A comparison between the performance of Smart Beta portfolios and the risk adjusted OMXS30 Index
The intrinsic goal of investors is to obtain the highest possible risk-adjusted return. In trying to maximize these returns, a recent strategy has been developed which combines active- and passive investing known as Smart Beta Investing. It combines the benefits of passive investing while simultaneously incorporates the advantages of active investing. The purpose of this thesis is to construct Smart Beta portfolios using Swedish stocks and test whether one can find excess returns during the period 2008-2018 with the OMXS30 index as a benchmark. The study is based on the Capital Asset Pricing Model (CAPM) and recent theory on Smart Beta Investing. The methodology uses previous research on portfolio theory to build the Smart Beta portfolios which ranks, scores and weights stocks according to key financial ratios for the different chosen factors Value, Quality and Low Volatility. The findings showed positive and significant Alphas for all Smart Beta portfolios.
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1. Introduction

The goal of investing is to obtain the highest possible risk-adjusted return also known as the Sharpe ratio (Sharpe, 1964). This is done by creating portfolios of securities that generates excess returns compared to the market, commonly called Alpha (\(\alpha\)). Investors face two choices when trying to hunt for these returns, either using their own knowledge to gain additional value, known as active investing, or follow the market by investing in the market portfolio, known as passive investing (Sorensen, Miller, & Samak, 1998). One can argue about the superiority of either strategy but it is still unclear which proves more useful. In an attempt to bridge the gap between the strategies, Smart Beta Investing has become a popular alternative. Smart Beta combines the benefits of passive investing while simultaneously incorporating the advantages of active investing. Its goal is to seek the best construction of an optimally diversified portfolio (Booth & Bowen, Jr, 1993).

Smart Beta is not a revolutionary strategy however. Similarly related concepts, such as factor investing and rules-based strategies have been circulating in academia and the asset management industry for decades. In the 1960’s, Jan Mossin (1966), John Lintner (1965), William Sharpe (1964), and Jack Treynor (1961) proposed the Capital Asset Pricing Model (CAPM), which states that the rate of return of an asset is a function of its exposure to the market factor, Beta. Stephen Ross (1976) expanded on this model with his work on Arbitrage Pricing Theory (APT), which included the possibility of several factors determining asset returns. Since then, a plethora of studies have emerged on these factors, such as research on Value and Quality by Novy-Marx (2013), on Size by Israel & Moskowitz (2013), on Momentum by Jegadeesh & Titman (1993), and on Low Volatility by Bali & Zhou (2016). Some of these studies will be discussed further in the previous research section and throughout the work.

The purpose of this thesis is to construct Smart Beta portfolios containing Swedish stocks over the period 2008-2018 and test whether Alpha can be obtained using OMXS30 as the benchmark for the market. The chosen Smart Beta portfolios are Value, Quality and Low Volatility. The stocks generated from the Swedish Stock Exchange will be ranked, scored and weighted based on the financial ratios corresponding to their different factors.
2. Theory

This section will cover well recognized models and theories within the field of financial economics from which Smart Beta Investing originates. The models presented provide the reader with a solid background on modern portfolio theory.

2.1 Modern portfolio theory

The modern portfolio theory was introduced by Harry Markowitz (1952) and then followed up by William Sharpe (1964) and John Lintner (1965) with the Capital Asset Pricing model (CAPM). Modern portfolio theory explains the relationship between risk and expected return. Harry Markowitz (1952) describes how to combine and optimize a portfolio of risky assets that can maximize expected return based on a given level of risk. The goal is to eliminate the idiosyncratic risk which is the risk of each particular asset, and only be exposed to the systematic risk also called market risk. Markowitz assumes that investors are rational and risk averse meaning that they always prefer the portfolio with maximized expected return given any level of volatility, so called the mean-variance-efficient portfolio. Other important assumptions are that investors have access to the same information, the market is efficient and that the returns are normally distributed (Markowitz, 1952).

Furthermore, Markowitz (1952) explains the importance of diversification and how one can combine stocks in portfolios to reduce the risk of investments. The diversification effect can be obtained by acquiring assets that are not perfectly correlated with each other, as illustrated in the figure below.

![Figure 1: Diversification effect](source: Bodie, Kane & Marcus, 2014)
There are many conflicting opinions on the amount of stocks needed for creating a well-diversified portfolio. Evans & Archer (1968) found in their study that 10 diversified securities were enough to remove approximately 70% of the diversifiable risk, while a study by Statman (1987) revealed that 30 to 40 stocks are required to have a well diversified portfolio.

The average risk of a portfolio will fall rapidly as the number of stocks included in the portfolio increases. After approximately 30 to 40 stocks, the effect of adding more assets will have a significantly less impact on the diversification effect (Bodie, Kane, & Marcus, 2014).

2.2 Capital Asset Pricing Model (CAPM)

Jack Treynor (1961), William Sharpe (1964), John Lintner (1965), and Jan Mossin (1966) introduced the Capital Asset Pricing Model that illustrate the relationship between the risk and expected return of a security. For a CAPM equilibrium to be obtained there are some necessary assumptions that need to be met. Berk & DeMarzo (2017) mention some of the essential ones:

1. Investors can buy and sell securities at the competitive market price without any incurring taxes or transaction costs. They can also borrow and lend at the risk-free interest rate.
2. Investors will only hold efficient portfolios that yield the maximum expected return for a given level of volatility.
3. Investors share the same expectations regarding volatilities, correlations, and expected returns of securities.

