higher risk premium because of the greater risk of distress. John M. Griffin and Michael L. Lemon examined the relationship between the book-to-market equity, distress risk and stock returns and found out that there is a high return differential in returns between high and low book-to-market securities among firms with the highest distress risk (Griffin & Lemmon, 2002). In addition to these authors Ou and Penman for example show that an array of financial statements can accurately predict future changes in earnings (Ou & Penman, 1989), while Holthausen and Larcker show that a similar statistical model could be used to successfully predict future excess returns directly (Holthausen & Larcker, 1992).

The idea behind selecting companies based on multiple criteria is that one would have superior chances of outperformance by selecting highly profitable predictable companies, with low probability of default at low prices. One is more likely to find such companies among smaller corporations which in general also have higher potential for growth. Following the ideas of the above mentioned authors and the results of their research studies, multiple variable approach is going to be examined within this text. The above mentioned research provided motivation to investigate the accuracy of predicting future returns using multiple variables criteria.

2 HYPOTHESES

Based on the literature review we developed the below described hypotheses predicting factors of outperformance. Throughout our hypotheses we attempted to investigate whether it makes sense to construct a portfolio and abandon the index as well as if such effort still makes sense when adjusting it to the expected higher volatility of our portfolio and whether we would be able to make similar or higher returns simply by purchasing small or high book-to-market stocks.

2.1 Testing performance

We used the below mentioned benchmarks to test the performance of the strategies.

2.1.1 S&P

H_0: Return of the selected portfolio is equal to the return of the general market[1].

H_1: Return of the selected portfolio is higher than the return of the general market.

In order for our strategy to make sense it needs to outperform the previously declared benchmark. If one believes that the benchmark is too low for his set of opportunities and does not expect high enough outperformance of the strategy, one should avoid it. However, it is our opinion that the S&P benchmark is very high for majority of individuals and funds and is a very tough competitor to beat in the long run.

[1] S&P 500

There are only two possible outcomes for this test - the strategy beats the benchmark or it does not. If it does and continues to do so in the long run, it provides us with a powerful tool worth considering. But even if this is the case, the strategy shall not represent a definite guide to investing since there is always a possibility that the history was just a onetime event and our results are a coincidence.

2.1.2 CAPM

H_0: The return of the selected portfolio is equal to the return of the general market[2] taking risk in consideration.

H_1: The return of the selected portfolio is higher than the return of the general market taking risk in consideration.

Many people consider volatility a risk. If we would like to provide these people an investment strategy, we have to prove that our tool of selection is interesting to them. Volatility of the constructed portfolio has to be, ceteris paribus, lower than the volatility of the benchmark. Our portfolio has to yield higher results than the CAPM model during the same period.

2.1.3 Fama French

H_0: The return of the selected portfolio is equal to the return of the general market[3] taking risk in consideration.

H_1: The return of the selected portfolio is higher than the return of the general market taking risk in consideration.

After examining absolute and relative returns the question that remains is whether there is an option for an individual investor to only buy a low cost index fund focusing on small companies or companies with low price-to-book ratios and outperform the strategy, especially after taking into account potential fees and commissions. If we are able to prove that our return is not solely based on small low price-to-book volatile companies we would prove that our selection criteria has a so-called alpha return that is not explained by these variables. In order to investigate this issue further we calculated the benchmark Fama French returns. If a portfolio can consistently beat these returns, one can except H_1.

2.2 Testing feasibility of selection criteria

The question to be explored here is whether it makes sense to build a portfolio on multiple selection criteria.

[2] S&P 500.
[3] S&P 500.

2.2.1 Combination of variables outperform

H_0: The four variables portfolio outperforms every single other considered portfolio.

H_1: The four variables portfolio does not outperform every single other considered portfolio.

If the four variables portfolio beats every single other portfolio over the observed period, we can state that on average that approach was better to use than any other we observed. We will also analyse all other variables to make the results comparable.

2.3 Testing portfolio stability

2.3.1 Drawdowns

H_0: The maximum drawdown is equal or lower than the maximum drawdown of the market.

H_1: The maximum drawdown is greater than the maximum drawdown of the market.

Since the feeling of losing money brings serious emotional distress that leads to irrational behavior in many people, we decided to test the maximum portfolio drawdown against the market maximum drawdown over the observed period.

3 METHODOLOGY

First we select 20 companies to construct a portfolio. They are selected based on the four metrics, namely the five year average reported return on equity (ROE), book-to-market ratio (BtoM), Altman's Z-score (AZS) and market capitalization (Mcap). In Four Vriables portfolio, all these metrics are equally weighted. Each of the 20 companies represents an equal stake (1/20). The returns include dividends. The portfolio is rebalanced every year from 2000 to 2012 and sold out in May 2013.

Portfolios were constructed and measured for each individual variable as well as for combination of the return on equity and book-to-market portfolio and a combination of all variables. All portfolios are built within the S&P 500 index.

After measuring raw returns, performance benchmarks are set up. First benchmark is the S&P total return. Second benchmark is the CAPM expected return. The third benchmark is the expected Fama French Model return.

3.1 Portfolio concentration

As with everything, there is a debate regarding diversification. We will present the two views and then argument number of shares in our portfolio.

Brigham claims that diversification is crucial. By diversifying wisely, he says, an investor can dramatically reduce risk without reducing their expected returns (Ehrhardt & Brigham, 2011). The main idea of diversification is to reduce specific risk through holding a number of companies in various industries (Rosenbaum & Pearl, 2009).

On the other hand, Warren Buffett explains that the riskiness of an investment is not measured by beta but rather by the probability of that investment causing its owner a loss of purchasing power over his contemplated holding period. Assets can fluctuate greatly in price and not be risky as long as they are reasonably certain to deliver increased purchasing power over their holding period (Buffett, 2012). In the 1993 Berkshire Hathaway annual report Warren Buffet writes that the policy of portfolio concentration may as well decrease the risk if it rises, as it should, both the intensity with which an investor thinks about a business and the comfort level he must feel with its economic characteristics before buying into it. He also states that the conventional definition of risk is far off the mark and even produces absurdities. He gives an example of a company whose stock has dropped very sharply compared to the market. The company then becomes "riskier" at a lower price than it was at a higher price. He goes on to pose a question whether that would make sense to someone who was offered the entire company at a vastly reduced price. In the next paragraph he adds that the true investor welcomes the volatility, because that means that the wildly fluctuating market will offer opportunities of solid businesses with irrationally low prices attached to it (Buffett, 1993).

In the same annual report Buffett states that while the risk cannot be calculated with engineering precision, it can, in some cases be judged with a degree of accuracy that is useful. He states the following as the primary factors of evaluation (Buffett, 1993):

- The certainty with which the long-term economic characteristics of the business can be evaluated
- The certainty with which management can be evaluated, both as to its ability to realize the full potential of the business and to wisely employ its cash flows
- The certainty with which management can be counted on to channel the rewards from the business to the shareholders rather than to itself
- The purchase price of the business
- The levels of taxation and inflation that will be experienced and that will determine the degree by which an investor's purchasing power return is reduced from his gross return

For the purpose of research we use portfolios of 20 companies, which should provide enough diversification, and consequently safety though we do not go into depth with research of individual companies.

3.2 Portfolio construction and company selection

The entire thesis and research is based mostly on the Bloomberg database from which the data was gathered. Firstly, we built a database of U.S. corporations that were in S&P 500

index on the portfolio rebalancing date. We determined that the portfolio should be rebalanced on the first trading day of May since the selection criteria should be widely available and analyzed by then. The first portfolio was constructed in May 2000 and last sold out in May 2013.

All corporations which were missing data required for the applicable selection criteria were removed from the database. For the purpose of constructing Four Variables portfolio companies were ranked by an individual criterion as a first step. The highest ranking or "the best" company was ranked 1, while the "worst" corporation was ranked n. The corporation with the highest five year average the ROE was ranked 1. The corporation with the highest book-to-market ratio was ranked 1. The company with the highest Z-Score was ranked 1^{st}. The company with the lowest market capitalization was ranked 1. The top 20 companies in accordance with the selection criteria were selected for the portfolio.

After assigning ranks the combined rank was calculated. The mentioned combined rank determined whether the company will qualify for the portfolio or not. For example, if a company would rank 1^{st} in five year average ROE, it would have the second best rank in the book-to-market ratio (2^{nd}), third highest Z-Score (3^{rd}) and would be the 4^{th} smallest corporation within the S&P 500. Its total rank would be the sum of these numbers and would be calculated as follows: 1+2+3+4=10. The company with the lowest total score would rank the highest. All categories were assigned with equal weights.

After ranking the companies and calculating the total rank, top 20 of the corporations with the lowest total rank were selected. These 20 corporations represent the portfolio. First portfolio was constructed with data available on first trading day in May 2000. The portfolio of companies was held until May 2001 and rebalanced on the same day using same criteria, but based on the newly available data.

The ranking for inclusion in other portfolios was performed in a similar manner. The difference between the previously described ranking and the ranking performed for other portfolios is that other portfolios were ranked based on a single variable.

- Price-to-book portfolio – in every year only 20 companies that were included in S&P 500, and ranked the lowest according to the metric were included in the portfolio
- ROE portfolio – in every year 20 companies that were included in the S&P 500, and had the highest reported five year average ROE were included in the portfolio
- AZS portfolio – in every year 20 companies that were a part of the S&P 500 and had the highest Altman's Z-Score were included in the portfolio
- Mcap portfolio – in every year 20 of the smallest companies that were part of the S&P 500 index were included in the portfolio
- BtoM + ROE – in every year 20 companies were selected based on the book-to-market ratio and average five year return on equity. The ranking was based on the same principle as for the purpose of the Four Variables Portfolio. The difference is that only BtoM and ROE rankings were considered. The 20 companies with the lowest sum of rankings were included in portfolio each year

Using the previously described selection criteria we narrowed the list down to names of corporations that construct our portfolio.

3.3 Calculating returns

3.3.1 Portfolio returns

The next stock price (t+1) was divided with the price of a stock we would have paid for the stock on the day of portfolio rebalancing (t). Gross dividends we would have received were included in the next year stock price. These dividends were summed with the t+1 stock price regardless of their payout date; no reinvesting of dividends within a year was considered. Dividends would be held as cash until the date of portfolio rebalancing. When rebalancing, these dividends would be included to buy new stock based on the same quantitative selection criteria.

We used the following formula:

$$Percentage\ Return = \frac{(Pt+1) + Dividend}{Pt} \tag{23}$$

Where:

- P_t: the price on the day of purchase
- P_{t+1}: stock price on the day of portfolio rebalancing, the first trading day in May one year after t
- Dividend: Gross dividend payout during the period of holding a stock based on the dividend yield

Individual stock returns were then weighted with their relative size in the portfolio. Since the portfolio consisted of 20 corporations and each was assigned equal weight, the returns were multiplied with 1/20 and summed up. The result of this calculation is the portfolio yearly return.

After calculating these, the average return, average compound rate of return and compound return were calculated. These metrics were calculated for all portfolios in order to enable the comparison.

Market return was calculated as the S&P 500 return including dividends with the same time frame as portfolio holding period in order to be comparable. Each individual portfolio performance was measured and evaluated against the index return.

3.3.2 CAPM

The Capital Asset Pricing Model is based on the premise that equity investors need to be compensated for their assumption of systematic risk in the form of a risk premium, or the amount of market return in excess of a stated risk free rate (Rosenbaum & Pearl, 2009).

Capital Asset Pricing Model is many times considered to be a centerpiece of modern financial economics. The result of this model is an exact prediction of the relationship between the risk of an asset and its expected return. The relationship serves two vital functions:

- It provides a benchmark rate of return for evaluating possible investments
- The model helps us make an educated guess as to the expected return on assets that have not been traded on the market

Although the CAPM does not fully withstand the empirical tests, it is widely used because of the insight it offers and because its accuracy is deemed acceptable for important applications (Bodie, Kane, & Marcus, 2009). The Capital Pricing Model was developed in 1964 in articles by William Sharpe (Capital Asset Prices: A Theory of Market Equilibrium), John Lintner (The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets) and Jan Mossin (Equilibrium in a Capital Asset Market).

According to Bodie, the CAPM is built on the insight that the appropriate risk premium on an asset will be determined by its contribution to the risk of investors' overall portfolios. (Bodie, Kane, & Marcus, 2009)

With help of the following model we calculated the expected return:

$$E(ri)=rf+\beta[E(rM)-rf] \quad (24)$$

- $E(ri)$ stands for expected return
- rf stands for risk free
- β stands as a measure of volatility
- $E(rM)$ stands for expected market return

At least two potential issues with the CAPM should be noted (Ehrhardt & Brigham, 2011):

- It has never been proven that investors base their required rates of return on the CAPM equation
- Numerous studies provided no definite answer regarding the model's validity

3.3.2.1 Risk free rate of return

The risk-free rate of return is obtained by investing in a riskless security. According to (Rosenbaum & Pearl, 2009) the U.S. government, securities such as T-bills, T-notes, and T-bonds are accepted by the market as risk free securities. The general goal is to use as long dated instrument as possible to match the expected lifespan of the company, while taking into account practical considerations. Ehrhardt and Brigham (Ehrhardt & Brigham, 2011) support that view claiming that the real risk free rate is the one that would exist on a riskless security if no inflation was expected. They also add that it may be thought of as the rate of interest on short term U.S. Treasury securities (Ehrhardt & Brigham, 2011). In their

ninth edition the authors state that the real risk free rate is not static, but changes over time (Eugene & Daves, 2007).

3.3.2.2 Beta

The primary conclusion of the CAPM is that the relevant risk of an individual stock is the amount of risk the stock contributes to a well-diversified portfolio. The benchmark for a well-diversified stock portfolio is the market portfolio, which is a portfolio containing all stocks. Therefore, the relevant risk of an individual stock, which is called beta coefficient, is defined under the CAPM as the amount of risk that the stock contributes to the market portfolio (Eugene & Daves, 2007). According to Sutton, beta is a stock market linked indicator of volatility, a company with beta of 1 on its shares fluctuates in line with the return on the stock market. Such a firm is considered to be of average risk. A riskier firm would have beta greater than 1 (Sutton, 2004). The beta coefficient used by investors should reflect the relationship between the stock's expected return and the market's return during the same period (Ehrhardt & Brigham, 2011). Beta is a measure of the covariance between the rate of return on a company's stock and the overall market return, with the S&P 500 traditionally used as a proxy for the market (Rosenbaum & Pearl, 2009). In practice it is common to use 1 to 2 years of weekly returns for beta calculation (Ehrhardt & Brigham, 2011).

Some practical issues that arise when estimating beta (Ehrhardt & Brigham, 2011):

- There is no theoretical guidance as to the correct holding period for measuring returns. One can use daily, weekly or monthly periods and betas will differ
- Beta is sensitive to the number of years of data that are used
- In theory the market return should reflect returns on every single asset. In practice it is common to only use an index of common stocks, such as S&P 500
- One has to select between different types of betas, such as adjusted beta or fundamental beta
- The estimate of beta for an individual company is statistically imprecise

3.3.2.3 Market premium

The market risk premium is the additional return that the investors demand for investing in risky securities as represented by the overall stock market (Sutton, 2004). It represents the spread of the expected market return over the risk free rate (Rosenbaum & Pearl, 2009). The required return on the market, and hence the equity premium, are not directly observable. The below three approaches may be used to estimate the premium (Ehrhardt & Brigham, 2011)

- Historical premiums
- Survey experts
- Estimating forward looking premiums with the help of the current market value

Result of performing this calculation is expected market return for an asset of similar risk, taking volatility as a risk proxy.

In order to calculate the market expected return we have taken the following steps. The risk free rate has been estimated using the one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing. We think that this is a proper risk free equivalent since it has the same maturity as portfolios, as well as very high probability of repayment. Expected market return was calculated as S&P500 return including dividends for the observed period. Expected returns were calculated for each observed year and treated the same as portfolio returns in other calculations.

3.3.3 Fama French returns

The Fama French three factor model was used in order to evaluate the portfolio performance. Fama and French expended the CAPM model with two additional factors, namely size and value. This model should adjust portfolio outperformance for the contribution of these two additional factors. Some think of it as a better tool for evaluation of management performance. In our opinion that depends on the alternatives, but it tells us one thing, if the majority of benchmark outperformance comes from value or small cap stocks; one might reconsider its investing approach.

According to the author this model is an alternative approach to specifying factors as candidates for relevant sources of systematic risk. The variables are chosen based on empirical evidence. They seem to predict average returns well and it is therefore argued that they may be capturing risk premiums. The systematic factors in this model are firm size, the book-to-market ratio as well as the market index. Fama and French were motivated by the fact that historical average returns on stocks of small firms and on stocks with high ratios of book equity-to-market equity are higher than predicted by the security market line of the CAPM.

$$r_{it}=\alpha_i+\beta_{Im}R_{Mt}+\beta_{iSMB}SMBt+\beta_{iHML}HML_t+e_{it} \quad (25)$$

$$E(r_i)-r_f=a_i+b_i[E(r_M)-r_f]+s_iE[SMB]+h_iE[HML] \quad (26)$$

- SMB = Small Minus Big, the return of a portfolio of small stocks in excess of the return on a portfolio of large stocks
- HML = High Minus Low, the return of a portfolio of stocks with high book-to-market ratio in excess of the return on a portfolio of stocks with low book-to-market ratio
- b_i, s_i, and h_i are the betas of the stock on each of the three factors (Bodie, Kane, & Marcus, 2009).

If these are the relevant factors, excess returns should be fully explained and the intercept of the equation should be zero.

The two characteristics are chosen because of the long standing observation that market capitalization and the book-to-market ratio predict deviations of average stock returns from levels consistent with the CAPM. Fama and French argue that these are risk factors with several arguments. They are pointing out that firms with high book-to-market value are more likely to be in financial distress and that small stocks may be more sensitive to changes in business conditions. On the other hand, there are authors who claim that the

value premium is a manifestation of market irrationality. The argument is that analysts tend to extrapolate recent performance too far out into the future, and thus tend to overestimate the value of firms with good recent performance. Thus on average glamour firms tend to underperform the value firms because of excessive optimism embedded into glamour (Bodie, Kane, & Marcus, 2009).

Bodie, Kane and Marcuse state that the problem with Fama French approach is that none of the factors in the model can be clearly identified as hedging a significant source of uncertainty. There is always a possibility that the past patterns appeared only by chance. The return premium to firm size has proven to be inconsistent[4] since discovered. Fama and French mitigate the potential effects of data snooping predicting average returns in various time periods and markets (Bodie, Kane, & Marcus, 2009).

The Fama-French three factor model version of the CAPM Security Market Line for the required return on stock is (Ehrhardt & Brigham, 2011):

$$r=rf+a+b(rm-rf)+c(SMB)+d(HML) \quad (27)$$

Where:

- r – Historical rate of return on stock i
- rf – Historical rate of return on the risk free rate
- rm – Historical rate of return on the market
- SMB – Historical rate of return on the small size portfolio minus big size portfolio
- HML – Historical rate of return on the high book-to-market portfolio minus low book-to-market portfolio
- A – vertical axis intercept term for stock i
- B,c, and d – slope coefficients for stock i

Correctness of the model is under question according to (Ehrhardt & Brigham, 2011) several studies which suggest the following:

- that the size effect no longer influences stock returns
- that there never was any size effect (peculiarities in the data sources)
- that the size effect does not apply to most companies
- that the book-to-market effect is not as significant as first predicted
- that the book-to-market effect is not a function of risk
- if the composition of a company's assets were changing over time with respect to the mix of physical assets and growth opportunities, than this would be enough to make it appear as though there were size and book-to-market effects

In order to build Fama French benchmark, regression coefficients have been estimated for each portfolio. Regressions have been run on the excess portfolio return versus the data

[4] See Fama, E. and French, K.,»Value versus Growth the International Evidence«, Journal of Finance, December 1998

retrieved from Ken French website. Based on these coefficients Fama French returns were estimated. To do so, following steps were taken:

1. Data collection and calculation:

- r_f: we took market yields on a one year constant maturity treasury bill as a proxy of a risk free rate (the data is retrieved from FED database, as stated on the day of portfolio rebalancing)
- $(r_m - r_f)$: The market premium used was retrieved from Kenneth R. French Database
- r: selected portfolio return during a period
- SMB and HML factors were retrieved from Kenneth R. French database

2. In order to estimate the coefficients (a, b, c and d) linear regression was run on previously described data over the period of 13 years (2000-13). Regressions were run for each individual portfolio.
3. Based on calculated coefficients and previously described data (namely: r_f, r_m, SMB and HML) the expected portfolio return was calculated
4. Example (The four variables portfolio, year one – 2000 to 2001):

- Step one: general equation used

$$r=rf+a+b(rm-rf)+c(SMB)+d(HML) \tag{28}$$

- Step two: calculation and inclusion of coefficients (a or alpha is excluded intentionally for the purpose of benchmark return calculation)

$$r=rf+0.84*(rm-rf)-0.49(SMB)+1.13(HML) \tag{29}$$

- Step three: inclusion of other variables and calculation of required return (unit of numbers shown is %)

$$19.22=6.24+0.84*(-16.71)-0.49(-5.69)+1.13(21.39) \tag{30}$$

3.3.4 Sharpe ratio

According to the sharperatio.net, the Sharpe ratio is an economic tool which allows investors to calculate the risk of the investment relative to its return. It is possible to apply the equation in the retrospect to *assess* how a particular portfolio performed over a specific period of time. It can also be used to make predictions (Sharperatio, 2014). A higher number indicates greater return on the same risk, or same return on less risk. In addition to other measures the Sharpe ratio was calculated for each constructed portfolio as follows.

Sharpe's reward-to-variability ratio is defined as the portfolio's average excess return over the risk free rate divided by its standard deviation (Ehrhardt & Brigham, 2011).

$$Sharp\ Ratio\ (for\ portfolios)=\frac{Excess\ return}{SD\ of\ excess\ return} \tag{31}$$

Source: Bodie, Kane and Marcus, Investments 8th edition, p. 129

Excess return was calculated as the difference between the portfolio return and the return on the used risk free asset. The standard deviation used in the denominator was calculated on same excess returns as the one used in the numerator.

The Sharpe ratio is a measure of reward to total volatility. The Sharpe ratio can be used to rank portfolio performance (Bodie, Kane, & Marcus, 2009). Its main strengths and weaknesses are presented below (Sharperatio, 2014):

Strengths:

- Simplicity
- Only the rate of return, the benchmark figure, and the standard deviation are required

Weaknesses:

- Variety of factors is not taken into consideration
- The standard deviation is only valid when used with normal distribution
- Sharpe ratio does not account for the extreme examples
- The risk free return is hard to determine
- It does not account for inflation

3.4 Limitations

There are several limitations to our research which need to be taken into consideration when interpreting the results. If one would attempt to apply the strategies investigated in this thesis, they should reflect upon following issues beforehand:

- Calculations were performed only within the S&P 500 index and within a very short time frame
- No really small capitalization stocks were examined, since the stocks were selected within the S&P 500 index
- No international stocks were taken into consideration
- All companies for which the data was not provided by the Bloomberg database were deleted from the database
- No financial stocks were taken into consideration, since Altman's Z-Score is only calculated for industrial corporations, thus banks were avoided crisis in and crisis out
- Dividends used for the calculation of performance are based on gross dividend yields
- Stock dividends were not taken into consideration
- Stock splits were not taken into consideration
- If there was no information on dividend yields, dividend yields were assumed to be zero
- When calculating the Fama French benchmark performance most of the coefficients were not significant most probably due to the short time period examined and consequently lack of data. The coefficients were used in the calculations anyway. If

the coefficients would be assumed to be zero, a kind of the CAPM would be calculated as a benchmark return
- No transaction costs, no fees and no taxes have been taken into consideration
- If a company falls out of index, it is assumed to be sold out of the portfolio on its last trading day in the S&P 500 index. This might not be possible and the price might differ materially. The price assumed might not be the price we could sell securities at. The company might get bankrupt, liquidity might diminish significantly, or some other unpredictable event might occur

3.4.1 Further research possibilities

- Reinvestment of dividends within the period was not taken into consideration. This is also an option that we yet to examine and might provide interesting further research material
- Based on the relative importance of performance factors and other characteristics the adjusted portfolio might be constructed
- One might also examine whether firms that rank better on average also perform better than the firms that rank less favorably
- If one would increase or decrease the portfolio size, the results might differ materially

Limitation due to the reported accounting data is nicely stated by Seth A. Klarman the reported book value, earnings, and cash flow are only the best guess of accountants who follow a fairly strict set of standards and practices designed rather to achieve conformity than to reflect economic value (Klarman, 1991).

3.5 Data

In this section we will state the kind of data we used and where we got it from. We will list the databases, their characteristics and the reason for data selection.

The data that was analyzed was based on the selected companies included in the S&P500 index on the day of portfolio rebalancing. S&P Dow Jones U.S. indices are designed to reflect the U.S. equity market. The S&P 500 focuses on the large-cap sector of the market, however since it includes a significant portion of the total value of the market, it is also widely considered to represent the market.

In order to qualify for the index, a company is filtered through the following criteria:

- Market capitalization
- Liquidity
- Domicile
- Public Float
- Sector Classification
- Financial Viability
- IPOs have some additional criteria
- Eligible Securities

The 2014 criteria for the company to qualify for the S&P 500 are the following:

- The company should have market capitalization of at least USD 4.6 billion
- The market capitalization of a potential addition to an index is looked at in the context of its historic trends as well as those of its industry
- The ranges are reviewed in order to assure consistency with market conditions
- Company should also trade a minimum of 250,000 shares
- Company should have a ratio of at least one when comparing the annual dollar value traded to float adjusted market capitalization

According to the S&P Dow Jones Indices web site the S&P 500 is widely regarded as the best single gauge of large cap U.S. equities. There is over USD 5.14 trillion benchmarked to the index, with index assets comprising approximately USD 1.6 trillion of its total. The index includes 500 leading companies and captures approximately 80% of available market capitalization (S&P Dow Jones Indices, 2014).

3.6 The database

The data are retrieved mainly from the Bloomberg database. The data are available from 1990 onwards, but due to significant incompleteness of information we were only able to base our research on the data from 2000 onwards. The time span is between the first trading day in May 2000 and the first trading day in May in 2013. The portfolio was first established in 2000 based on the data available at that date. The portfolio was then rebalanced based on the available data on each first trading day in May. The portfolio was sold out at closing prices provided by the Bloomberg database on the first trading day of May 2013.

For the purpose of return calculation closing market prices are used as provided. The gross dividends are calculated based on the provided dividend yield for the year. The gross dividend is calculated as number in USD. The book-to-market ratio is calculated as an accounting book provided at year end divided by the current closing market price. Market capitalization is calculated as closing market price of common equity at the date of portfolio rebalancing multiplied by the number of common stocks issued. Altman's Z-Score is calculated only for industrial corporations; financial corporations were ignored and deleted from the database. The return on equity is calculated as a five year average return on equity, considered to be normalized on average, with the hope that this would increase our forecasting capability. Betas were calculated as raw betas for the two year period and calculated against the S&P 500 index. They are stated as a volatility measure of the percentage price change of the security given a one percent change in the representative market index. The beta value is determined by comparing the price movements of the security and the representative market index for the weekly data over past two years. Betas were also provided by the Bloomberg Database.

The Standard and Poor's 500 total return we used as an index benchmark was retrieved from the YCharts database. The rate of return used as a risk free rate is the market yield on

a one year treasury bill with constant maturity as stated on the day of portfolio rebalancing, based on the Federal Reserve database.

Fama French annual benchmark factors are retrieved from Kenneth R. French Data Library. Data were used in performing a regression analysis of excess returns against the small market capitalization companies excess returns, large book-to-market corporations' excess returns and market over the risk free rate excess returns.

The calculations are performed based on the Kenneth R. French Data Library annual returns which are available from 1927 until 2013 year end. According to the website, the Fama French factors are constructed using the 6 value weighted portfolios. Small minus big is the average return on three small portfolios minus the average return on three big portfolios.

$$SMB=1/3(Small\ Value+Small\ Neutral+Small\ Growth)-1/3(Big\ Value+Big\ Neutral+Big\ Growth) \quad (32)$$

$$HML=1/2(Small\ Value+Big\ Value)-1/2(Small\ Growth+Big\ Growth) \quad (33)$$

Excess return calculation (French, 2014):

- R_m-R_f the excess return on the market is calculated as value weighted return of all CRSP firms incorporated in the U.S.
- The firms are listed on the NYSE, AMEX, or NASDAQ
- Shares and price data are retrieved at the beginning of the period
- The excess return is calculated with subtracting one month Treasury bill rate from the market return

For the purpose of calculating regressions and benchmarking portfolio returns all the data including risk free rates were retrieved from the previously mentioned Ken French Data Library.

4 RESULTS

In this section we will examine the results calculated on previously presented data based on the presented methodology. We will present the Four Variable Portfolio, AZS portfolio, Mcap portfolio, BtoM portfolio, ROE portfolio and a combination of the BtoM and ROE metrics portfolio. Portfolios are going to be described and then measured against the S&P 500 index performance, CAPM adjusted return, Sharpe ratio, as well as against the Fama French return. The differences between the portfolio return and their benchmarks are going to be presented.

4.1 Book-to-market Portfolio

Book-to-market portfolio was created in order to examine the performance of a so-called value portfolio. The 20 lowest ranked book-to-market securities were selected in each of the observed periods among the U.S. 500 largest listed corporations and included into the portfolio. The portfolio was then rebalanced on an annual basis level for 13 years.

4.1.1 Portfolio results and betas

The book-to-market portfolio returns varied from positive 70.67 percent in 2004 to negative 31.06 percent annual return in 2003. The book-to-market portfolio returns averaged out to 15.06 percent. The average annual compound rate of return over the observed period amounted to 11.21 percent which gave a boost of 397.85 percent to the initial principal over the observed period. Portfolio betas varied from 0.58 to 1.61 and averaged at 1.13 throughout the observed 13-year period.

4.1.2 Sharpe ratio

The Sharpe ratio amounted to 0.28 meaning that we get that return for every additional standard deviation of excess returns.

Table 1. Book-to-market Portfolio

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	AVG	COMPOUND	CAGR
Rf	6.24	3.91	2.33	1.21	1.60	3.34	4.97	4.89	1.94	0.49	0.43	0.22	0.19	2.44	36.53	2.42
Rm	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
Mp	-18.98	-16.94	-16.45	22.86	4.25	11.07	11.05	-8.17	-38.01	39.42	15.07	5.31	14.97	1.96	n.m.	n.m.
β	0.58	0.93	1.61	1.28	0.99	1.29	0.98	1.16	1.13	1.27	1.02	1.03	1.42	1.13	n.m.	n.m.
S&P	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
CAPM	-4.81	-11.90	-24.09	30.45	5.81	17.64	15.85	-4.57	-41.17	50.54	15.79	5.69	21.42	5.90	50.40	3.19
Fama French	-2.51	6.88	-21.93	51.21	22.85	8.75	24.40	-7.54	-48.62	51.43	26.06	-4.05	23.48	10.03	119.64	6.24
BtoM	14.32	6.02	-31.06	70.67	4.61	26.23	19.32	0.74	-28.83	65.16	22.19	-10.75	37.11	15.06	297.85	11.21
Difference S&P	27.06	19.05	-16.94	46.60	-1.25	11.82	3.30	4.03	7.24	25.25	6.69	-16.29	21.96	10.66	219.77	9.35
Difference CAPM	19.13	17.92	-6.97	40.23	-1.20	8.59	3.47	5.32	12.34	14.62	6.40	-16.45	15.70	9.16	183.73	8.35
Difference FF	16.84	-0.86	-9.13	19.46	-18.24	17.48	-5.08	8.28	19.79	13.73	-3.88	-6.70	13.64	5.03	72.36	4.28

All numbers in the above table are stated as percentage with exception of β, and "Difference" which is stated as percentage point.

R_f – risk free rate of return – one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing, retrieved from FED in 2014
R_m – market rate of return – calculated from S&P 500 total returns provided by YCharts, retrieved in 2014
M_p – calculated as the difference between market rate of return and risk free rate of return of the period
β – portfolio beta – average beta of companies included in portfolio in a year. Individual betas were retrieved from Bloomberg database in 2014
CAPM – capital asset pricing model required return – calculated as: $R_f + \beta(R_m - R_f)$ for each individual year
Fama French – Fama French required return – calculated as: $rf + a + b(rm - rf) + c(SMB) + d(HML)$. For detailed explanation refer to 4.3.3 Fama French returns
BtoM – return of the observed portfolio in the period. Returns are calculated based on prices retrieved from Bloomberg database in 2014
S&P – S&P 500 total return in the observed period, retrieved from YCharts in 2014
Difference CAPM – the difference between portfolio and CAPM return
Difference S&P – the difference between portfolio and S&P return
Difference FF – the difference between portfolio and Fama French return
AVG – Arithmetic mean of numbers in columns 2001 to 2013
COMPOUND – Holding period total return
CAGR – Compound annual rate of return

4.1.3 Portfolio versus index

Overall the portfolio performed better than the S&P 500 index. If one would select 20 companies with the highest book-to-market ratio out of the 500 largest American corporations each year and do this on an annual basis for a period of 13 years, they would beat the compound average annual return of the index by 8.7 percentage points. The difference between the portfolio and the index varied from positive 46.6 percentage points in 2004 to a negative of 16.94 percentage points in 2003. The difference averages out to a positive difference of 10.66 percentage points.