As one of the assumptions is that investors share the same expectations, those who are aiming for the highest possible Sharpe ratio will eventually end up having the same portfolio which is equal to the market portfolio. Additionally, the demand will be the efficient portfolio and the supply will be the securities in that portfolio. If a security does not fulfil the assumptions that is required for the CAPM to hold, then no investor would buy that particular security and the price would fall until it becomes an attractive investment. This way, prices will adjust until the efficient portfolio and the market portfolio match, in other words when demand equals supply (Berk & DeMarzo, 2017).
Figure 2 illustrates the effect of acting in accordance with the CAPM assumptions. Under these conditions the tangent portfolio becomes the market portfolio/efficient portfolio (Berk & DeMarzo, 2017).

### 2.2.1 The CAPM formula

To identify the expected return or the cost of capital of a security one can use the CAPM equation by applying the market portfolio as a benchmark (Berk & DeMarzo, 2017).

The equation is defined as the following:

$$ E[R_i] = R_f + \beta_i (ER_m - R_f) $$

(1)

Where:

- $E[R_i] = $ Expected return
- $R_f =$ Risk-free return (T-bill)
- $\beta_i = \frac{\text{cov}(R_i, R_m)}{\text{var}(R_m)} =$ Beta of security
- $ER_m =$ Expected return of market
- $(ER_m - R_f) =$ Market risk premium

The expression explains how a higher risk generates a higher reward i.e. expected return. The risk-free rate is a treasury bond and the Beta of a security is the volatility/risk relative to the market as a whole, which means that it explains the sensitivity of a security in comparison to the market risk. A security with a Beta of 1 has the same risk as the market, meaning it is perfectly correlated with the market. If the market goes up by 5% then the security will also go
up by 5% and vice versa if the market goes down. A security with a Beta greater than 1 has a larger volatility than the market. Hence, if the market increase by 5% the security will increase more than 5%. By multiplying the Beta with the market risk premium and adding the risk-free rate one will get the expected return. This is needed to estimate the security and to see whether it is fairly priced or not, which is done by plotting the Security Market Line (SML) (Berk & DeMarzo, 2017).

The Security Market Line illustrates the expected return of a stock as a function of its Beta in relationship to the market. Since the CAPM assumes that the market portfolio is efficient, all stocks and portfolios should be placed on the Security Market Line. If that is not the case, then the stock is under- or overperforming, as shown in the figure above. The distance between the Security Market Line and the individual stock is the Alpha (Bodie, Kane, & Marcus, 2014).
3. Previous studies

This section will provide insight into past literature on the foundations of Smart Beta Investing and its evolution. Starting by exploring factor investing, moving on to Smart Beta research and ending with the selected factors.

3.1 Factor Investing

Fama & French (1993) established the Fama-French three-factor model, which has been cited as one of the cornerstones in contemporary factor investing. This model builds on the CAPM and incorporates the Size and Value effects, which are some of the main empirical facts at odds with the CAPM. Their statistical description of returns is as follows:

\[
R_t - R_f = \alpha_i + \beta_{i,Mkt}Mkt + \beta_{i,SMB}SMB + \beta_{i,HML}HML + \epsilon_i
\]  

Where:

\[
R_t - R_f = \text{Risk premium}
\]

\[
R_t = \text{Return of the portfolio}
\]

\[
R_f = \text{Risk-free return}
\]

\[
Mkt = \text{Market excess return}
\]

\[
SMB = \text{Small minus Big}
\]

\[
HML = \text{High minus Low}
\]

SMB is the difference between the return of a portfolio of small capitalization stocks and a portfolio of large capitalization stocks, this factor accounts for the size effect. On average, small firms have a positive exposure (\(\beta_{i,SMB}\)) to this factor, thus a higher risk premium than large capitalization stocks, which instead show a negative exposure to SMB. HML is the difference between the return of a portfolio of stocks with a high book-to-market ratio (value stocks) and a portfolio of stocks with a low book-to-market ratio (growth stocks), this factor accounts for the value effect. On average, value stocks have a positive exposure (\(\beta_{i,HML}\)) to this factor, hence a higher risk premium than growth stocks which tend to have a negative exposure to HML.
(Fama & French, 1993). Furthermore, Fama and French (1993) noticed that a portfolio’s Beta explained around 70% of the excess returns in CAPM, while the addition of Value and Size factors bumped the explanatory power up to 95%.

An expansion of the Fama-French model was done by Carhart (1997), who added a fourth factor to the existing model, Momentum. The statistical description of returns became:

$$ R_i - R_f = \alpha_i + \beta_{i,Mkt} Mkt + \beta_{i,SMB} SMB + B_{i,HML} HML + B_{i,MOM} MOM + \epsilon_i $$  \hspace{1cm} (3)

Momentum (MOM) is the tendency of stocks that have performed well in the recent past (3-12 months) to outperform stocks that have performed badly. Like the Fama-French factors SMB and HML, the momentum factor is the differential return between a portfolio of stocks that have had a high performance over the past 12 months and a portfolio of stocks that have had a low performance over the same period. Carhart (1997) explained momentum to be the tendency for prices to continue falling if they are going down and vice versa when they are going up.

Furthermore, in recent academia researchers such as Piotroski (2000), Novy-Marx (2013) and Fama & French (2014) have studied the quality factor. The main purpose of this factor is to define the quality of a stock by finding certain characteristics such as high profitability and low leverage. The intuition of the quality factor is that financially healthy companies tend to outperform less-efficient peers. Hence, in this case, it seeks to identify stocks that exhibit high profitability and low leverage.

Lastly, another factor is low volatility. Frazzini & Pedersen (2014) provided evidence for the outperformance of stocks exhibiting low volatility against high-risk stocks on a risk-adjusted basis over longer periods of time. The basis for this assumption is that since many investors, such as individuals, mutual funds and pension funds are constrained in their use of leverage, they overweight risky securities due to their intrinsic goal of seeking the highest possible returns. In turn, this leads to the negative effect of an increase in the price of those securities thus lowering their expected return.
3.2 Smart Beta

Since Smart Beta is a relatively new and vague concept, there are not many studies on it. Hence, even though research of various factors explaining excess returns have been conducted, it cannot be directly tied to Smart Beta. There is however recent research by the Ecole des Hautes Etudes Commerciales du Nord (EDHEC) Risk Institute that help define the concept. Martellini & Milhau (2018) concluded that Smart Beta portfolios reduces the unrewarded risk and improves the Sharpe ratio by differing from the normal cap-weighting scheme which is the method used in constructing indices such as OMXS30. The presented result indicates that by implementing a smart weighting scheme one can expect higher Sharpe ratios.

Amenc, Goltz, & Shah (2013) propose that Smart Beta indices are likely to outperform cap-weighted indices, but also highlight the potential risks with Smart Beta equity indices and suggests a new approach to Smart Beta Investing. They argue that it is perfectly legitimate to indicate superiority of Smart Beta over the long term but to not discount the risks with this new method and especially its systematic risk. Their proposition is Smart Beta 2.0 which gives investors a new method of measuring and controlling the risks associated with the usual cap-weighted benchmarks and offer a modern, more advanced benchmark.

Cai, Jin, Qi, & Xu (2018) tested the Smart Beta strategy by analysing five popular approaches to portfolio weightings: equal weighting, fundamental indexation, mean-variance optimization, low volatility strategy and minimum-variance portfolio and comparing them to the Shanghai Stock Exchange (SSE 50 index). Their results showed that each portfolio outperformed the index with higher returns and Sharpe ratios (risk-adjusted return). Hence, providing evidence for the notion that Smart Beta indices outperform cap-weighted indices (the SSE 50 index in this case) as proposed by Amenc, Goltz, & Shah (2013).

Another important element worth mentioning is how companies and especially banks use this new strategy. Handelsbanken launched three new certificates early in 2019: Nordic Momentum, Nordic High Dividend Low Yield and Nordic Dynamic Risk Control. Each with different risk, but all using the same passive (Beta) and active (Alpha) strategy indicative to Smart Beta (Handelsbanken, 2019).

The famous investment management company BlackRock has been utilizing factor investing principles for over 30 years and is one of the leading players in the world of Smart Beta
Investing. Their different ETFs such as *iShares Edge MSCI Australia Minimum Volatility ETF* and *iShares Edge MSCI World Multifactor ETF* are examples of these principles in action. Using factors common to factor investing they create their portfolios and indices. In their own words, they explain the iShares Smart Beta ETFs to *rewrite the rules of traditional index investing in an effort to deliver targeted outcomes that can help investors reduce risk, generate income, or potentially enhance returns. The ETFs are designed to capture broad, persistent drivers of returns, take advantage of economic insights, and improve diversification* (BlackRock, 2019, paragraph 2).

The growing trend of major financial actors and institutions incorporating Smart Beta Investing into their products indicate the legitimacy of the strategy, as seen in the examples mentioned previously. One could therefore expect the further development, optimization and implementation of Smart Beta Investing in the future.

### 3.3 Value

The Value factor is characterized by the belief that securities which inhibit strong fundamental values and which are underpriced compared to the market, will outperform securities that are overpriced. Some of the more common ratios used in determining a company’s fundamental value are: price-to-earnings (P/E), price-to-book (P/B), debt-to-equity, free cash flow (FCF) and price-to-earnings-to-growth (PEG) (Novy-Marx, 2013).

As mentioned previously, Fama & French (1993) defines the value factor (HML) as the difference between stocks exhibiting high book-to-market ratios (value stocks) and low book-to-market ratios (growth stocks).

Basu (1977) found that stocks with low P/E ratios outperformed comparable indices over time, hence supporting the assumption of lower valued securities outperforming their counterparts.

### 3.4 Low Volatility

According to CAPM, one should expect a positive relationship between higher returns and risk. That is an assumption investors take for granted, but in the work by Haugen & Heins (1972) they found the opposite to be true. Using data on US stocks between the years 1926 and 1971 they proved that high volatility stocks actually delivered lower returns than low volatility stocks did during the same period. This anomaly has since then been proven by many researchers in markets around the world. Both Chan, Karceski & Lakonishok (1999) and Haugen & Baker
(1991) found that portfolios of low volatility stocks under a risk-adjusted basis performed better than their higher-risk counterparts.

Bali & Zhou (2016) also came to the same conclusion but theorized it to be based on the lottery demand effect, which assumes that high volatility stocks are functioning like a lottery, with inconsistent high returns. If these stocks are also preferred by a majority of investors, it will increase the demand and therefore adjust the price upwards. Hence, the hypothesis states that investors are risk-seekers which bumps up the price of the high volatility stocks, leaving low volatility stocks undervalued and therefore exposing them to higher possible returns.

3.5 Quality

There are different interpretations regarding what best captures the foundations of the quality factor. Fama & French (2014) defines it as gross profitability divided by total assets. Novy-Marx (2013) also bases his definition on gross profitability, more specifically on simple metrics, such as gross profits-to-assets. He believes that such ratios are similar in their effectiveness to tried-and-true ratios such as P/E and P/B which are used in the value factor.