4.1.4 CAPM returns

If we compare the portfolio returns to the CAPM expected returns, we come to the conclusion that portfolio did much better percentage wise. Comparing average annual percentage growth rates the portfolio beat the CAPM return by 2.85 percentage points. The difference in returns varied from positive 40.23 percentage points to negative 16.45 percentage points. The differences average out to a 9.16 percentage point difference.

The money in our portfolio would compound to 397.84 percent of the initial principal, while according to the CAPM our principal should compound to 150.4 percent of our investment. S&P compounded the principal by 137.85 percent over the 13-year period.

4.1.5 Fama French adjusted returns

Letting Rm-Rf, SMB and HML represent the impact of market performance, small stocks performance and value stock performance the estimated coefficients imply the following relationship between the x and y variable:

$$R_i - R_f = 0.05 + 0.011*(R_m - R_f) + 0.001*SMB + 0.005*HML \quad (34)$$

Since all of the coefficients represent a positive interpretation of individual coefficients, the following applies. If the market excess return over risk free rate of return increased for one percentage point, this would lead to an increase in the portfolio excess return over risk free rate of return of 1.1 percentage points on average, ceteris paribus. If small stocks excess return over large capitalization stocks would increase for one percentage point, the portfolio excess return over risk free rate of return would increase by 0.002 percentage points. If high book-to-market stocks excess return over low book-to-market stocks would increase by one percentage point, the portfolio excess return over the risk free rate of return would increase by 0.006 percentage points.

4.1.5.1 The regression analysis

The R-square of 0.83 indicates that the regression explains 83 percent of the variation in the excess portfolio return over the risk free rate during the period of 13 years. The F-statistics suggests that the regression is strongly significant at the 0.078 percent level. So we can be reasonably confident that good fit of the equation is not due to chance. Note that only market excess return over the risk free rate is statistically significant at the 5 percent

level. Thus it does not appear that the excess return of small capitalization stocks over the large capitalization stocks or high book-to-market excess return over the low book-to-market stocks has a statistically significant effect on the portfolio excess return over the risk free rate of return. None of the variables appear to be a very significant determinant of the portfolio excess return over the risk free rate of return during the observed period. The t-statistic of the market excess return is in excess of 5 in absolute value, and the P-value of 0.05 percent. Based on the lower and upper bound of its confidence interval one can be 95 percent confident that for every percentage point of market excess return the portfolio excess return will increase between 0.7 and 1.7 percentage points, ceteris paribus.

4.1.5.2 Analysis of Fama French adjusted returns

Fama French returns vary between positive 51.43 percent in 2010 and negative 48.62 percent in 2009 within the observed period of 13 years. The annual returns average out to 10.03 percent. The annual compound rate of that portfolio would be 6.24 percent, which gives it a negative difference of 4.97 percentage points over our portfolio. Over the entire period that produces a compound difference of 178.22 percentage points to the BtoM's portfolio advantage.

4.1.5.3 Outperformance and time

The portfolio based on the book-to-market measure outperformed the S&P 500 index in 10 out of 13 years. That amounts to 76.9 percent of the observed periods. Its longest period of outperformance against the benchmark index lasted for six consecutive years, between 2006 and 2011. The longest period of lagging behind lasted for one year and has happened three times within the observed period with a period of at least one year of outperformance in between.

The portfolio has outperformed the CAPM expected return in 10 out of 13 years as well. Its longest period of outperformance lasted for six years and also took place during the same time period as the outperformance of the Standard and Poor's index. The portfolio lagged behind the CAPM returns for one year in a row at most.

If we subtract the Fama French returns from our portfolio returns, we get the portfolio excess returns over the Fama French adjusted returns. The excess return varies from negative 18.24 percent in 2005 to 19.79 percent in 2009. The longest period of outperformance the benchmark return lasted for three years and occurred 2008 and 2010. The longest period of underperformance lasted for two years and occurred twice, between 2002 and 2003 and between 2011 and 2012.

When compared to the risk free rate of return the portfolio outperformed that benchmark in nine out of thirteen observed years. Its longest period of outperformance lasted for four years in a row and occurred between 2004 and 2007. The longest period of underperformance lasted for two years and took place between 2008 and 2009.

4.2 Market Capitalization Portfolio

The market capitalization portfolio or the Mcap was constructed in order to see what would happen if one would only select the smallest 20 stocks within the Standard and Poor's 500 index each year and hold the portfolio year round until rebalancing. If one would perform such an action throughout the observed thirteen-year period the results would be as follows.

4.2.1 Portfolio results and betas

The portfolio based on market capitalization is constructed based on the 20 smallest corporations among the 500 largest corporations quoted in the United States. The annual return varies from positive 89.06 percent in 2010 to minus 31.07 percent in 2003. The returns average out to 20.29 percent. The portfolio compounds at an average annual rate of 14.46 percent which grows the principal to a 579.05 percent of initial investment during the observed 13-year period. The portfolio average beta varies from 0.6 in 2001 to 1.45 in 2003.

4.2.2 Sharpe ratio

The Sharpe ratio is 0.28 meaning this is what we get for each standard deviation of excess return.

4.2.3 Portfolio versus index

If we compare portfolio returns to the S&P 500 index returns we get a positive difference in favor of the Mcap portfolio in 8 out of 13 years. The difference varies between 55.88 percentage points in 2006 and negative 16.95 percentage points in 2003 and averages out to a positive 15.89 percentage point difference. The difference in CAGR's amounts to 11.95 percentage points.

Table 2. Market Capitalization Portfolio

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	AVG	COMPOUND	CAGR
Rf	6.24	3.91	2.33	1.21	1.60	3.34	4.97	4.89	1.94	0.49	0.43	0.22	0.19	2.44	36.53	2.42
Rm	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
Mp	-18.98	-16.94	-16.45	22.86	4.25	11.07	11.05	-8.17	-38.01	39.42	15.07	5.31	14.97	1.96	n.m.	n.m.
β	0.60	0.97	1.45	1.18	1.52	1.39	1.19	1.15	1.12	1.33	1.43	1.25	1.33	1.22	n.m.	n.m.
S&P	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
CAPM	-5.15	-12.52	-21.49	28.21	8.06	18.72	18.13	-4.49	-40.82	53.05	21.91	6.86	20.09	6.97	71.31	4.23
Fama French	5.37	3.10	-25.97	50.19	26.96	11.80	30.21	-12.73	-58.26	57.71	25.28	-4.77	29.04	10.61	97.46	5.37
Mcap	8.96	10.08	-31.07	72.64	-2.91	70.30	22.83	-10.07	-25.25	89.06	6.63	-8.52	61.15	20.29	479.05	14.46
Difference S&P	21.70	23.10	-16.95	48.57	-8.76	55.88	6.81	-6.79	10.82	49.15	-8.86	-14.06	45.99	15.89	394.69	13.09
Difference CAPM	14.11	22.60	-9.59	44.43	-10.97	51.57	4.71	-5.58	15.56	36.01	-15.27	-15.38	41.06	13.33	287.40	10.98
Difference FF	3.58	6.97	-5.11	22.45	-29.87	58.49	-7.37	2.65	33.01	31.36	-18.65	-3.76	32.11	9.68	145.92	7.17

All numbers in the above table are stated as percentage with exception of β, and "Difference" which is stated as percentage point.
R_f – risk free rate of return – one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing, retrieved from FED in 2014
R_m – market rate of return – calculated from S&P 500 total returns provided by YCharts, retrieved in 2014
M_p – calculated as the difference between market rate of return and risk free rate of return of the period
β – portfolio beta – average beta of companies included in portfolio in a year. Individual betas were retrieved from Bloomberg database in 2014
CAPM – capital asset pricing model required return – calculated as: $R_f + \beta(R_m - R_f)$ for each individual year
Fama French – Fama French required return – calculated as: $rf + a + b(rm - rf) + c(SMB) + d(HML)$. For detailed explanation look under title 4.3.3 Fama French returns
BtoM – return of the observed portfolio in the period. Returns are calculated based on prices retrieved from Bloomberg database in 2014
S&P – S&P 500 total return in the observed period, retrieved from YCharts in 2014
Difference CAPM – the difference between portfolio and CAPM return
Difference S&P – the difference between portfolio and S&P return
Difference FF – the difference between portfolio and Fama French return
AVG – Arithmetic mean of numbers in columns 2001 to 2013
COMPOUND – Holding period total return
CAGR – Compound annual rate of return

4.2.4 CAPM returns

The difference between the portfolio return and the CAPM expected return varies between 51.57 percentage points and a negative of 15.38 percentage points. The difference averages out to a 13.33 percentage point difference. The difference in CAGRs amounts to 3.48 percentage points.

4.2.5 Fama French adjusted returns

Letting Rm-Rf, SMB and HML represent the impact of market performance, small stocks performance and value stock performance, the estimated coefficients imply the following relationship between the x and y variables:

$$R_i\text{-}R_f=0.096+0.013*(R_m\text{-}R_f)\text{-}.002*SMB+0.009*HML \quad (35)$$

Since the coefficient of the SMB is -0.002, a percentage point increase in excess return of small stocks over large caps would decrease the portfolio excess return over risk free rate for 0.2 percentage points on average, ceteris paribus.

4.2.5.1 The regression analysis

The R-square of 0.632 indicates that the regression explains 63 percent of the variation of the excess portfolio return over the risk free return, over the period of 13 years. The F-statistic suggests that the regression is significant at the 2.4 percent level. So we can be reasonably confident that the good fit of the equation is not due to chance. Notice that only one estimated parameter is statistically significant at the 5 percent level. Market excess return over the risk free rate is statistically significant at 1.2 percent level. Thus, it does not appear that small stocks excess return over large capitalization stocks has a statistically significant effect on the excess portfolio return over the risk free rate. The same stands for the HML coefficient. It does not appear that high book-to-market companies' excess return over low book-to-market would have a statistically significant effect on the excess portfolio return over the risk free rate. Excess market return over the risk free rate appears to be the only determinant that has a statistically significant impact on portfolio excess return over the risk free rate, as it is significant at the 1.2 percent level. The t-statistic for this coefficient is in excess of 3 in the absolute value, and the P-value is 1.18 percent. Based on the lower and upper bound of its confidence interval one can be 95 percent confident that for every percentage point increase in the market return over the risk free rate of return the portfolio excess return is will on average increase between 0.4 and 2.3 percentage points, ceteris paribus.

4.2.5.2 Analysis of Fama French adjusted returns

The Fama French calculated returns varied between positive 50.19 percent in 2004 and negative 58.26 percent in 2009. They averaged out to 10.61 percent. The Fama French returns would increase our principal by 5.37 percent per annum on average and compound the initial investment to 197.46 percent throughout the observed period of 13 years. A portfolio based on the 20 smallest corporations out of the S&P 500 based on market capitalization would have an average annual compound rate 9.9 percentage points higher

than the previously mentioned return which would amount to a compound difference of 381.59 percentage points on the initial principal over the observed 13-year period. The difference between the Fama French calculated return and the portfolio return equals the Fama French adjusted return. The adjusted return varies from positive 58.49 percentage points in 2006 to negative 18.65 percentage points in 2011.

4.2.5.3 Outperformance and time

The portfolio based on market capitalization outperformed the Standard and Poor's 500 index during eight out of 13 years which amounts to 61 percent of the observed period. The longest period of outperformance lasted only two years, but occurred three times; 2001-2002, 2006-2007 and 2009-2010. The longest period of underperformance lasted two years, namely between 2011 and 2012.

When compared to the CAPM expected return the portfolio also outperformed during 8 out of 13 years. The longest period of outperformance against the CAPM lasted for two years and occurred three times. The longest period of underperformance lasted two years, namely between 2011 and 2012.

When measured against the Fama French adjusted return was positive 8 out of the 13 observed years. The longest period of portfolio underperformance lasted for two consecutive years between 2011 and 2012.The longest period of portfolio outperformance lasted for three years in a row, between 2008 and 2010.

When measured against the risk free rate, the portfolio also outperformed in eight out of 13 years. The longest period of underperformance lasted two consecutive years and occurred between 2008 and 2009. The longest period of outperformance lasted two years and occurred twice.

4.3 Return on Equity Portfolio

The return on equity portfolio was constructed in order to examine performance of the portfolio consisting of corporations with the highest five year average return on equity. Companies were selected among those listed in the S&P 500 index during the year of purchase. Portfolios of 20 corporations with previously mentioned characteristics were constructed. The portfolio was rebalanced annually.

4.3.1 Portfolio results and betas

The portfolio returned between positive 49.59 percent in 2013 and negative 17.91 percent in 2009. The returns averaged out to 9.63 percent. The average annual growth rate of the constructed portfolio was 7.96 percent which amounts to 270.65 percent increase in the initial investment over the thirteen-year period. The portfolio beta varied between 0.61 in 2003 and 1.06 in 2008 and averaged out to 0.8 over the observed period.

4.3.2 Sharpe ratio

The calculated Sharpe ratio is 0.26 which means that we receive such return for every additional unit of standard deviation.

4.3.3 Portfolio versus index

When compared to the S&P index, the portfolio did much better with the average annual growth rate difference of 5.45 percentage points. The difference in annual returns between the portfolio and the S&P 500 varied between positive 34.43 percentage points in 2013 and a negative 11.79 percentage point difference in 2006. The difference averaged out to 5.23 percentage points. The difference between the portfolio return and the index return was positive in 8 of 13 annual periods.

4.3.4 CAPM returns

The portfolio did very well against the CAPM expected return as well. The difference in the compound annual rate of return was 4.79 percentage points. The annual difference varied from 37.29 percentage points in 2013 to negative 9.65 percentage points in 2006. The annual difference averages out to 5.21 percentage points. The difference between portfolio and CAPM adjusted return was positive in 9 out of 13 annual periods.

Table 3. ROE Portfolio

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	AVG	COMPOUND	CAGR
Rf	6.24	3.91	2.33	1.21	1.60	3.34	4.97	4.89	1.94	0.49	0.43	0.22	0.19	2.44	36.53	2.42
Rm	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
Mp	-18.98	-16.94	-16.45	22.86	4.25	11.07	11.05	-8.17	-38.01	39.42	15.07	5.31	14.97	1.96	n.m.	n.m.
β	0.68	0.66	0.61	0.77	0.81	0.81	1.01	1.06	0.87	0.86	0.67	0.82	0.81	0.80	n.m.	n.m.
S&P	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
CAPM	-6.67	-7.35	-7.71	18.92	5.05	12.27	16.14	-3.81	-31.26	34.45	10.51	4.55	12.30	4.41	49.95	3.17
Fama French	7.56	-5.97	-15.81	20.84	14.46	9.22	19.50	-3.16	-33.63	28.37	10.95	-0.99	17.26	5.28	63.37	3.85
ROE	13.71	-2.28	-16.71	28.49	-2.61	2.63	18.93	-2.56	-17.91	40.08	9.15	4.64	49.59	9.63	170.65	7.96
Difference S&P	26.45	10.75	-2.59	4.42	-8.46	-11.79	2.91	0.72	18.16	0.17	-6.35	-0.89	34.43	5.23	76.10	4.45
Difference CAPM	20.39	5.07	-9.00	9.57	-7.66	-9.65	2.79	1.25	13.34	5.63	-1.36	0.09	37.29	5.21	77.75	4.52
Difference FF	6.15	3.69	-0.90	7.65	-17.07	-6.59	-0.56	0.60	15.71	11.71	-1.80	5.63	32.34	4.35	61.46	3.75

All numbers in the above table are stated as percentage with exception of β, and "Difference" which is stated as percentage point.