Banks, for example the Norges Bank Investment Management (NBIM), defines it differently. They divide it into three categories. The first is profitability measured by gross profits over assets, operating profit, ROE (Return on Equity), ROA (Return on Assets) or ROIC (Return on Invested Capital). The second is safety, which is measure by a variety of solvency metrics, for example debt/assets. The third is earnings quality, measured by differences between accounting items (accruals) and cash (Norges Bank Investment Management, 2015).
4. Methodology

This section will give a description of the data and the procedure of portfolio generation in the form of stock selection, scoring- and weight methodologies, and an explanation on how the portfolios are tested.

4.1. Data

The data used in this thesis is collected from Thomson Reuters and NASDAQ using a screening tool provided by Borsdata.se. The time period used is 10 years, spanning from 2008-2018 for all stocks to simplify the comparison between the portfolios and OMXS30. By using the screening tool and selecting the variables corresponding to each factor one can find the relevant stocks for the portfolios. The selected stocks are given a score and the top 30 are included in each portfolio. This provides the basis for the weighting scheme and portfolio construction.

An example of the final product of this process is shown below where one can see a snapshot of each portfolio (see Appendix C for complete portfolios).

<table>
<thead>
<tr>
<th>Value Portfolio Weight</th>
<th>Quality Portfolio Weight</th>
<th>Low Volatility Portfolio Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tele 2 6.40%</td>
<td>H&amp;M 9.12%</td>
<td>Castellum 4.08%</td>
</tr>
<tr>
<td>Electra Gruppen 6.27%</td>
<td>AstraZeneca 9.11%</td>
<td>Wallenstam 4.03%</td>
</tr>
<tr>
<td>Rottneros 4.93%</td>
<td>Swedish Match 8.51%</td>
<td>Industrivärden 3.94%</td>
</tr>
<tr>
<td>Lundin Petroleum 4.33%</td>
<td>BioGaia 8.40%</td>
<td>Investor 3.89%</td>
</tr>
<tr>
<td>Öresund 4.26%</td>
<td>Atlas Copco 5.81%</td>
<td>Diös 3.85%</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>…</td>
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<td>…</td>
</tr>
</tbody>
</table>

*Figure 4: Snapshot of the Smart Beta Portfolios*
4.2 Portfolio Generation

In generating the Smart Beta portfolios, a scoring method is used to rank each stock according to their different factor criteria’s. The stocks are then given a weight according to their respective scores. This procedure is explained below.

4.2.1 Scoring and Weighting Method

For the Value- and Quality factors, the score of each stock is based on different variables. The Value factor consists of three variables namely Dividend Yield, P/E and P/B. The Quality factor consists of four variables ROA, ROE, CFO and D/E (see definitions in Appendix A). Due to the different measurements used in the variables, one needs to provide an equal framework to be able to rank them. This is done by standardizing them according to the equation below (see Appendix B for details).

\[
Z_{Ni}^i = \frac{X_{Ni}^i - \mu_i}{\sigma_i}
\]  

Where:

\(Z_{Ni}^i\) = Standardized score for variable \(i\) of stock \(N\)

\(X_{Ni}^i\) = Raw data for variable \(i\) of stock \(N\)

\(\mu_i\) = Mean of variable \(i\)

\(\sigma_i\) = Standard Deviation for variable \(i\)

By subtracting the raw data for variable \(i\) of stock \(N\) \((X_{Ni}^i)\) by the mean of variable \(i\) \((\mu_i)\) and dividing it by the standard deviation of variable \(i\) \((\sigma_i)\), the standardized score for variable \(i\) of stock \(N\) \((Z_{Ni}^i)\) is obtained. The standardized variable has a mean of zero and variance of one. This procedure is done for all stocks’ variables and to simplify, the process can be explained in three steps. The first step is downloading the relevant stocks (see figure 5).
The second step is to standardize each variable using equation (4) to be able to rank and collect the 30 best stocks (see figure 6).

\[
\text{Factor Score}_i = \frac{(Z - \text{Score } V^1_N + Z - \text{Score } V^2_N + Z - \text{Score } V^i_N)}{\sum_{i=1}^{N} V^i}
\]  

(5)

Where:

\[ Z - \text{Score } V^1_N = \text{Standardized Score for variable 1 of stock } N \]
\[ Z - \text{Score } V^2_N = \text{Standardized Score for variable 2 of stock } N \]
\[ Z - \text{Score } V^i_N = \text{Standardized Score for variable } i \text{ of stock } N \]
The Factor Scores are obtained by adding all standardized scores for each stock’s variables \((Z - Score V^i_k)\) and then dividing it by the number of variables that each factor contains \((\sum_{i=1}^n V^i)\) as seen in equation 5. The 30 stocks that exhibit the highest factor scores will be picked into their respective Smart Beta portfolio (see Appendix C for exact details on the scoring procedure).

The stocks in each portfolio are then weighted according to how much the Factor Score contributes to the sum of all 30 scores.

\[
W_i = \frac{Factor \ Score_i}{\sum_{i=1}^{30} Factor \ Score_i} \quad (6)
\]

Where:

\[
W_i = \text{Weight for stock } i
\]

\[
Factor \ Score_i = \text{Factor Score for stock } i
\]

And:

\[
\sum_{i=1}^{30} W_i = 1
\]

The total sum of all weights in the portfolio must be equal to 1 and that is obtained automatically by equation 6 where each factor score is divided by the sum of the top 30 factor scores (see Appendix C for exact details on the weighting procedure).

4.2.2 Value Factor

The chosen variables for the Value factor are Dividend Yield, P/E and P/B (see definitions in Appendix A) and the scoring equation for this factor is:

\[
Value \ Score_i = \frac{(Z_{DivY^i} - Z_{PE^i} - Z_{PB^i})}{3} \quad (7)
\]

Where:

\[
Z_{DivY^i} = Z\text{-Score for the variable Dividend Yield for stock } i
\]

\[
Z_{PE^i} = Z\text{-Score for the variable } P/E \text{ for stock } i
\]

\[
Z_{PB^i} = Z\text{-Score for the variable } P/B \text{ for stock } i
\]
The P/E and P/B ratios are subtracted since a low P/E and P/B is preferred. Hence, a lower P/E or P/B will generate a higher score because it has a lower negative impact on the total score. For the Dividend Yield there is no negative sign because the score and the variable are positively correlated where a high Dividend Yield is preferred.

4.2.3 Quality Factor
The chosen variables for the Quality factor are ROA, ROE, CFO and D/E ratio (see definitions in Appendix A). The stocks will be scored by the same procedure as for the Value factor and the scoring equation is:

$$Quality\ Score_i = \frac{(Z_{ROA_i} + Z_{ROE_i} + Z_{CFO_i} - Z_{DE_i})}{4}$$  \hspace{1cm} (8)

Where:

$$Z_{ROA_i} = Z\text{-Score for the variable ROA for stock } i$$

$$Z_{ROE_i} = Z\text{-Score for the variable ROE for stock } i$$

$$Z_{CFO_i} = Z\text{-Score for the variable CFO for stock } i$$

$$Z_{DE_i} = Z\text{-Score for the variable D/E for stock } i$$

High ratios of ROA, ROE and CFO are preferred while a high D/E ratio is not, and that is the reason why D/E is subtracted from the total score. A high D/E ratio will have a greater negative impact on the total score than a lower D/E ratio.

4.2.4 Low Volatility
The Low Volatility factor only contains one variable and that is the volatility of returns measured in 100 days. The stocks with lowest volatility will obtain the highest scores and since there is only one variable the scoring equation the Low Volatility factor will be:

$$Low\ Volatility\ Score_i = -\frac{Z_{VOL_i}}{1}$$  \hspace{1cm} (9)

Where:

$$Z_{VOL_i} = Z\text{-Score for the variable Volatility for stock } i$$
4.3 Jensen’s Alpha test

The performance analysis of the Smart Beta Portfolios will be examined by Jensen’s Alpha Test to see whether the average return on the portfolios differs from the CAPM value. The objective is to find a positive Alpha which would indicate the portfolios outperformance over the theoretical performance index of the portfolios.

\[ r_{pt} - r_{ft} = \alpha_t + \beta_p (r_{Mt} - r_{ft}) + \epsilon_t \]  \hspace{1cm} (10)

Where:

- \( \alpha_t \) = Portfolio performance compared to the theoretical performance index
- \( r_{pt} - r_{ft} \) = Excess return of portfolio at time t
- \( \beta_p = \sum_{i=1}^{30} W_i \beta_i \) = Beta of portfolio
- \( (r_{Mt} - r_{ft}) \) = Excess return of market index at time t
- \( \epsilon_t \) = Random error term at time t

The Jensen’s Alpha test is a version of the standard Alpha, but instead of measuring the performance against the market index it does so against the theoretical performance index. The theoretical performance index is predicted using CAPM. The testing procedure is done by downloading historical prices and computing the portfolio return for each Smart Beta portfolio. The Beta for the portfolios is found by computing the Beta for each stock and then multiplying each Beta by its corresponding weight. With all necessary variables one can now run the Jensen’s Alpha test by regressing each Smart Beta portfolio on the Market portfolio. See Appendix C for the step-by-step testing procedure.
5. Empirical Analysis

The studied Smart Beta portfolios are Value, Quality and Low Volatility. Each portfolio is measured from 1st January 2008 to 1st January 2018 and contain stocks from the Swedish Stock Exchange. They are compared with the benchmark index OMXS30 and the time series data will be tested for stationarity with a unit root test as well as for serial correlation with a LM test.

5.1 Smart Beta Portfolio performance

\[ H_0: \alpha = 0 \]
\[ H_1: \alpha \neq 0 \]

<table>
<thead>
<tr>
<th></th>
<th>Value Portfolio</th>
<th>Quality Portfolio</th>
<th>Low Volatility Portfolio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alpha ((\alpha)) daily</td>
<td>0.047%</td>
<td>0.059%</td>
<td>0.146%</td>
</tr>
<tr>
<td>Alpha ((\alpha)) yearly</td>
<td>11.78%</td>
<td>14.76%</td>
<td>36.48%</td>
</tr>
<tr>
<td>t-Statistic</td>
<td>3.999350</td>
<td>5.765205</td>
<td>6.353228</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.731</td>
<td>0.775</td>
<td>0.413</td>
</tr>
<tr>
<td>(H_0) Rejected</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Durbin Watson</td>
<td>1.826</td>
<td>1.886</td>
<td>2.497</td>
</tr>
</tbody>
</table>

Table 1: Summary of Jensen's Alpha test results

As seen in table 1, all portfolios show positive Alphas and P-values of 0 meaning that the results are significant. The portfolios have had a greater risk-adjusted return than the theoretical performance index hence they outperformed the market index OMXS30 in the 10-year time period. Among the three portfolios, Low Volatility performed the best as it had the largest Alpha and the Quality portfolio was the second best, closely followed by the Value Portfolio with a yearly Alpha of 11.78\%.

The \(R^2\) for the Value- and Quality portfolios are both around 0.7 indicating that about 70\% of returns can be explained by the market. Low Volatility shows a low relationship with the market, only about 40\% of the returns can be attributed to the market indicating that there may be explanatory variables missing or that the model is misspecified.