R_f – risk free rate of return – one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing, retrieved from FED in 2014
R_m – market rate of return – calculated from S&P 500 total returns provided by YCharts, retrieved in 2014
M_p – calculated as the difference between market rate of return and risk free rate of return of the period
β – portfolio beta – average beta of companies included in portfolio in a year. Individual betas were retrieved from Bloomberg database in 2014
CAPM – capital asset pricing model required return – calculated as: $R_f + \beta(R_m - R_f)$ for each individual year
Fama French – Fama French required return – calculated as: $rf + a + b(rm - rf) + c(SMB) + d(HML)$. For detailed explanation look under title 3.3.3 Fama French returns
BtoM – return of the observed portfolio in the period. Returns are calculated based on prices retrieved from Bloomberg database in 2014
S&P – S&P 500 total return in the observed period, retrieved from YCharts in 2014
Difference CAPM – the difference between portfolio and CAPM return
Difference S&P – the difference between portfolio and S&P return
Difference FF – the difference between portfolio and Fama French return
AVG – Arithmetic mean of numbers in columns 2001 to 2013
COMPOUND – Holding period total return
CAGR – Compound annual rate of return

4.3.5 Fama French adjusted returns

Letting Rm-Rf, SMB and HML represent the impact of market performance, small stocks performance and value stock performance, the estimated coefficients imply the following relationship between the x and y variable:

$$R_i\text{-}R_f=0.043+0.007*(R_m\text{-}R_f)\text{-}004*SMB+0.006*HML \quad (36)$$

4.3.5.1 The regression analysis

Since the coefficient of excess return of small capitalization stocks over large capitalization stocks is -0.004, a percentage point increase in small companies' excess return over large capitalization traded corporations would decrease the portfolio excess return over the risk free rate by 0.4 percentage points. The R-square of 0.685 indicates that the regression explains 68.5 percent of the variation in the portfolio excess returns over the risk free rate of return for the observed period of 13 years. The F-statistic suggests that the regression is significant at the 1.2 percent level, so one can be reasonably confident that the good fit of the equation is not due to chance. Notice that two of the estimated parameters are not statistically significant at the 5 percent level. It does not appear that the excess returns of small capitalization stocks over the excess returns of large capitalization stocks have a statistically significant effect on the portfolio excess returns over the risk free rate of return. The only statistically significant coefficient represents the relationship between market excess return over the risk free rate and portfolio excess return over the risk free rate. If the market excess return increases by one percentage point, the portfolio excess return over the risk free rate is going to increase by 0.79 percentage points on average, ceteris paribus. Based on the lower and upper bounds of its confidence interval we can be 95 percent confident that for every percentage point increase in the market excess return over the risk free return the portfolio excess return over the risk free rate of return will increase between 0.32 and 1.25 percentage points, ceteris paribus.

4.3.5.2 Analysis of Fama French adjusted returns

The Fama French returns vary between positive 28.37 percent in 2010 and negative 33.63 percent in 2009 and average out to 5.28 percent. The average annual compound rate should yield to 3.85 percent according to the calculation which is 4.11 percentage points less than the 7.96 percent portfolio return. Over the observed period of 13 years that produced a difference in the compound return on the principal of 107.28 percentage points in the ROE portfolio advantage.

4.3.5.3 Outperformance and time

The portfolio based on the five year average return on equity of a corporation outperformed the Standard and Poor's index benchmark in eight out of thirteen observed years. The longest period of underperformance against the index lasted for two years in a row and occurred between 2005 and 2006.

When compared to the CAPM expected return the portfolio did better in nine out of thirteen years. Its longest period of outperformance lasted for four years between 2007 and

2010. The longest period of underperformance occurred between 2005 and 2006 and lasted for two years.

The portfolio excess return over the Fama French return varies between 32.34 percentage points in 2013 and negative 17.07 percentage points in 2005. The longest period of portfolio underperformance of the mentioned benchmark lasted for three years between 2005 and 2007. The longest period of portfolio outperformance lasted for three consecutive years and occurred between 2008 and 2010.

When compared to the risk free rate of return, portfolio outperformed in only seven observed years. The longest period of outperformance occurred between 2010 and 2013 and lasted for four consecutive years. The longest period of underperformance lasted for two years in a row and occurred three times - in 2002 and 2003, 2005 and 2006, as well as in 2008 and 2009.

4.4 Z-Score Portfolio

The Z-Score portfolio is ranked solely with regards to the Altman's Z-Score. It represents the top 20 companies selected for a particular the year - companies with the highest Z-Score. The low number of bankruptcies among the companies in this group was expected.

4.4.1 Portfolio results and betas

Selected companies yielded the following results. Annual returns varied from negative 40.84 percent in 2001 to positive 47.3 percent in 2010. The average return was minus 3.23 percent, while the average annual rate of return was even deeper into red with negative 5.81 percent on average per annum. Over the entire observed period (2000-2013) the portfolio lost more than half of its value. In 2013 its liquidation value was 45.9 percent of the initial investment. The portfolio beta varied from 0.91in 2011 to 2.08 in 2002 and averaged out to 1.3 throughout the entire period.

4.4.2 Sharpe ratio

The Sharpe ratio of the AZS portfolio was negative and amounted to minus 0.3335, meaning that the portfolio brought negative return together with higher deviation.

4.4.3 Portfolio versus index

If we compare the AZS portfolio returns to the benchmark index we get positive difference in only 4 out of 13 observed annual periods. The average difference was calculated as the AZS portfolio return and the S&P 500 total return and equaled minus 7.64 percent. The portfolio faced the best comparative result in 2010 (plus 7.39 percent) and the worst result in 2001 when the difference between the portfolio and the index amounted to negative 28.1 percent. During the entire observed period when the S&P 500 was compounding at an average annual rate of 2.51 percent the portfolio was losing value at an average of 5.81 percent per annum.

4.4.4 CAPM returns

When the portfolio was benchmarked to the CAPM model expected returns it performed better than when compared to the index. The difference varied from negative 25.86 percent in 2013 to positive 10.86 in 2010 and averaged out to negative 5.1 percent which is 2.54 percentage points better than when compared with the S&P500.

Table 4. Altman's Z-Score Portfolio

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	AVG	COMPOUND	CAGR
Rf	6.24	3.91	2.33	1.21	1.60	3.34	4.97	4.89	1.94	0.49	0.43	0.22	0.19	2.44	36.53	2.42
Rm	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
Mp	-18.98	-16.94	-16.45	22.86	4.25	11.07	11.05	-8.17	-38.01	39.42	15.07	5.31	14.97	1.96	n.m.	n.m.
β	1.56	2.08	1.59	1.21	1.46	1.38	1.25	1.36	1.04	0.91	0.91	1.12	1.05	1.30	n.m.	n.m.
S&P	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
CAPM	-23.43	-31.30	-23.85	28.89	7.82	18.68	18.74	-6.26	-37.68	36.43	14.17	6.18	15.84	1.87	-12.19	-0.99
Fama French	-23.43	-1.97	-17.49	42.97	9.89	2.61	9.93	10.70	-29.26	29.17	23.92	1.07	11.28	5.34	54.74	3.42
AZS	-40.84	-20.98	-15.25	26.55	-10.53	6.33	0.72	-9.89	-30.26	47.30	15.53	-0.69	-10.02	-3.23	-54.10	-5.81
Difference S&P	-28.10	-7.95	-1.13	2.48	-16.39	-8.08	-15.31	-6.61	5.81	7.39	0.03	-6.23	-25.18	-7.64	-67.49	-8.28
Difference CAPM	-17.41	10.32	8.60	-2.33	-18.36	-12.34	-18.03	-3.64	7.42	10.86	1.35	-6.87	-25.86	-5.10	-54.47	-5.87
Difference FF	-17.41	-19.01	2.24	-16.41	-20.42	3.72	-9.22	-20.59	-1.00	18.13	-8.39	-1.77	-21.31	-8.57	-71.83	-9.29

All numbers in the above table are stated as percentage with exception of β, and "Difference" which is stated as percentage point.

R_f – risk free rate of return – one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing, retrieved from FED in 2014
R_m – market rate of return – calculated from S&P 500 total returns provided by YCharts, retrieved in 2014
M_p – calculated as the difference between market rate of return and risk free rate of return of the period
β – portfolio beta – average beta of companies included in portfolio in a year. Individual betas were retrieved from Bloomberg database in 2014
CAPM – capital asset pricing model required return – calculated as: $R_f + \beta(R_m - R_f)$ for each individual year
Fama French – Fama French required return – calculated as: $rf + a + b(rm - rf) + c(SMB) + d(HML)$. For detailed explanation look under title 3.3.3 Fama French returns
BtoM – return of the observed portfolio in the period. Returns are calculated based on prices retrieved from Bloomberg database in 2014
S&P – S&P 500 total return in the observed period, retrieved from YCharts in 2014
Difference CAPM – the difference between portfolio and CAPM return
Difference S&P – the difference between portfolio and S&P return
Difference FF – the difference between portfolio and Fama French return
AVG – Arithmetic mean of numbers in columns 2001 to 2013
COMPOUND – Holding period total return
CAGR – Compound annual rate of return

4.4.5 Fama French adjusted returns

Letting the Rm-Rf, SMB and HML represent the impact of market performance, small stocks performance and value stock performance, the estimated coefficients imply the following relationship between the x and y variables:

$$R_i\text{-}R_f\text{=-}0.085\text{+}0.009\text{*}(R_m\text{-}R_f)\text{-}0.007\text{*SML-}0.005\text{*HML} \quad (37)$$

Since the SML coefficient is -0.007, a percentage point increase in small stocks excess return over large capitalization stocks would decrease the portfolio excess return over the risk free rate on average by 0.7 percentage points, ceteris paribus. The increase in excess return of high book-to-market stocks over low book-to-market stocks for one percentage point would decrease the portfolio excess return over the risk free rate on average, ceteris paribus, by 0.5 percentage points due to the negative HML coefficient of -0.005.

4.4.5.1 The regression analysis

The R-square of 0.756 indicates that the regression explains 76 percent of the variation in portfolio excess return over risk free rate. The F-statistics suggests that the regression is significant at the 0.39 percent level, so one can be reasonably confident that the good fit of the equation is not due to chance. Notice that only one estimated parameter is statistically significant at the 5 percent level. The parameter estimating the excess market return is the only significant one, while SMB and HML are not. Thus it does not appear that SMB and HML have a statistically significant effect on the demand of the rental units. The excess market return over the risk free rate appears to be a very significant determinant of the excess portfolio return over the risk free rate. The t-statistics for this coefficient is in excess of 4.36 in its absolute value and the P-value is 0.18 percent. Based on the lower and upper bounds of its confidence interval one can be 95 percent confident that for every percentage point of market return over risk free rate return the portfolio excess return will on average increase between 0.4 and 1.4 percentage points, ceteris paribus.

4.4.5.2 Analysis of Fama French adjusted returns

The Fama French returns varied between 42.97 percent in 2004 and negative 29.26 percent in 2009. The returns averaged out to negative 5.34 percent. The average annual growth rate amounts to 3.42 percent which is 9.23 percentage points better than the average annual compound rate of the portfolio. The Fama French returns would win us a bit over 54 percent of the principal, while the portfolio returns would lose us a bit more than 45 percentage of capital over the observed period of 13 years. The difference between the Fama French annual returns and the portfolio annual returns varies between negative 21.31 percent in 2013 and positive 18.13 percent in 2010.

4.4.5.3 Outperformance and time

Portfolio based only on Altman's Z-Score outperformed the benchmark index in only 4 of 13 years, or in a bit more than 30 percent of rebalancing periods. The longest period of outperformance was three years long and occurred between 2009 and 2011. The longest period of underperformance occurred between 2005 and 2008 and lasted for four years.

This is expected since the Altman's Z-Score was included in order to avoid companies that would go bankrupt within our portfolio. Since the score eliminates these, it is expected to be our shield during market downturns and the reason for lagging behind in the bull market.

The CAPM expected return was outperformed five out of thirteen times during the observed period. The longest period of underperformance was between 2004 and 2008 and lasted for five years; the timing is, as mentioned, expected.

The Fama French adjusted return was positive in 3 of 13 observed years. The longest period of portfolio outperformance lasted for one year. The longest period of portfolio underperformance lasted for three years and has occurred twice over the observed period; between 2007 and 2009 and between 2011 and 2013.

Portfolio has outperformed the risk free rate in only four years. The longest period of underperformance lasted for three years and has happened twice. The first time between 2001 and 2003, and the second time between 2007 and 2009.

It would be quite frustrating to hold a portfolio like that.

4.5 Low Price to Book, High Return on Equity Stocks

Since the linkage between the multiples and profitability makes more meaningful comparisons, the following test was performed. The price-to-book value is a useful measure where value is generated from tangible assets. Because of its close linkage to the return on equity (the price-to-book is P/E multiplied by the ROE) it is useful to view piece to book the value together with the ROE (Suozzo P. , Cooper, Sutherland, & Deng, 2001).

The idea was to compare the price-to-book value as an asset based multiple with return on equity as an excess return multiple. According to Suozzo this approach should provide a clear picture of over and undervaluation, since it should directly tie the market's valuation of an asset to the excess return earned over and above the cost of that asset in a linear fashion (Suozzo P. , Cooper, Sutherland, & Deng, 2001).

As stated this portfolio was constructed in order to evaluate the performance based on strategy of selecting high quality, but relatively underpriced securities. Each year for a period of 13 years 20 companies which performed best, based on the combination of the two metric, were selected to be part of the portfolio-that is equally weighted and rebalanced on the annual level. The results are provided in the table and descriptions below.

4.5.1 Portfolio results and betas

The portfolio compounded 9.34 percent average annual rate of return and at this rate it raised the initial principal for 319.28 percent. The returns varied between positive 53.62 percent in one year (2010) and negative 40.86 percent in another (2009). The simple average return amounted to 12.27%.

4.5.2 Sharpe ratio

The Sharpe ratio amounted to 0.26, average beta of the portfolio varied between 0.66 in 2001 and 1.45 in 2008.

Table 5. BtoM+ROE Portfolio

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	AVG	COMPOUND	CAGR
Rf	6.24	3.91	2.33	1.21	1.60	3.34	4.97	4.89	1.94	0.49	0.43	0.22	0.19	2.44	36.53	2.42
Rm	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
Mp	-18.98	-16.94	-16.45	22.86	4.25	11.07	11.05	-8.17	-38.01	39.42	15.07	5.31	14.97	1.96	n.m.	n.m.
β	0.66	0.83	1.01	1.02	0.78	1.22	1.38	1.45	1.20	1.41	0.99	1.12	1.25	1.10	n.m.	n.m.
S&P	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
CAPM	-6.37	-10.10	-14.32	24.58	4.93	16.86	20.24	-6.92	-43.86	56.26	15.42	6.15	18.97	6.30	57.67	3.56
Fama French	2.68	1.11	-18.55	36.16	18.68	8.92	21.89	-5.53	-40.75	39.93	18.52	-2.63	20.22	7.74	97.13	5.36
BtoM+ROE	12.89	13.69	-16.55	35.22	12.99	20.94	-0.06	12.74	-40.86	53.62	20.22	-8.39	43.12	12.27	219.28	9.34
Difference S&P	25.63	26.72	-2.43	11.14	7.13	6.52	-16.08	16.02	-4.79	13.71	4.72	-13.93	27.96	7.87	139.54	6.95
Difference CAPM	19.26	23.79	-2.23	10.63	8.06	4.08	-20.30	19.66	3.00	-2.64	4.80	-14.54	24.15	5.98	90.97	5.10
Difference FF	10.20	12.59	2.01	-0.94	-5.69	12.02	-21.95	18.27	-0.11	13.69	1.70	-5.76	22.90	4.53	63.52	3.86

All numbers in the above table are stated as percentage with exception of β, and "Difference" which is stated as percentage point.

R_f – risk free rate of return – one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing, retrieved from FED in 2014
R_m – market rate of return – calculated from S&P 500 total returns provided by YCharts, retrieved in 2014
M_p – calculated as the difference between market rate of return and risk free rate of return of the period
β – portfolio beta – average beta of companies included in portfolio in a year. Individual betas were retrieved from Bloomberg database in 2014
CAPM – capital asset pricing model required return – calculated as: $R_f + \beta(R_m - R_f)$ for each individual year
Fama French – Fama French required return – calculated as: $rf + a + b(rm - rf) + c(SMB) + d(HML)$. For detailed explanation look under title 3.3.3 Fama French returns
BtoM – return of the observed portfolio in the period. Returns are calculated based on prices retrieved from Bloomberg database in 2014
S&P – S&P 500 total return in the observed period, retrieved from YCharts in 2014
Difference CAPM – the difference between portfolio and CAPM return
Difference S&P – the difference between portfolio and S&P return
Difference FF – the difference between portfolio and Fama French return
AVG – Arithmetic mean of numbers in columns 2001 to 2013
COMPOUND – Holding period total return
CAGR – Compound annual rate of return

4.5.3 Portfolio versus index

When compared with the S&P 500, the portfolio did better in 9 out of 13 years. Comparing average annual growth rate portfolio did 6.83 percentage points better than the index on average. The portfolio delivered 319.28 percent over the entire 13 year observed period while the index delivered 137.97 percent on the initially invested principal. The difference in yearly returns varies between 27.96 percentage points in 2013 and negative 16.08 percentage points in 2007. Difference between simple average returns amounts to 7.78 percent.

4.5.4 CAPM returns

The portfolio also did better when compared to CAPM expected return. The difference between the average annual compound rates of the two amounts to a 5.75 percentage points for the portfolio. The difference varies between 24.15 percentage points in 2013 and minus 20.3 percentage points in 2007. The portfolio returns were above the CAPM returns for 9 out of 13 yearly periods. The difference between simple average returns amounts to 5.97 percent.

4.5.5 Fama French adjusted returns

Letting Rm-Rf, SMB and HML represent the impact of market performance, small stocks performance and value stock performance, the estimated coefficients imply the following relationship between the x and y variable:

$$R_i\text{-}R_f=0.045+0.009*(R_m\text{-}R_f)\text{-}0.001*SMB+0.006*HML \quad (38)$$

4.5.5.1 The regression analysis

Since the coefficient of the small capitalization stocks excess return over large capitalization corporations' return is -0.001, a percentage point increase in small corporations' excess return over large corporations' return would on average decrease the portfolio excess return over risk free rate by 0.1 percentage points, ceteris paribus. The R-square of 0.779 indicates that the regression explains 77.9 percent of the variation in the portfolio excess return over the risk free rate during the 13 observed periods. The F-statistic suggests that the regression is significant at the 0.26 percent level, so we can be reasonably confident that the good fit of the equation is not due to chance. Notice that again only the first coefficient is statistically significant at the 5 percent level. Thus, it does not appear that excess return of small market capitalization companies over large market capitalization companies or the excess return of high book-to-market companies over low book-to-market companies has a statistically significant effect on the portfolio excess return over the risk free rate. The excess market return over the risk free rate appears to be a relatively significant determinant of the excess portfolio return over the risk free rate of return. The t-statistic for this coefficient is in excess of 4 in the absolute value, while the P-value is 0.119 percent. Based on the lower and upper bounds of its confidence interval we can be 95 percent confident that for every percentage point increase in the market excess return over the risk free rate the portfolio excess return over the risk free rate will on average increase between 0.5 and 1.4 percentage points, ceteris paribus.

4.5.5.2 Analysis of Fama French adjusted returns

The Fama French calculated returns for the selected portfolio based on the intersection of rankings of two variables, namely the Book to Market ratio and the ROE.They varied between 36.16 percent in 2004 and negative return of 40.75 percent in 2009. The returns averaged out to 7.74 percent. If one would reinvest at rates of return as calculated, the principal would compound to 5.36 percent per annum on average which would give us 197.13 percent of the initially invested principal in 2013. This is a 3.98 percentage point lower average annual compound rate than that of the portfolio and results in a difference of 122.15 percentage points in the compound principal over the period of 13 years.

4.5.5.3 Outperformance and time

The book-to-market compared to the benchmark index of 500 biggest corporations incorporated in the United States outperformed in nine out of thirteen observed years. The longest period of outperformance lasted three years in a row and occurred in 2004, 2005 and 2006. The longest period of underperformance was one single year and occurred four times; in 2003, 2007, 2009, and in 2012.

The portfolio lagged behind the expected CAPM return for four years during the observed period and outperformed nine times. The longest period of outperformance lasted three years and occurred in 2004, 2005 and 2006. The longest period of underperformance was one year and occurred in 2003, 2007, 2010, and in 2012.

The portfolio excess return over the Fama French returns varied between positive 22.9 percentage points in 2013 and negative 21.95 percentage points in 2007. The longest period of portfolio beating the benchmark has lasted for three consecutive years, and has occurred in the beginning of the holding period, between 2001 and 2003. The longest period of underperformance has lasted for two years, and has occurred between 2004 and 2005. The portfolio returns have beaten the Fama French returns in six out of 8 observed years.

Compared to risk free rate as benchmark, portfolio has outperformed in nine out of thirteen observed years. The longest period of outperformance has lasted for three years and occurred in the following years: 2004, 2005, 2006. The longest period of underperformance lasted for one year and has occurred for four times in years: 2003, 2007, 2009, and 2012.

4.6 Four Variables Portfolio

The below seen table provide us with results of the constructed four variables portfolio. The variables used for selecting the top 20 companies that comprise the annually rebalanced portfolio are the following: Book-to-market, Five Year Return on Equity, Market Capitalization and Altman's Z-Score.

4.6.1 Portfolio results and betas

In the above table the Portfolio results are presented in bold. The results range from -40.13 percentage to +57.67 percentage over the observed period. The average annual return equals 12.16 percentage. The average compound return is 9.01 percentage per annum. The compounded return for the observed 13 year period amounts to 306.87 percentage. The initial investment would more than triple during the period from May 2000 to May 2013. Portfolio betas range from 0.75 to 1.26 and average to 1.11 for the entire observed period.

4.6.2 Sharpe ratio

If we compare the excess return to the standard deviation of returns, we get to the Sharpe ratio of 0.2422. Meaning we get a return of 24.22 percentage points for every unit of standard deviation.

4.6.3 Portfolio versus index

First we compared the absolute returns to the S&P 500 index total returns which we consider as benchmark. During the period the S&P on average returned 2.51 percentages per annum. If we compound that, we get a 137.97 percentage return for the entire period. The return ranged from -36.07 percent in one year to +39.91 percent. The index return was positive in 8 out of 13 observed periods. The average of returns amounts to 4.40 percent. The portfolio outperformed the index in 8 out of 13 periods. The average difference between the portfolio and the index is 7.76 percentage points. The total return of differences amounts to the 225.6 percent for the period. The difference in compound annual rates of return amounts to 6.5 percentage points.

Table 6. Four Variables Portfolio

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	AVG	COMPOUND	CAGR
Rf	6.24	3.91	2.33	1.21	1.60	3.34	4.97	4.89	1.94	0.49	0.43	0.22	0.19	2.44	36.53	2.42
Rm	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
Mp	-18.98	-16.94	-16.45	22.86	4.25	11.07	11.05	-8.17	-38.01	39.42	15.07	5.31	14.97	1.96	n.m.	n.m.
β	0.75	1.20	1.26	1.07	1.07	1.16	1.24	1.25	1.13	1.26	0.90	1.03	1.09	1.11	n.m.	n.m.
S&P	-12.74	-13.03	-14.12	24.07	5.85	14.41	16.02	-3.28	-36.07	39.91	15.50	5.53	15.16	4.40	37.97	2.51
CAPM	-8.02	-16.34	-18.46	25.59	6.13	16.20	18.72	-5.33	-40.98	50.05	14.06	5.70	16.46	4.91	35.80	2.38
Fama French	19.22	8.19	-15.02	30.46	22.51	11.62	26.94	-15.40	-40.96	43.14	14.04	-5.40	22.60	9.38	134.71	6.78
Portfolio	24.28	11.48	-3.72	36.24	3.21	22.22	4.12	-18.17	-40.13	47.38	16.91	-3.41	57.67	12.16	206.86	9.01
Difference S&P	37.02	24.51	10.40	12.17	-2.64	7.81	-11.90	-14.89	-4.06	7.47	1.41	-8.95	42.52	7.76	125.60	6.46
Difference CAPM	32.30	27.82	14.74	10.65	-2.92	6.02	-14.60	-12.84	0.85	-2.67	2.85	-9.11	41.22	7.25	113.13	5.99
Difference FF	5.06	3.29	11.30	5.78	-19.30	10.61	-22.82	-2.77	0.83	4.24	2.87	1.98	35.08	2.78	27.46	1.88

All numbers in the above table are stated as percentage with exception of β, and "Difference" which is stated as percentage point.

R_f – risk free rate of return – one year U.S. Treasury bill yield to maturity on the date of portfolio rebalancing, retrieved from FED in 2014
R_m – market rate of return – calculated from S&P 500 total returns provided by YCharts, retrieved in 2014
M_p – calculated as the difference between market rate of return and risk free rate of return of the period
β – portfolio beta – average beta of companies included in portfolio in a year. Individual betas were retrieved from Bloomberg database in 2014
CAPM – capital asset pricing model required return – calculated as: $R_f + \beta(R_m - R_f)$ for each individual year
Fama French – Fama French required return – calculated as: $rf + a + b(rm - rf) + c(SMB) + d(HML)$. For detailed explanation look under title 3.3.3 Fama French returns
BtoM – return of the observed portfolio in the period. Returns are calculated based on prices retrieved from Bloomberg database in 2014
S&P – S&P 500 total return in the observed period, retrieved from YCharts in 2014
Difference CAPM – the difference between portfolio and CAPM return
Difference S&P – the difference between portfolio and S&P return
Difference FF – the difference between portfolio and Fama French return
AVG – Arithmetic mean of numbers in columns 2001 to 2013
COMPOUND – Holding period total return
CAGR – Compound annual rate of return

4.6.4 CAPM returns

The CAPM calculated returns range from -14.6 percent to 41.22 percent of return per annum. This return averages out through the observed period to 4.91 percent. The compound annual rate of the CAPM returns for the period is 2.38 percent. This gives us a 135.8 percentage return for the entire period. In order to compare the CAPM returns with the portfolio returns we calculated the difference. The portfolio return exceeds the CAPM return in 9 out of 13 observed periods or in nearly 70 percent of the cases. The average positive difference in return is 7.25 percentage points. The difference would compound our money at 5.99 percent on average per annum. This would amount to a 213.13 percent total excess return for the period.

4.6.5 Fama French adjusted returns

Letting the Rm-Rf, SMB and HML represent the impact of market performance, small stocks performance and value stock performance, the estimated coefficients imply the following relationship between the x and y variables:

$$R_i-R_f=0.027+0.008*(R_m-R_f)-0.005*SML+0.011*HML \quad (39)$$

Since the coefficient of SML is negative, a one percentage point increase in small stock excess return would on average decrease the portfolio excess return over the risk free rate by 0.5 percentage points, ceteris paribus. High book-to-market stocks exceed the return over low book-to-market stocks as well as market return over risk free rate return and have a positive correlation with the portfolio excess return.

4.6.5.1 The regression analysis

The portfolio return was also benchmarked against the Fama French return and adjusted returns were calculated. This return tells us what percentage of the return return did not come from the three factors, increased volatility compared to the S&P 500 index, selecting low price-to-book stocks and selecting relatively low market capitalization stocks. The multiple R was 0.856 while R^2 of the portfolio was 0.732 which indicates that the regression explains 73 percent of the variation of the excess return during the observed period. The F statistics suggests that the regression is significant at the 0.6 percent level. Therefore one can be reasonably confident that good fit of the equation is not due to chance. Note that all the estimated parameters are statistically significant at the 5 percent level (excess return at the 0.7 percent level, HML at the 2.7 percent level) apart from the SMB coefficient. Thus, it does not appear that size has a statistically significant effect on the portfolio excess returns. The excess market return appears to be a very significant determinant of the portfolio excess return. The t-statistic for this coefficient is 3.5 in the absolute value, while the P value is 0.72 percent. Based on the lower and upper bounds of its confidence interval we can be 95 percent confident that for every percentage point of the market excess return the portfolio excess return will increase between 0.2 and 1 percentage points, ceteris paribus.

4.6.5.2 Analysis of Fama French adjusted returns

The Fama French returns vary between 43.14 percent in 2010 and a negative return of 40.96 in 2009. The returns average out to 9.38 percent and compound to 234.71 percent through the observed 13 year period. The average yearly compound rate is 6.78 percent and is 2.22 percentage points lower than the portfolio average annual compound rate of return. The difference in the compound return over the entire period is 72.15 percent. The difference between the portfolio return and the Fama French return equals the Fama French adjusted return. The Fama French adjusted return for the portfolio varies between 35.8 percent in 2013 and a negative of 22.82 percent.

4.6.5.3 Outperformance and time

Portfolio outperformed the index on yearly level in a bit more than 60 percent of the observed periods. The longest period of underperformance lasted for three years and has happened between 2007 and 2009. The longest period of outperformance lasted for four years and has happened in the first four years of the observed period.

Portfolio also outperformed the CAPM adjusted returns in 60 percent of the observed years. The longest period of outperformance lasted for four years and has happened in the beginning of the observed period. The longest period of underperformance has happened in 2007 and lasted for two years.

Portfolio outperformed the Fama French return in 10 out of 13 years. The longest period of outperformance lasted for 5 consecutive years from 2009 to 2013. The longest period of underperformance lasted for two years and has occurred between 2007 and 2008.

The portfolio lagged behind risk free returns five times during the observed period. The longest period of outperformance lasted for three years and has happened between 2004 and 2006, interestingly, when the risk free rate was at its highs. The longest period of underperformance has happened between 2007 and 2009and it lasted for three years.

4.7 Portfolio Comparison

In the table (7) portfolio returns can be found. In order to enable the comparison portfolios constructed on the basis of different variables are presented in a single table. We provide the description below.

Table 7. Portfolio Comparison 1

Factor/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Portfolio	24.28	11.48	-3.72	36.24	3.21	22.22	4.12	-18.17	-40.13	47.38	16.91	-3.41	57.67
AZS	-40.84	-20.98	-15.25	26.55	-10.53	6.33	0.72	-9.89	-30.26	47.30	15.53	-0.69	-10.02
MCAP	8.96	10.08	-31.07	72.64	-2.91	70.30	22.83	-10.07	-25.25	89.06	6.63	-8.52	61.15
BtoM	14.32	6.02	-31.06	70.67	4.61	26.23	19.32	0.74	-28.83	65.16	22.19	-10.75	37.11
ROE	13.71	-2.28	-16.71	28.49	-2.61	2.63	18.93	-2.56	-17.91	40.08	9.15	4.64	49.59
BtoM + ROE	12.89	13.69	-16.55	35.22	12.99	20.94	-0.06	12.74	-40.86	53.62	20.22	-8.39	43.12

All numbers in the above table are stated as percentage.

Portfolio –annual returns of portfolio based on four variables
AZS – annual return of portfolio based on AZS
Mcap – annual return of 20 smallest stocks in the S&P 500 in the observed year
BtoM – annual return of portfolio based on book-to-market metric
ROE – annual return of portfolio based on ROE metric
BtoM + ROE – annual return of portfolio based on combination of book-to-market and return on equity metric

4.7.1 Raw returns comparison

The portfolio based on four variables had 9 positive years compared to other portfolios that had between 5 positive years (AZS) and 10 positive years (BtoM). In terms of the number of positive years it ranked second together with the BtoM + ROE portfolio. If we calculate the absolute difference in return between the constructed portfolios, the Four Variable Portfolio exceeded all others in 2001 and 2003. It was exceeded by only one portfolio in years 2002 and 2013. It was exceeded by the BtoM + ROE in 2002 and by the Mcap in 2013. No portfolio was exceeded by the Four Variables Portfolio every single year and no portfolio exceeded the Four Variables Portfolio every single year. The portfolio that exceeded the portfolio based on multiple variables for the most times was the book-to-market portfolio. It exceeded our portfolio 8 out of 13 times, closely followed by the Mcap portfolio with 7 winning years.

4.7.2 Comparison of calculated metrics

Below I compare same portfolios based on their compound annual growth rate and their Sharpe ratio.

Table 8. Portfolio Comparison 2

(in %)	AVG	COMPOUND	CAGR	STDEV	Sharp	Difference to S&P	Difference to CAPM	Difference to FF
BtoM	15.06	297.85	11.207	31.34	28.03	8.70	8.02	4.97
MCAP	20.29	479.05	14.464	40.40	29.80	11.96	10.24	8.23
AZS	-3.23	-54.10	-5.8137	24.70	-33.35	-8.32	-4.82	-9.23
ROE	9.63	170.65	7.9598	21.01	26.35	5.45	4.79	4.11
BtoM + ROE	12.27	219.28	9.341	25.63	26.98	6.83	5.78	3.98
Portfolio	12.16	206.86	9.0076	27.18	24.22	6.50	6.63	2.22

When compared to the index, the Mcap portfolio was the absolute winner with its CAGR of 14.5% compared the index's negative CAGR of -7.18% (a 20pp difference). As a result the same portfolio was also number one when comparing the compound return. When comparing the portfolios against the index using the Sharpe ratio, the Mcap was the absolute winner as well. When the returns were adjusted for risk using the CAPM model, the Mcap portfolio represented the winning combination of stocks again exceeding the CAPM adjusted return by 15.4 pp. 1.5 pp before its nearest competitor BtoM. When further adjusting to the Fama French risk factors, the Mcap portfolio remained in the lead, beating the FF adjusted return by 13pp, 5.3pp before its nearest competitor in this category – the ROE portfolio.