The Durbin Watson test statistic is used to test for autocorrelation in the error terms. The detection of autocorrelation is observed in the numbered range of 0-4, where a number of 2
indicates no autocorrelation, 0 indicates severe positive autocorrelation and 4 indicates severe negative autocorrelation (Gujarati & Porter, 2009).

The Durbin Watson results for the Low Volatility portfolio show indications of negative autocorrelation while the Quality- and Value portfolios exhibit values close to two, which most likely means that there is no autocorrelation present.

**5.1.1 Value Portfolio**

![Jensen's Alpha Test Value Portfolio](image)

*Figure 7: Daily risk adjusted Value portfolio returns on Y-axis and Daily risk adjusted OMXS30 returns on X-axis*

Figure 7 gives a clearer picture over the relationship between the Value portfolio and the market where each dot represent the risk adjusted daily returns of both portfolios. The dots in the top right square shows the days where the portfolios exhibit positive returns, while the dots in the bottom left square shows the days where the portfolios have negative returns. The bottom right and top left corners show the days with negatively correlated returns between the portfolios where the bottom right shows when the market has positive returns while the Value portfolio exhibits negative returns and vice versa for the top left corner.

The Value portfolio contains variables that give additional value to investors. This is illustrated in Figure 8 on the next page, where the outcome of a 1 SEK investment in 2008 would have transformed the value of the investment in the Value portfolio into approximately 4.50 SEK, while an equal investment would yield 1.50 SEK in OMXS30. One explanation for this outperformance is that OMXS30 does not consider dividends which is one of the variables in the Value portfolio. This can have a big impact in the long run due to the compounding effect. The two other variables P/E and P/B are valuation measures where low ratios of these indicate that a stock’s price is low compared to its fundamentals, such as earnings. As mentioned
previously, Basu (1977) found that stocks with low P/E ratios tend to outperform comparable indices over time, which coincide with the findings of this paper.

$$\text{Calculation: } (1 + r_t) \times P_{t-1} \text{ where } P \text{ starts at 1}$$

5.1.2 Quality Portfolio

The Quality portfolio displays the same pattern as the Value portfolio but with slightly higher positive risk adjusted returns due to the higher Alpha. As in the case of the Value portfolio the Quality portfolio consists of variables that generates a higher value than those of OMXS30 and a 1 SEK investment in 2008 would have generated 6 SEK in 2018 (see Figure 10). The Quality portfolio contains four variables that have characteristics of high profitability, cash flow and low debt relative to its equity. High ROA and ROE indicate the efficiency of generating returns.
on the assets within the company. A high CFO and low D/E are signs of financial stability. These ratios help in explaining the outperformance of the Quality portfolio against OMXS30. As mentioned in section four, Novy-Marx (2013) and Fama & French (2014) found that financially healthy companies tend to outperform less-efficient peers, which validates the findings of this paper as the OMXS30 is a cap-weighted index which means that quality factors such as ROA and ROE etc. are not prioritized in the weighting process.

![Quality Portfolio VS. OMXS30](image)

*Figure 10: The return of 1 SEK investment. Calculation: (1 + r)_t * P_{t-1} where P starts at 1*

5.1.3 Low Volatility Portfolio

![Jensen's Alpha Test Low Volatility Portfolio](image)

*Figure 11: Daily risk adjusted Low Volatility portfolio returns on Y-axis and Daily risk adjusted OMXS30 returns on X-axis*
The Low Volatility portfolio only contains one variable, therefore Figure 11 shows higher deviations from OMXS30 than the two other portfolios. This matches with the low $R^2$ value of the Low Volatility factor. For a higher $R^2$ and a more compact figure, one need to add the missing variables that explain the returns of the Low Volatility portfolio. The high Alpha for this portfolio is then not only explained by the fact that the stocks included in this portfolio have low volatility but also due to the nature of the selected stocks. For example, the Low Volatility portfolio contains eight real-estate companies who have exhibited very high returns during the time period (see figure 13 in Appendix D), which may be attributed to other variables than only low volatility. Figure 12 illustrates this extremely profitable period, where a 1 SEK investment in 2008 would have generated 47 SEK in 2018. Low Volatility stocks have proven to yield better risk-adjusted returns compared to riskier stocks as evidenced in the paper Chan, Karceski & Lakonishok (1999) who found that low volatility stocks under a risk-adjusted basis performed better than stocks with higher risk. However, that is only a comparison between low- and high risk stocks and not with an index such as OMXS30.

![Low Volatility Portfolio VS. OMXS30](image)

*Figure 12: The return of 1 SEK investment. Calculation: $(1 + r_t) \times P_{t-1}$ where $P$ starts at 1*
### 5.2 Portfolio correlation

**Correlation Matrix**

<table>
<thead>
<tr>
<th></th>
<th>OMXS30</th>
<th>Low Volatility</th>
<th>Quality</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OMXS30</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low Volatility</td>
<td>0.6428</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality</td>
<td>0.8806</td>
<td>0.6604</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>0.8551</td>
<td>0.7084</td>
<td>0.8528</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 2: Correlation matrix for Smart Beta portfolios*

As seen in table 2, the Quality portfolio has the highest correlation with OMXS30. One could explain this by the variables that define the Quality portfolio. High ROA, ROE, CFO and low D/E are characteristics that are shared by large capitalization stocks, which are the constituents of the cap-weighted OMXS30. The same reasoning can be used for the Value portfolio, where Dividend Yield is a common trait for large capitalization stocks. In principle, one would expect low volatility to also explain much of the OMXS30 since a low standard deviation is typical for large capitalization stocks. However, due to the fact that the Low Volatility portfolio only contains one variable the $R^2$ could be suffering.