Based on the Sharpe ratio, which is calculated as the excess return divided by the standard deviation of excess return, the Mcap portfolio exceeds all other portfolios. It may be

clearly observed table 8 that the portfolio based on market capitalization exceeded all other portfolios by a great great margin. The portfolio had the Sharpe ratio of 0.3 most closely followed by the BtoM portfolio. It is interesting that the combination of the BtoM and ROE performed worse than the BtoM portfolio on its own. The Four Variables portfolio had the lowest Sharpe ratio among the portfolios except for the AZS portfolio which had a negative Sharpe ratio. It is interesting that the Mcap portfolio that had the highest Sharpe ratio also had the highest compound annual return and consequently the highest total return.

4.8 Level of pain

Maximum drawdowns were calculated for each portfolio. These drawdowns were later compared to the maximum S&P500 index in order to add some comparative value. The results are presented in the table below.

Table 9. Maximum drawdown comparison

Portfolio	**Maximum drawdown (in %)**	**Difference* (in percentage points)**
BtoM	-31.1	7.1
Mcap	-32.8	5.4
ROE	-20.0	18.2
AZS	-69.8	-31.6
BtoM + ROE	-40.9	-2.7
Four variables	-51.0	-12.8

*The difference is calculated as a difference between the respective portfolio maximum drawdown and the S&P 500 index maximum drawdown over the observed period. A positive number indicates that the portfolio had a lower maximum drawdown than the index over the observed period, while the negative number indicates the opposite.

The AZS portfolio recorded the largest maximum drawdown between 2000 and 2013, while the ROE portfolio recorded the lowest maximum drawdown over the same period. When compared to the benchmark index, three portfolios have positive difference which means that their maximum drawdown is smaller than the maximum drawdown of the index. The S&P 500 total return recorded the maximum drawdown of 38.2% over observed period.

CONCLUSION

In conclusion we shall return to our hypotheses and conclude with facts. This research was motivated by the idea of investigating the performance of well-known strategies within the group of U.S. largest corporations.

In order to test the hypotheses six portfolios were formed based on previously determined selective criteria, namely the five-year average return on equity, the book-to-market ratio, the Altman's Z-score and market capitalization. All metrics were equally weighted. Each portfolio consisted of 20 corporations that were part of the S&P 500 index at the time of the selection. We examined their performance during the thirteen year period. The portfolio performance was benchmarked against the S&P 500 index as well as adjusted for risks taken into account in the CAPM model and the Fama French factors.

The entire case is built mainly on the data retrieved from the Bloomberg database. For the purpose of the research the data for the selected corporations were retrieved for the years from 2000 to 2013. The Standard and Poor's 500 index total return was retrieved from the YCharts database, while the market yield on a one year treasury bill with constant maturity used as a risk free return was retrieved from the Federal Reserve database. When calculating the FF adjusted returns, the FF annual benchmark factors were retrieved from the Kenneth R. French Data Library.

Firstly, we considered whether portfolios beat the market as a benchmark over the observed period.

Basing our portfolio on the book-to-market metric brought good results. The average compound rate of 11.21 percent exceeded the index by 8.7 percent. The portfolio would almost quadruple our principal over the observed period.

Investing based on the Mcap would have beaten the S&P 500 in 8 out of 13 years over the observed period. The compound annual growth rate of such portfolio would be 14.46 percent, a double digit difference of 11.96 percent if compared to the market. While the portfolio would have given us almost six fold returns on our principle, the market would have less than double it.

The ROE portfolio had grown at an average compound rate of 7.96 percent. It exceeded the S&P 500 average compound annual growth by 5.45 percentage points. The ROE portfolio would almost triple our initial principal over the period.

The return of the portfolio that was based on the Altman's Z-Score had beaten the market in four out of thirteen years. The compound annual growth rate of the portfolio was -5.81 percent compared to a positive market return of 2.51 percent which made a difference of 8.32 percent. While investing in the S&P 500 would increase the principal and reinvesting according to the AZS plan would be value destroying over the observed period.

Book-to-market in combination with return on equity portfolio has also strongly beaten the market. The average compound annual growth rate of this portfolio was almost in double

digits and amounted to 9.34 percent. It exceeded the index return by 6.83 percentage points. The portfolio would more than triple our initial principal. All but the AZS portfolio beat the S&P 500 over the observed period.

The return of the portfolio that was based on the four variables had beaten the S&P 500 index return in eight out of thirteen years. The compound growth rate of the portfolio was 9.01 percent against the S&P 500 compound growth rate of 2.51 percent over the period. The staggering difference of 6.5 percentage points was recorded. The initially invested principle would increase by 137.97 percent over the period of 13 years, while if invested in the portfolio, it would more than triple.

Among all examined portfolios the Mcap portfolio is the absolute winner in exceeding the S&P 500 over the observed period.

The idea behind the hypothesis two was to compare the total return of portfolios to a frequently used calculated benchmark, CAPM. This benchmark was used in order to show what part of our excess returns is due to additional risk taken.

According to the CAPM model our book-to-market portfolio was supposed to return 3.19 percentage points on average, while it actually returned 11.21 percent per annum on average which is a difference of 8.02 percentage points. Our book-to-market portfolio almost quadrupled the principle, while according to the CAPM the principle should increase by 150.4 percent.

The Mcap portfolio exceeded the CAPM adjusted return in 8 out of 13 observed periods. According to the CAPM model the principal should compound to 4.23 percent average annual rate of return, while it actually compounded at 14.46 percent average annual rate of return. According to the CAPM, the principle should compound to 171.31 percent over the period, while our portfolio compounded to a 661.14 percent.

The ROE portfolio exceeded the CAPM expected return in 9 out of 13 years. It compounded the initial invested principle at an average annual return of 7.96 percent, while the principle was expected to compound to 3.17 percent on average per annum according to the CAPM.

The AZS portfolio exceeded the CAPM adjusted return in only 5 out of 13 observed years. According to the CAPM, the portfolio should return a negative 0.99 percentage points per annum, while it in fact generated much greater loss. It generated a negative return of 5.81 percentage points on average per annum. The portfolio value is supposed to fall decrease 87.81 percent, while it actually decreased to 45.53 percent of the initial principal.

A portfolio that was constructed based on the book value and the return on equity factor, returned on average 9.34 percent per annum, while according to CAPM expected return, it should only generate a compound average return of 3.56 percent. It outperformed the CAPM expected return in 9 out of 13 years.

The Four Variables Portfolio exceeded the CAPM return in 8 out of 13 years. The difference between the compounded annual rates of return amounted to 6.63 percentage points over the observed period. According to the CAPM adjusted return, our portfolio should return 135.8 percent over the period or 2.38 percent on average per annum. The portfolio in fact returned over 300 percent and more than tripled its expected compound annual rate of return.

The portfolio that exceeded the CAPM expected return the most by a great margin was by a great margin the Mcap portfolio (10.24%). Followed by the book-to-market portfolio (8.02%), The Four Variables Portfolio (6.63%), BtoM + ROE portfolio (5.78%) and the ROE portfolio (4.79%). The only portfolio that lagged behind the CAPM expected return was the AZS portfolio (-4.35%).

Afterwards the CAPM the portfolio returns were also compared to the Fama French adjusted return.

The BotM portfolio strategy generated better results than expected by the FF adjusted return. While our portfolio was growing with the CAGR of 8.8% the FF returns were predicting only 1.4% CAGR, indicating an alpha in our strategy.

The Mcap portfolio proved an even higher alpha to previously mentioned portfolio over the observed period. While the FF expected return for the portfolio was even slightly negative (CAGR of -0.2%), our portfolio actually returned the CAGR of 12.8% over the observed period.

The AZS portfolio was a disappointment in this perspective since it underperformed in terms of the FF expected returns by a substantial margin, yielding a negative CAGR of -5.8% in comparison to a positive expected CAGR of 3.4%.

The ROE portfolio yielded better results than predicted by the Fama French model. Our portfolio yielded a CAGR of 7.9% while the FF expected return would yield a CAGR of 3.85%, indicating a positive portfolio strategy alpha.

The BtoM+ROE portfolio was another portfolio strategy which CAGR of 9.3% exceeded its FF expected return of 5.5%. This represents another examined portfolio strategy showing FF defined alpha.

Portfolio based on the four variables exceeded the FF expected return as well. The portfolio returned a CAGR of 9%, while the FF formula could only explain 6.8%.

It is interesting to note that the portfolio constructed of the smallest 20 corporations within S&P 500 has proved to exceed the Fama French CAGR by over 9 percentage points. This portfolio outperformance was followed by the BtoM portfolio (outperforming the FF expected returns CAGR by 4.97 percentage points), the ROE portfolio (4.11 percentage points), the BtoM + ROE portfolio (3.98 percentage points) and finally the Four variables portfolio with 2.22 percentage points.

In my thesis I was questioning whether a return of the portfolio constructed by a combination of factors yields the same result as a portfolio based on a single variable. The portfolio that was constructed on all four variables exceeded two out of four portfolios based on a single variable (the AZS and ROE). The Mcap and BtoM exceeded the portfolio constructed on all four variables. That indicates that it might be wise to weight the portfolio more on these variables when performing further testing in the search for an optimal value portfolio based on quantitative factors. Based on the results we cannot conclude that selecting multiple criteria would necessarily yield better results.

We performed a drawdown calculation in order to look into portfolio stability and the level of emotional stability required from a person in order to continue with this portfolio over the bad year's maximum. The BtoM portfolio faced the maximum drawdown of 31%, a positive difference of 7% compared to the index over the observed period, thus indicating lower risk in comparison to the index. The Mcap portfolio faced the maximum drawdown of 32% with a positive difference of 5.4%, thus indicating low risk of this portfolio strategy. The ROE portfolio faced the maximum drawdown of 20% with a staggering positive difference of 18% compared to the index. The AZS portfolio had the maximum drawdown of almost 70%, indicating that one would lose 70% of its principal in a single year following this strategy. The difference compared to the index was negative -31%. The BtoM+ROE portfolio also decreased by more than the index in its worst year. Its maximum drawdown amounted to over 40% with a negative difference of almost -3% compared to the index. The portfolio based on four variables was also one of the investigated portfolios with a negative difference compared to the index. Its maximum drawdown amounted to negative 51%, while the difference amounted to almost -13%.

When comparing solely the maximum drawdowns one would probably need least emotional stability with the ROE portfolio, since this portfolio performed the best in this section; during its worst year it decreased over 18% less than its benchmark index during its worst year.

It came as a surprise that the Mcap strategy performed best by a great margin. It exceeded the S&P 500 index set as a benchmark and on its own performed better than the CAPM and FF expected returns. In addition to this it also exceeded all tested portfolios in every single category. It also proved that it can perform better than a portfolio based on multiple selection criteria. The only category in which the Mcap strategy came second was maximum drawdown testing in which it actually came second to the ROE, but still performing over 7% better than the S&P 500 over the period observed by this metric.

With regard to everything above stated the Mcap strategy seems to be worth looking into by an investor searching for opportunities.

Based on the results of this master thesis one can see several potential directions for future research. Among other it would be interesting to see how book-to-market performs over a longer period of time and on different markets to search for potential value opportunities and what is the influence and source of small market capitalization companies' outperformance. We would also like to see the Four Variables Portfolio adjusted for

relative importance and tested over a longer period of time. Another interesting subject for further research would be examining portfolio companies and weighing the portfolio exposure against them. Due to various factors influencing the market we believe there are important market inefficiency gaps waiting to be exploited. We also believe thus could be done based on the quantitative and freely available data as shown in the thesis.

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APPENDIXES

TABLE OF APPENDIXES

Appendix A: Povzetek v Slovenščini

Uvod

Magistrsko delo je motivirano na osnovi raziskav tržnih anomalij. Cilj magistrskega dela je poiskati nekaj anomalij nakazanih v preteklih raziskavah in jih testirati na zgodovinskih podatkih, v okviru javno trgovalnih podjetij, vključenih v indeks S&P 500.

Empirične raziskave kažejo, da imajo navadne delnice, kupljene na osnovi visokega razmerja knjigovodske vrednosti proti tržni ceni, v povprečju višje donosnosti od navadnih delnic, kupljenih po nizkih vrednostih istega kazalca. Tovrstne anomalije naj ne bi bilo moč pojasniti s pomočjo široko uporabljenega CAPM modela. Spodaj navajam nekaj raziskav, ki potrjujejo zgoraj zapisano.

Lakonishok, Shleifer in Vishny so v letu 1994 objavili zanimivo študijo, v kateri so preučevali široko uporabljene kazalnike vrednosti: knjigovodska vrednost proti tržni ceni, denarni tok proti tržni ceni in dobiček na tržno ceno. Kot dodatek pa so upoštevali tudi rast prodaje ter kombinacijo zgoraj omenjenih faktorjev. Na podlagi petih let računovodskih podatkov so formirali enako utežne portfelje in dokazali, da portfelji, sesavljeni na podlagi vrednostih faktorjev, ustvarjajo nadpovprečne rezultate, in da podjetja, kupljena na podlagi boljših vrednosti kazalnikov dajejo boljše rezultate ter da uporaba več faktorjev hkrati ta rezultat še izboljša. Strategija deluje tako v pri malih kot tudi pri velikih podjetjih (Lakonishok S. V., 1994). Rafael La Porta, Josef Lakonishok, Andrei Schleifer, and Robert Vishny so v svoji študiji dokazali, da so pozitivna presenečenja dobičkov sistematično bolj pozitivna pri navadnih delnicah, kupljenih na podlagi izbranih faktorjev vrednosti. Avtorji pripisujejo pomembno vlogo vedenjskim faktorjem (Rafael La Porta, 1997).

Nedavne empirične raziskave kažejo, da sta faktorja knjigovodske vrednosti proti tržni ceni in tržna kapitalizacija pomembnejša izmed faktorjev pri izbiri nadpovprečno donosnih portfeljev (Fama & French, 2012). Nekatera druga dela in avtorji, ki potrjujejo zgoraj zapisano so Rosenberg, Reid in Lanstein (1984), Chan, Hamao in Lakonishok (1991), Fama in French (1992) kot tudi Chui, Titman in Wei (2010). Nekateri izmed avtorjev zanimivo povežejo pomembnost donosnosti kapitala in cene, ki jo za ta kapital plačamo ter kažejo na pomembnost tega razmerja (Wilcox, 1984). Avtor te rezultate ponovno dokaže tudi v novejši študiji (Wilcox & Philips, 2005), dokazujejo pa jih tudi drugi avtorji kot na primer How, Xue in Zhang (2012). Rafael La Porta (1997) na primer zgoraj zapisanega ne zavrača, a poudarja pomembnost cene, ki jo plačamo in le to postavlja pred donosnost kapitala, ki ga kupujemo.

Raziskave, ki se ukvarjajo z varnostjo vrednostnih papirjev, pa so razmišljanje pri iskanju najboljše kombinacije faktorjev usmerile tudi v drugo smer. Ideja, ki se je porodila, je naslednja; če se nam pri izbiri podjetij znotraj indeksa uspe izogniti najslabšim, bi to samo po sebi moralo zagotoviti donosnost, višjo od povprečne donosnosti indeksa. Edvard Altman v svojih študijah dokazuje, da je stečaj podjetja na podlagi kvantitativnih podatkov v večini primerov možno dokazati tudi za več kot dve leti vnaprej (Altman, 1968), v svojih kasnejših raziskavah to ponovno potrdi s podobnimi rezultati (Altman, 2000).

Da bi se sploh lotili raziskave takšnega fenomena in ga smatrali za pomembnega ter rezultate za mogoče, moramo verjeti, da obstajajo vsaj kotički tržne neučinkovitosti najbolj odprtega tržnega sistema kar jih poznamo. Kljub dejstvu, da veliko avtorjev verjame, da so bili višji donosi portfeljev izbranih na podlagi vrednostnih faktorjev zgolj rezultat prevzemanja večjega tveganja, obstajajo avtorji, ki trdijo drugače. Vedenjske finance tako kot eno izmed možnosti ponudijo neracionalno, čustveno obnašanje posameznika (Bodie, Kane, & Marcus, Investments, 2009) in dokazujejo, da obstajajo okoliščine v katerih trg popolnoma odpove (Akerlof, 1970). Kot je zapisal že Benjamin Graham (Graham, 2006):

"*Investitor bo po vsej verjetnosti sam sebi najhujši sovražnik in največji problem*."

Strokovnjaki in analitiki so tako v dobro znanem fenomenu »dotcom boom« vrednost podjetja začeli upravičevati na vse mogoče načine (Glassman & Hassett, 1999). Dokazano je, da ljudje pozabljajo in ponavljajo lastne napake (Pfeffer, 1992). Ljudje prav tako podcenjujejo verjetnost negativnih in precenjujejo verjetnost pozitivnih dogodkov in so tako v realnem svetu v povprečju nerealni optimisti (Lench & Ditto, 2007). Na optimizem sam pa močno vplivajo čustva, še posebej močen vpliv ima strah, ki vodi do hitrih neracionalnih odločitev (Lench & Levine, 2005). Študije povezujejo tudi optimizem in občutek obvladovanja situacije (Klein & Larsen, 2002) in verjetnostjo posameznikov, da dogodke predstavljajo v pozitivni luči (Klein, 1996). Ljudje radi kupujejo nerealno natančnost (Radzevick & Moore, 2009), analitiki pa neradi priznajo da nekateri dogodki preprosto niso predvidljivi (Tyszka & Zielonka, Expert Judgments: Financial Analyst vs. Weather Forecasters, 2002). S povečano količino informacij se njihova samozavest dvigne, medtem ko sposobnost napovedovanja upade. (Tsai, Klayman, & Hastie, 2008). Prav tako je tu pomemben vpliv ega (Langhe, Sweldens, Osselaer, & Tuk, 2008) ter z njim povezanega kockanja (Langhe, Sweldens, Osselaer, & Tuk, 2008); ego sam povzroča zmanjšanje racionalne presoje posameznika (Bruyneel, Dewitte, Vohs, & Warlop, 2006). Vse zgoraj zapisano nakazuje, da bi na trgu vsaj v določenem delu ali časovnem obdobju morala nerazsodnost in posledično neučinkovitost biti prisotna.

Cilj te magistrske naloge je preučiti izbrane strategije, ki so delovale v preteklosti ter jih testirati znotraj izbranega nabora največjih ameriških podjetij, uvrščenih na borzo, proti različnim vrstam alternativ prilagojenih in neprilagojenih za različne vrste tveganja. Posebej bom uporabil strategijo izbire podjetij z visokim razmerjem med knjigovodsko in tržno ceno delnice, nizko tržno kapitalizacijo, donosnostjo kapitala in podjetja z ugodnim AZS faktorjem kot strategijo izogibanja najmanj uspešnim podjetjem. Dodatno bom preverjal ali portfelja, sestavljena na kombinaciji faktorjev, dajeta boljše rezultate od portfeljev, sestavljenih na podlagi posameznih spremenljivk. Tako bom testiral tudi portfelj, izbran na podlagi kombinacije donosnosti kapitala in razmerja knjigovodske vrednosti proti tržni vrednosti, ter portfelj, sestavljen na podlagi vseh štirih spremenljivk. Vsi donosi bodo primerjani in popravljeni za različne pogosto uporabljene oblike tveganja skozi CAPM ter Fama French faktorje. Da bi našli kar najboljši portfelj, pa bodo primerjani tudi med seboj.

Najprej bom, s ciljem prikaza nekaj najbolj priznanih in pogosto citiranih del znanosti posameznega področja, skozi pregled literature predstavil preteklo delo ter dosedanje dosežke

in dognanja. Vsaka uporabljena mera vrednosti bo opisana in njena uporaba argumentirana. Po pregledu literature v delu zastavljam raziskovalna vprašanja in hipoteze. Razložim metodološki pristop ter uporabljene podatke. Po natančnem opisu pristopa predstavim rezultate, merjene proti različnim splošno uporabljenim referenčnim meram. Rezultati so najprej prikazani posamično, na koncu pa interpretirani skupaj s preračuni. Portfelji so merjeni proti ne tvegani stopnji donosa, indeksu S&P 500, CAPM pričakovanim donosnostim, Fama French pričakovanim donosnostim, kot tudi eden proti drugem. Nalogo zaključim s končno oceno rezultatov raziskave in odgovori na raziskovalna vprašanja.

Literatura

V tem poglavju pregledam in predstavim pogosto uporabljene mere vrednosti. Te koeficiente kasneje uporabim za izgradnjo portfeljev in tako sestavljene portfelje testiram na zgodovinskih podatkih. V magistrskem delu se osredotočam na kvantitativne, javne in enostavno pridobljive faktorje , z željo da bi bili rezultati primerljivi in lahko ponovljivi, sestavljanje portfelja pa enostavno.

Knjigovodska vrednost proti tržni

Ena izmed prednosti izbrane mere je, relativna stabilnost in intuitivnost (Damodaran, 2002) ter omogočanje vrednotenja podjetja tudi v primeru negativnih dobičkov (Damodaran, 2002). Kot dokazujeta Fama in French, je izbrana mera močno povezana s prihodnjimi donosi (Fama E. F., 1992). Težava te mere je, da so vrednosti sredstev podane na osnovi zgodovinskih knjigovodskih podatkov, ki so pogosto nezanesljiv pokazatelj ekonomske vrednosti podjetja (Suozzo P. , Cooper, Sutherland, & Deng, 2001), različna obravnava prevzemov dela knjigovodsko vrednost med podjetji neprimerljivo, težava glede primerljivosti pa nastane tudi pri odkupu lastnih delnic (Damodaran, 2002).

Več avtorjev potrjuje pomembnost in napovedno moč zgoraj omenjenega kazalnika vrednosti. Tako na primer Rosenberg, Reid, in Lanstein (1984), Chan, Hamao, in Lakonishok (1991), Fama in French (1992), Chui, Titman in Wei (2010) kot tudi Fama in French (2012) potrjujejo, da delnice z visokim razmerjem knjigovodske vrednosti proti tržni ceni v povprečju prinašajo donose višje od tržnih.

Seth A. Klarman v svoji knjigi zapiše, da je knjigovodska vrednost v veliko primerih dober približek ekonomske vrednosti in da si s kupovanjem vrednostnih papirjev pod to vrednostjo zagotovimo prostor za nenatančnost, nesrečo, nepopolnost informacij in druge napake (Klarman, 1991). Damodaran poudarja pomembnost uporabe knjigovodske vrednosti v kontekstu, še posebej v povezavi z donosnostjo kapitala (Damodaran, 2002).

Donosnost kapitala

Donosnost kapitala je ena izmed pomembnejših mer uspešnosti podjetja. Warren Buffett v svojem pismu vlagateljem leta 1987 zapiše pregled zanimive študije. Zgolj 25 od 1.000 preučevanih podjetij je imelo, v obdobju med letoma 1977 in 1986, donosnost kapitala med 15% in 20%. 24 od teh 25 podjetij je vlagatelju prineslo donosnosti, višje od donosnosti indeksa S&P 500 (Buffett, 1987). Pomembnost donosnosti kapitala dokazujejo tudi Kewei

Hou, Chen Xue in Lu Zhang v svoji študiji, naslovljeni "Digesting anomalies: an investment approach", pomembnost donosnosti kapitala pa ostaja tudi po prilagoditvi za tveganje (Kewei, Che, Lu, 2012). Sama sposobnost ustvarjanja visokih donosnosti je pomembna sestavina vrednosti podjetja in kaže na visoke vstopne ovire (Damodaran, 2002).

Donosnost kapitala se pogosto povezuje s premijo plačano na knjigovodsko vrednost podjetja. Wilcox uspešnost te kombinacije potrdi v svoji študiji iz leta 1984 (Wilcox, 1984), v letu 2005 ponovna študija rezultate vnovič potrdi, avtor pa tokrat dodatno izpostavi pomembnost stabilnosti donosnosti kapitala (Wilcox & Philips, 2005). La Porta v svoji raziskavi poudari, da uspešnost podjetja, merjena z donosnostjo kapitala, ni vse, ter da mora imeti cena, ki jo plačamo za to podjetje, vpliv na uspešnost naše strategije (Rafael La Porta, 1997). Bodie podobno trdi, da kombinacija nizke donosnosti kapitala in še nižje cene pogosto vodijo do boljših rezultatov (Bodie, Kane, & Marcus, Investments, 2009). V tem kontekstu postavljamo in testiramo portfelj, osnovan na kombinaciji omenjenih kazalcev.

Tržna kapitalizacija

Strategija, osnovana na tržni kapitalizaciji podjetja, je verjetno ena izmed bolj preprostih strategij. Banz (1981) in Reinganum (1981a, 1981b) tako med prvimi ugotovita, da manjša podjetja v povprečju prinašajo boljše rezultate od večjih. Rolf W. Banz nadalje ugotavlja, da investicije v manjša podjetja v povprečju prinašajo boljše rezultate od investicij v večja podjetja; tudi po prilagoditvi za tveganje. Dokaže tudi, da vpliv velikosti ni linearen, največje razlike v donosnostih namreč najdemo ob primerjavi donosnosti najmanjših podjetij proti donosnostim največjih (Banz, 1980). Debond in Thaler podobno potrdita na podlagi podatkov podjetij uvrščenih na NYSE med januarjem 1926 in decembrom 1982 (De Bondt & Thaler, 1985). Lakonishok, Shleifer in Vishny pa na širokem vzorcu (NYSE, AMEX in COMPUSTAT) med aprilom 1963 in aprilom 1990 dokažejo da strategije izbiranja podjetij na podlagi vrednostnih faktorjev delujejo tako pri majhnih kot velikih podjetjih (Lakonishok, Shleifer, & Vishny, 1994), kar kasneje v magistrskem delu uporabim kot dodaten argument postavljanja portfelja na podlagi kombinacije spremenljivk. Tudi Fama in French v svojih študijah posebej poudarjata pomembnost velikosti podjetja, kar kažejo tudi rezultati njune študije osnovane na podlagi podatkov pridobljenih z Bloomberga, DataStreama in Worldscopa podatkovne baze, v obdobju med novembrom 1989 in marcem 2011, dokazujeta pa tudi da je efekt prisoten tudi zunaj ameriških trgov (Fama & French, 2012).

Altman's Z Score

Altman's Z-score je preprosta formula ki zahteva zgolj kvantitativne kazalnike. Formula je zgrajena z namenom predvidevanja stečajev in prvič objavljena s strani Edward I. Altmana, leta 1968. Zgrajena je na podlagi empiričnih raziskav, izključno za nefinančna podjetja,. Višji rezultat formule glede na raziskavo pomeni boljše podjetje, oziroma manjšo verjetnost stečaja. Model po avtorjevih besedah pravilno napove 94% stečajev, tudi do dve leti vnaprej (Altman, 1968). V kasnejši raziskavi Altman napovedno sposobnost nekoliko zniža in ji postavi razpon med 80% in 94% (Altman, 2000). June Li (2012) dokaže da formula deluje tudi na podjetjih, ki so že v stečajnem ali likvidacijskem postopku. Obstajajo tudi številne novejše študije s pozitivnimi dokazi o uporabnosti formule, kot na primer: Li M.-Y.l (2012), Gutzeit (2011),, Satish (2011), Wang (2010), Lugovskaya (2010), Gerantonis (2009).

Kombinacija spremenljivk

Vrsta avtorjev potrjuje pomembnost in smiselnost uporabe kombinacije spremenljivk pri izbiri optimalne strukture portfelja. Tako na primer Eugene F. Fama in Kenneth R. French (1992) odkrijeta, da sta izbrani spremenljivki knjigovodske vrednosti proti tržni in tržne kapitalizacije vsaj robustna na vključitev drugih spremenljivk. Mohanram (2005) dokaže, da kombinacija spremenljivk daje nadpovprečne rezultate. Nekateri drugi avtorji, ki tudi predlagajo uporabo več spremenljivk, so Campbell & Cochrane (1999), Duffe (2005) in Santos & Veronesi (2006).

Z uvedbo več spremenljivk bi želel priti do podjetij, ki so visoko donosna, predvidljiva, z nizko verjetnostjo stečaja in se prodajo po nizkih cenah. Takšna podjetja pričakujem, da bom hitreje našel med manjšimi podjetji, slabše pokritimi s strani izkušenih uspešnih investitorjev.

Hipoteze

V tem poglavju si zastavim ključna raziskovalna vprašanja. V prvi hipotezi se sprašujem ali je donosnost portfelja višja od donosnosti trga. Nadalje si zastavim vprašanje, ali to drži, ko donosnost prilagodimo za tveganje, tako CAPM kot tudi Fama French. Namen do sedaj zastavljenih vprašanj je raziskati smiselnost napora sestavljanja portfelja.

V naslednjih hipotezah želim preveriti še ali portfelj, sestavljen na osnovi vseh spremenljivk, daje boljše rezultate od portfelja, sestavljenega na osnovi posamezne spremenljivke, in preveriti, kolikšna čustvena stabilnost ter disciplina bi bila potrebna pri takšni strategiji.

Metodologija

Posamezni portfelj sestavlja dvajset podjetij. Podjetja so v portfelje izbrana na osnovi štirih opazovanih vrednosti: povprečnega petletne donosnosti kapitala (ROE), knjigovodske vrednosti delnice proti njeni tržni ceni (BtoM), vrednosti Altman Z-score (AZS) in tržne kapitalizacije (Mcap). Dva portfelja sta sestavljena iz kombinacije zgoraj opisanih faktorjev, eden na podlagi kombinacije BtoM in ROE, drugi ob upoštevanju vseh spremenljivk. Pri sestavljanju kombiniranih portfeljev so vse spremenljivke tehtane enako. Vsako izmed izbranih podjetij predstavlja 1/20 portfelja. Pri preračunu donosnosti sem upošteval dividende, sestavo portfeljev pa menjal na leto dni med majem 2000 in majem 2013.

Drugi portfelji so bili sestavljeni na enak način, razlika je le v tem, da sem pri drugih portfeljih kot selekcijski kriterij uporabljal eno samo mero vrednosti. Vsi portfelji obravnavani v tej magistrski nalogi so zgrajeni znotraj indeksa S&P 500.

Po postavitvi portfeljev in preračunu donosnosti sem portfelje primerjal z ne tvegano stopnjo donosa, donosnostjo S&P 500,pričakovano CAPM donosnostjo in pričakovano donosnostjo Fama French.

Vsa podjetja z manjkajočimi oziroma nepopolnimi podatki so bila odstranjena. Podjetja sem razporedil glede na uporabljen kriterij in iz vsake skupine izbral najboljših dvajset, pri čimer je imelo najboljše podjetje rang ena innajslabše podjetje rang n.

Za namene portfeljev, sestavljenih na podlagi več spremenljivk, je bil izračunan skupni rang. Skupni rang je preprosto seštevek posameznih rangov, tako se prvih dvajset podjetij z najnižjim skupnim rangom uvrsti v portfelj. Vsi portfelji so bili prvič postavljeni v maju 2000, ter zadnjič prodani v maju 2013. V vmesnem obdobju sem portfelje menjal na leto dni, na podlagi istega sistema in novih informacij.

Povprečna letna in celotna donosnost je bila izračunana za vse portfelje. Tržna donosnost je bila izračunana kot celotna donosnost indeksa S&P 500, torej vključujoč dividende.

CAPM

Capital Asset Pricing Model je osnovan na predpostavki, da morajo biti investitorji poplačani za prevzem sistematičnega tveganja v obliki premije ali presežka tržne donosnosti nad ne tvegano stopnjo donosnosti (Rosenbaum & Pearl, 2009). Pričakovana donosnost je bila izračunana na podlagi spodaj zapisane formule:

$$E(ri)=rf+\beta[E(rM)-rf] \quad (1)$$

Kjer E(ri) pomeni pričakovano donosnost, rf netvegano stopnjo donosnosti, β mero volatilnosti in $E(rM)$ pričakovano tržno donosnost.

Da bi izračunal pričakovano donosnost, sem ocenil *rf* na podlagi letnega U.S. T-billa z donosnostjo do dospetja na dan spremembe portfelja. Kratkoročna obveznica ima tako enako dospetje in ročnost kot portfelj, poleg tega ocenjujem možnost plačila kot zelo verjetno. Pričakovana tržna donosnost je bila zamenjana z dejansko celotno donosnostjo indeksa S&P 500 v posameznem letu. Pričakovane donosnosti so bile izračunane za vsako opazovano obdobje in obravnavane enako kot donosnosti portfelja.