Some of the underlying assumptions used in the correlation between OMXS30 and the Value- and Quality portfolios can also be drawn between the portfolios themselves. Because both portfolios exhibit properties related to large capitalization stocks, one could presumably find similarities between them as well. Hence, the relatively high and especially very similar $R^2$ values could be warranted. Using the same logic, the correlations between the Quality- and Low Volatility portfolios as well as the Value- and Low Volatility portfolios can be justified. Both show very similar $R^2$ values, indicating that the variables in the portfolios have properties that could explain the correlation between them.

### 5.3 Stationarity test

The data used in this thesis is time series, so the proper procedure to test for stationarity of random processes is by using a unit root test. The purpose of this test is to see if the $R^2$ values are valid. The procedure of testing for unit root can be done in several ways, but the chosen method is the Augmented Dickey-Fuller test since it can be used in cases where serial correlation is an issue. As seen in Table 1, the risk-adjusted returns in the Value- and Quality
portfolios shows a DW of 1.8-1.9, but the risk-adjusted returns for the Low Volatility portfolio shows a DW of approximately 2.5 which is an indication of possible negative autocorrelation. The downside of using the Augmented Dickey-Fuller test is the fairly high Type I error rate (Gujarati & Porter, 2009).

\[ H_0 = \text{Unit root} \]

\[ H_1 = \text{No unit root} \]

<table>
<thead>
<tr>
<th>Augmented Dickey-Fuller test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>t-statistics</td>
</tr>
<tr>
<td>P-value</td>
</tr>
<tr>
<td>H0 Rejected</td>
</tr>
</tbody>
</table>

*Table 3: Summary output of Unit Root test*

Table 3 illustrates a summary of the Augmented Dickey-Fuller test where all Smart Beta portfolios show signs of stationarity since the null hypotheses are rejected, and because the tests rejects \( H_0 \), one can trust the results from Jensen’s Alpha test.

### 5.4 Serial Correlation Test

The Durbin Watson statistics is a first indication of serial correlation and to ensure that no serial correlation exists one can perform the LM test since it is statistically more powerful than the DW test due to less restrictions. If serial correlation is significant one can use the Newey-West estimator to overcome serial correlation (Gujarati & Porter, 2009).

\[ H_0 = \text{No Serial Correlation up to order 2} \]

\[ H_1 = \text{Serial Correlation} \]

<table>
<thead>
<tr>
<th>Breusch-Godfrey Serial Correlation LM Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portfolio</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>F-statistics</td>
</tr>
<tr>
<td>P-value</td>
</tr>
<tr>
<td>H0 Rejected</td>
</tr>
</tbody>
</table>

*Table 4: Summary output of serial correlation test*
The LM test confirms that serial correlation exists and to overcome this problem one need to run the Newey-West regression.

\[ H_0: \alpha = 0 \]
\[ H_1: \alpha \neq 0 \]

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Value</th>
<th>Quality</th>
<th>Low Volatility</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>t-Statistics</strong></td>
<td>3.484038</td>
<td>5.362638</td>
<td>8.515762</td>
</tr>
<tr>
<td><strong>Alpha (( \alpha )) daily</strong></td>
<td>0.047%</td>
<td>0.059%</td>
<td>0.146%</td>
</tr>
<tr>
<td><strong>Alpha (( \alpha )) yearly</strong></td>
<td>11.78%</td>
<td>14.76%</td>
<td>36.48%</td>
</tr>
<tr>
<td><strong>P-Value</strong></td>
<td>0.00005</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td><strong>R^2</strong></td>
<td>0.731</td>
<td>0.775</td>
<td>0.413</td>
</tr>
<tr>
<td><strong>H_0 Rejected</strong></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>t-Statistic from OLS</strong></td>
<td>3.999350</td>
<td>5.765205</td>
<td>6.353228</td>
</tr>
</tbody>
</table>

Table 5: Summary output of HAC (Newey-West) regression. The last row show the t-Statistics from the first Ordinary Least Square regression.

The new results is shown in Table 5 where the only difference from the ordinary least square regression is in the t-statistics. The most notably change is in the Low volatility portfolio where it increased from approximately 6.35 to 8.52. The change does not affect the results since the variable is still significant, and one can trust the results that are obtained from the regressions.
6. Conclusion

The Smart Beta portfolios exhibited yearly Alphas of approximately 12%, 15% and 36% for the Value, Quality and Low Volatility portfolios. The abnormal high excess returns could be partly explained by the nature of the selection process. When building schemes of stock selection procedures using historical data one can single out the highest performing stocks during the given period and obtain an optimized cohort of securities. However, if one would replicate these portfolios and invest for themselves, there is a high probability for failure due to the ever-changing nature of markets. Historical returns are never a guarantee for future returns.

Important factors explaining the high returns in the portfolios are macroeconomic trends. For example, the Low Volatility portfolio consists of many real-estate companies which exhibited very high returns during the booming markets post the financial crisis period in 2008. Hence, the reason for the abnormally high returns in the Low Volatility portfolio might not be due to the low standard deviation of the stocks but rather the macroeconomic environment the real-estate companies operated in.

Another issue when observing the results from the portfolios is the problem of using variables that cannot be interpreted correctly for stocks in certain industries. E.g. in the Value portfolio where the P/E and P/B variables are limited in their explanatory capabilities of certain companies or industries, such as for investment- and real-estate firms. To be able to properly value the stocks in these industries one needs to use the net asset value (the value of a company’s assets minus the value of its liabilities). Hence, this portfolio may be slightly misleading. To resolve this one should add the net asset value as a variable and drop the P/E and P/B ratios for the selected stocks. However, that would overly complicate the thesis and was thus disregarded.