Fama French donosnosti

Fama French predstavlja drugo izračunano donosnost uporabljeno za primerjavo z donosnostmi ustvarjenimi s portfelji, namen je prepoznati del donosnosti ustvarjene na podlagi naložbene strategije in del pridobljen na podlagi prevzemanja višje stopnje tveganja kot definiranega s samim modelom.

Tržne donosnosti na letni T-bill so uporabljene kot približek ne tvegane stopnje donosnosti. Tržna premija, SMB in HML spremenljivki so pridobljeni s spletne podatkovne baze Kenneth R. French. Koeficienti (a, b, c in d) so ocenjeni na podlagi linearne regresije v obdobju med leti 2000 in 2013. Koeficienti so bili izračunani za vsak posamezni portfelj. Na podlagi koeficientov in prej opisanih podatkov (r_f, r_m, SMB in HML), je bila pričakovana donosnost izračunana po naslednjih korakih:

5. Splošna enačba:

$$r=rf+a+b(rm-rf)+c(SMB)+d(HML) \quad (2)$$

6. Izračun ter vključitev koeficientov

$$r=rf+0.84*(rm-rf)-0.49(SMB)+1.13(HML) \quad (3)$$

7. Vključitev spremenljivk ter izračun pričakovane donosnosti:

$$19.22=6.24+0.84*(-16.71)-0.49(-5.69)+1.13(21.39) \quad (4)$$

1.1.2.1. Sharpe

Sharpe je bil uporabljen kot pogosto uporabljena mera tveganja investicije glede na njeno donosnost. Sama definicija in uporaba, je osnovana na uradni spletni strani (Sharperatio, 2014). V splošnem višji kazalnik nakazuje višjo donosnost pri enakem tveganju, ali pa enako donosnost pri nižjem tveganju. Sharpe je bil izračunan pri vsakem preučevanem portfelju. Poleg uporabe ter načina izračuna v magistrskem delu izpostavim tudi izbrane prednosti, slabosti in omejitve.

Podatki

V poglavju pod istoimenskim angleškim naslovom podrobno opišem izbrane podatke in uporabljene podatkovne baze.

Preučevani podatki so zbrani okrog preučevanega nabora podjetij vključenih v S&P 500, na dan oblikovanja portfelja.

Podatkovna baza

Podatki so pridobljeni večinoma iz podatkovne baze Bloomberg. Baza omogoča vpogled v podatke od leta 1990 dalje, zaradi pomanjkljivosti podatkov pa raziskavo opravljam zgolj na podatkih od leta 2000 dalje. Prva podjetja so bila v portfelj zajeta maja 2000, zadnji portfelj pa razprodan maja 2013. Portfelj je preoblikovan na letnem nivoju. Omejitvena predpostavka je da je portfelj na prvi trgovalni dan preoblikovan, po trenutnih tržnih cenah ob zaprtju. Prodajnim cenam so dodane dividende izračunane na podlagi podane bruto dividendne donosnosti.

Razmerje knjigovodske do tržne vrednosti je izračunano kot računovodska knjigovodska vrednost podana konec zadnjega leta vlomljeno z trenutno ceno ob zaprtju. Tržna kapitalizacija je izračunana kot cena navadne delnice ob zaprtju trgovanja pomnožena s številom navadnih delnic. Altman Z-Score je izračunan zgolj za nefinančna podjetja, finančne institucije so bile tako zanemarjene ter izbrisane iz podatkovne baze. Donosnost kapitala je izračunana kot petletno povprečje poročane donosnosti. Bete so povzete z Bloomberga in so izračunane na podlagi dvoletnega povprečja tedenskih podatkov, merjene proti S&P 500. Celotna donosnost opazovanega indeksa je pridobljena iz podatkovne baze YCharts in uporabljena kot donosnost primerjalnega indeksa. Ne tvegana stopnja donosnosti je, za namene raziskave, enaka tržnem donosu letne zakladne menice, za katero so podatki pridobljeni iz podatkovne baze Federal Reserve. Fama French faktorji so pridobljeni z Kenneth R. French Data Library.

Rezultati

V tem poglavju predstavljam rezultate v vrstnem redu portfeljev ter posameznih testov. Pri vsakem portfelju opišem donosnost in bete, Sharpe ratio in jih primerjam s primerjalnim indeksom ter CAPM in Fama French pričakovanimi donosnostmi.

Pri primerjavi portfeljev z donosnostmi trga kot mere uspešnosti je portfelj osnovan na izbiri podjetij z nizko tržno kapitalizacijo izpadel kot absolutni zmagovalec (CAGR 14,5% proti -7,1%). Tudi pri primerjavi Sharpovega koeficienta je prej omenjeni portfelj izpadel kot zmagovalec. Portfelj osnovan na osnovi nizke tržne kapitalizacije ostaja absolutni zmagovalec tudi ko donosnost merimo proti CAPM in Fama French pričakovani donosnosti. Najbližji tekmec po prilagoditvi za CAPM je portfelj, je portfelj osnovan na poročani knjigovodskivrednosti, ta po letni donosnosti zaostaja za 1,5 odstotne točke. Ko portfelje še dalje prilagodimo za Fama French, isti portfelj ostaja v vodstvu z 13,3 odstotne točke razlike in 5,3 odstotne točke do drugega najboljšega portfelja, tokrat ROE. Zanimivo opažam, da je bil portfelj, osnovan zgolj na poročani knjigovodski vrednosti, boljša izbira od portfelja, sestavljenega na podlagi kombinacije knjigovodske vrednosti in donosa na kapital.

Kot dodatek posameznem portfelju izračunam še »maximum drawdown«, mero nato primerjam med portfelji in proti indeksu. Presenetljivo se je portfelj, osnovan na AZS, pri tem testu odrezal daleč najslabše in v opazovanem obdobju dosegel -51,0%, razliko 31,6 odstotnih točk do primerjalnega indeksa. Pri tej meri se je najbolje odrezal portfelj osnovan na podlagi ROE in dosegel vrednost -20,0%, ter pozitivno razliko do primerjalnega indeksa 18,2 odstotne točke.

Zaključek

V zaključku se vrnem h hipotezam in delo zaključim z ugotovljenimi dejstvi ter idejami za nadaljnje raziskave.

Kot prvi test portfelja sem preverjal ali je posamezni portfelj v opazovanem obdobju ustvarjal višjo donosnost od primerjalnega indeksa. Povprečna letna donosnost portfelja osnovanega na podlagi knjigovodske vrednosti znaša 11,2% in s tem presega povprečno letno donosnost indeksa za 8,7 odstotne točke. 14,4% bi bila donosnost portfelja osnovanega na podlagi tržne kapitalizacije kar je v povprečju 11,9 odstotne točke višja od tržne. Portfelj osnovan na podlagi ROE je v povprečju na leto rasel za 7,9%, kar je 5,4 odstotne točke hitreje od primerjalnega indeksa. Portfelj osnovan na AZS je imel negativno povprečno letno donosnost (-5,8%), kar predstavlja negativno razliko 8,3 odstotne točke v primerjavi s trgom. Portfelj, grajen na kombinaciji faktorjev knjigovodske vrednosti in donosnosti na kapital, je v povprečju letno rasel za 9,3%, pozitivna razlika 6,8 odstotnih točk do trga. Portfelj osnovan na kombinaciji štirih spremenljivk se je odrezal nekaj slabše in v povprečju letno zrasel 9,0%.

V naslednjem koraku sem primerjal doseženo donosnost s pričakovano CAPM donosnostjo. Portfelj, grajen na podlagi knjigovodske vrednosti, je to donosnost v povprečju prehitel za več kot 8 odstotnih točk, portfelj, sestavljen na podlagi tržne kapitalizacije, pa je pričakovano

CAPM donosnost prehitel za več kot 10 odstotnih točk. Tretji opazovani portfelj, osnovan na podlagi ROE, je prav tako dosegal višjo povprečno donosnost od pričakovane, in sicer za skoraj 5 odstotnih točk. AZS portfelj je ponovno razočaral saj je v povprečju dosegal donosnosti prek pet odstotnih točk pod pričakovanimi. Portfelj, osnovan na kombinaciji knjigovodske vrednosti in donosnosti kapitala, je pričakovano donosnost v povprečju prehitel za dobre tri odstotne točke. Portfelj, osnovan na podlagi štirih spremenljivk, je prav tako prehitel pričakovano povprečno letno donosnost, in sicer za več kot štiri odstotne točke.

Ko sem donosnosti portfeljev primerjal z Fama French pričakovanimi donosnostmi, je BtoM strategija ustvarjala donosnosti višje od pričakovanih, portfelj je rasel z CAGR 8,8% v primerjavi z pričakovanim CAGR 1,4%. Mcap portfelj je pokazal še višjo alfo, z razliko CAGR višjo od 12 odstotnih točk. AZS je sedaj že pričakovano razočaral, tokrat s CAGR razliko višjo od 9 odstotnih točk. Portfelj osnovan na podlagi ROE je izkazal alfo višjo od štirih odstotnih točk. Nekaj nižjo alfo je izkazal tudi BtoM+ROE portfelj ter portfelj osnovan na osnovi štirih spremenljivk.

Portfelj osnovan na štirih spremenljivkah je presegel donosnosti dveh izmed treh opazovanih portfeljev (AZS in ROE), Mcap in BtoM portfelj sta se kot boljša izkazala v vseh merah, kar nakazuje, da bi bilo v primeru, da se odločimo za konstrukcijo tovrstnega portfelja, modro težiti našo izbiro na podlagi teh spremenljivk.

Da bi ocenil stabilnost portfeljev, sem izračunal maksimalni vpad (drawdown) portfelja in ga primerjal z maksimalnim vpadom primerjalnega indeksa v opazovanem obdobju. V tem pogledu se je najbolje izkazal portfelj osnovan na podlagi ROE, ki je v najslabšem obdobju upadel 18 odstotnih točk manj od primerjalnega indeksa. Najslabše se je, sedaj že pričakovano, obnesel AZS portfelj, ki je v najslabšem obdobju vpadel 31odstotnih točk več kot primerjalni indeks.

Skozi celotno raziskavo je bil gotovo največje pozitivno presenečenje portfelj, osnovan na podlagi Mcap, ki je po vrsti prekašal S&P 500, CAPM in FF pričakovane donosnosti. Za nameček je prekosil vse ostale portfelje v sleherni opazovani kategoriji, z izjemo kategorije maksimalnega vpada »maximum drawdown«, v katerei se je izkazal kot drugi najboljši, takoj za portfeljem osnovanim na podlagi ROE.

Glede na zgoraj omenjeno, se portfelj osnovan na podlagi Mcap zdi vreden nadaljnjih raziskav. V prihodnjih raziskavah bi želel preveriti kako se izbrani portfelji obnašajo na daljša obdobja na različnih trgih. Izjemno zanimivo bi bilo raziskavo usmeriti v iskanje vzroka presenetljivo visokih in zanimivo zanesljivih donosnosti malih podjetij. Portfelj štirih spremenljivk bi želel preveriti z različnimi utežmi skozi daljše časovno obdobje. Glede na množico spremenljivk verjamem, da na trgu obstaja možnost izbire portfelja z nadpovprečno donosnostjo. Skozi magistrsko delo sem pokazal, da je tovrsten portfelj moč sestaviti celo na podlagi kvantitativnih in prosto dostopnih informacij.

Appendix B: Fama French regression output AZS portfolio

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,869979463
R Square	0,756864266
Adjusted R Square	0,675819022
Standard Error	0,140641775
Observations	13

ANOVA

	Df	SS	MS	F	Significance F
Regression	3	0,554166661	0,18472222	9,338786877	0,003988621
Residual	9	0,178020979	0,019780109		
Total	12	0,73218764			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95,0%	Upper 95,0%
Intercept	-0,085720733	0,04527379	-1,893385386	0,090843538	-0,188137162	0,016695696	-0,188137162	0,016695696
Rm – Rf	0,009268764	0,002124394	4,363015417	0,001815469	0,004463051	0,014074477	0,004463051	0,014074477
SMB	-0,007257662	0,004428608	-1,638813269	0,135675155	-0,002760546	0,017275869	-0,002760546	0,017275869
HML	-0,004700225	0,003734663	-1,258540601	0,239862365	-0,013148618	0,003748169	-0,013148618	0,003748169

Appendix C: Fama French regression output Mcap portfolio

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,794745435
R Square	0,631620306
Adjusted R Square	0,508827075
Standard Error	0,283115529
Observations	13

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	1,236887766	0,412295922	5,143771361	0,024148568
Residual	9	0,721389626	0,080154403		
Total	12	1,958277391			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,096827988	0,091137311	1,062440695	0,315711314	-0,109338932	0,302994908	-0,109338932	0,302994908
Rm – Rf	0,013434689	0,00427646	3,141544332	0,011898403	0,003760664	0,023108713	0,003760664	0,023108713
SMB	-0,002366473	0,008914903	-0,265451353	0,796642023	-0,022533384	0,017800438	-0,022533384	0,017800438
HML	0,009461323	0,007517972	1,258493947	0,239878464	-0,007545512	0,026468158	-0,007545512	0,026468158

Appendix D: Fama French regression output BtoM portfolio

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,912270168
R Square	0,832236859
Adjusted R Square	0,776315812
Standard Error	0,148207509
Observations	13

ANOVA

	Df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0,980693556	0,326897852	14,88235474	0,000779485
Residual	9	0,197689191	0,021965466		
Total	12	1,178382747			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,050256042	0,047709265	1,053381178	0,319624164	-0,057669814	0,158181897	-0,057669814	0,158181897
Rm – Rf	0,011843604	0,002238674	5,290453863	0,000500132	0,00677937	0,016907837	0,00677937	0,016907837
SMB	0,00180037	0,004666842	0,385779139	0,708620768	-0,00875676	0,012357501	-0,00875676	0,012357501
HML	0,005638608	0,003935566	1,432730907	0,185740507	-0,003264262	0,014541477	-0,003264262	0,014541477

Appendix E: Fama French regression output ROE portfolio

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,828041274
R Square	0,685652352
Adjusted R Square	0,580869802
Standard Error	0,136008975
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0,36313775	0,121045917	6,543573861	0,012199661
Residual	9	0,166485971	0,018498441		
Total	12	0,529623721			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,043508304	0,043782452	0,993738391	0,346314838	-0,055534485	0,142551092	-0,055534485	0,142551092
Rm – Rf	0,007929154	0,002054416	3,859566691	0,003849615	0,003281743	0,012576565	0,003281743	0,012576565
SMB	-0,004688627	0,004282728	-1,094775785	0,302046611	-0,01437683	0,004999577	-0,01437683	0,004999577
HML	0,005565131	0,003611641	1,540886924	0,157732813	-0,002604969	0,013735231	-0,002604969	0,013735231

Appendix F: Fama French regression output BtoM + ROE portfolio

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,882753929
R Square	0,779254499
Adjusted R Square	0,705672665
Standard Error	0,13907267
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0,614488207	0,204829402	10,59031094	0,00261186
Residual	9	0,174070868	0,019341208		
Total	12	0,788559076			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,045313563	0,044768682	1,012171022	0,3378928	-0,055960232	0,146587358	-0,055960232	0,146587358
Rm – Rf	0,009781419	0,002100693	4,656282571	0,001191474	0,005029322	0,014533515	0,005029322	0,014533515
SMB	-0,001299269	0,004379199	-0,296690952	0,773435447	-0,011205706	0,008607168	-0,011205706	0,008607168
HML	0,005633649	0,003692996	1,525495519	0,161476407	-0,002720488	0,013987786	-0,002720488	0,013987786

Appendix G: Fama French regression output Four Variables portfolio

SUMMARY
OUTPUT

Regression Statistics	
Multiple R	0,855897199
R Square	0,732560016
Adjusted R Square	0,643413354
Standard Error	0,162333604
Observations	13

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	3	0,649645216	0,216548405	8,217470004	0,006046907
Residual	9	0,237169791	0,026352199		
Total	12	0,886815007			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept	0,027806998	0,052256576	0,532124387	0,607523721	-0,090405589	0,146019586	-0,090405589	0,146019586
Rm – Rf	0,008468762	0,002452049	3,453749013	0,00723179	0,002921842	0,014015682	0,002921842	0,014015682
SMB	-0,004977239	0,005111653	-0,973704395	0,355645353	-0,0165406	0,006586123	-0,0165406	0,006586123
HML	0,011358509	0,004310677	2,634971148	0,02713658	0,001607081	0,021109938	0,001607081	0,021109938