Furthermore, the thesis does not account for possible brokerage fees associated with Smart Beta products when building the portfolios. Costs like these are commonplace for any actively managed financial products such as ETFs (Exchange Traded Funds).

A crucial element to consider when interpreting the results is the accuracy of the data. For example, in the Low Volatility portfolio the stock Latour suffered from severe disturbances in its data. As can be seen in Figure 14 in Appendix D, the data gets disrupted three times which gave an unfair representation of the daily returns in the portfolio. 2011-12-21 the stock drops from approximately 71 SEK to 18 SEK and then up to 73 SEK again the day after. This leads to a drop of 75% and then an increase of 300% to get back to its previous level. Disturbances
like these have significantly affected the average daily returns of Latour, which therefore also explains a large part of the abnormal return of the Low Volatility portfolio. Furthermore, the database did not take into account the stock split by Latour in 2015. A more advanced database could have accounted for errors like these and provide better accuracy of the data. This would also allow for the possibility of expanding the model and including more factors, such as Momentum.

Even though many elements are disregarded, the results of the portfolios concur with previous research. Chan, Karceski & Lakonishok (1999) and Haugen & Baker (1991) found that portfolios of low volatility stocks performed better than their higher-risk counterparts. The Low Volatility portfolio found the same (using the OMXS30’s stocks as the higher-risk counterpart). Basu (1977) found that stocks with low P/E ratios outperformed comparable indices over time. The Value portfolio found the same. Novy-Marx (2013) found that financially healthy companies tend to outperform less-efficient peers. The Quality portfolio found the same (using the OMXS30 as the less-efficient peer).

6.1 Suggested further research

To expand on the research done in this thesis one could implement the same methodology and try to predict future returns by testing the portfolios periodically against real returns at data points in the future. For example, using historical data for the period 2008-2018 and try to predict the returns for the period 2018-2028.

One could also investigate how each Smart Beta Factor performs over different business cycles. The time period used in this thesis was 2008-2018 where the starting period is at the aftermath of the biggest recession in modern history, and subsequently went through a recovery phase to end up in the current expansionary period. By testing the portfolios on other business cycles it may be possible to create better and more adaptive Smart Beta portfolios.

Furthermore, increasing explanatory variables in each Smart Beta portfolio to help bump up the $R^2$ values as well as more factors would contribute to further developing the research made in this thesis. For example, including the variable Beta in the Low Volatility portfolio, Price-to-Cash Flow in the Value portfolio and Earnings-per-Share Variability in the Quality portfolio. Additionally, since the Value, Quality and Low Volatility factors are largely based on the assumption of the efficient-market hypothesis, one could add the Momentum factor to incorporate the psychological aspect of investing. Behavioral finance is a very important area
within portfolio theory and should therefore be given more consideration. CAPM has evolved throughout time and it would not be surprising if future research include variables that try to measure this aspect to further expand upon the explanatory power of the model.

It could also be possible to create more efficient portfolios where one combines factors and build portfolios that optimizes returns based on different risk profiles. E.g. a portfolio with variables from the Low Volatility-, Quality- and the Value portfolio. As well as expanding current research by implementing hierarchies for the variables in the factors, giving a more important variable a higher weight to better capture the returns in the portfolios. For example, the Value factor could be altered by weighting the variables P/E 50%, Dividend Yield 30% and P/B 20% instead of the current equal weights.

Lastly, an important aspect of Smart Beta Investing is its potential impact for future policy implementation. Two of the currently active directives are Undertakings for Collective Investment in Transferable Securities (UCITS) and the Alternative Investment Fund Managers Directive (AIFMD). These serve to regulate investment products such as Smart Beta ETFs to create an equal framework for investors across the European Union. Within the EU legislations of collective investment funds, Packaged Retail and Insurance-based Investment Products (PRIIP) is the framework that protects consumers by regulating banks and other institutions to have transparent information for their investment products (European Commision, 2019). Since Smart Beta Investing is a relatively new investment method, more frameworks surrounding the construction of the products might come about. For example, regulations around the scoring or weighting process of the securities in the products. However, Smart Beta investment products will not necessarily cause laws to change because its foundation is a mixture of passive and active investment theories, which is prevalent in the world of investing.
References


Appendix A

Dividend Yield

The Dividend Yield is expressed in percentage and it is the yearly company’s dividend payment in relation to its stock price.

\[
\text{Dividend Yield} = \frac{\text{Annual Dividend}}{\text{Stock Price}}
\]  
(11)

P/E ratio

The P/E ratio is a measure of value that shows a stock’s price relative to its earnings per share (EPS).

\[
P/E = \frac{\text{Stock Price}}{\text{Earnings per Share}}
\]  
(12)

P/B ratio

The P/B ratio is also a measure of value that shows a stock’s price relative to its book value per share.

\[
P/B = \frac{\text{Stock Price}}{\text{Book Value per Share}}
\]  
(13)

ROA

ROA stands for Return on Assets which is a measurement of profitability. It shows the return in relation to its total assets, where a high number of ROA is an indication of efficiency in managing assets to generate earnings.

\[
ROA = \frac{\text{Net Income}}{\text{Total Assets}}
\]  
(14)
ROE

ROE stands for Return on Equity which is a measure of profitability. It shows the return in relationship to shareholders’ equity. A high number of ROE means that investors gets a high return from the money that is invested in a company.

\[
ROE = \frac{Net\ Income}{Average\ Shareholders'\ Equity}
\]  \hspace{1cm} (15)

CFO

CFO is the Cash Flow from Operating Activities. It shows the amount of money that comes in from the regular business activities. CFO only focuses on the core business and do not take into account temporarily transactions such as long-term capital expenditure or investment costs.

\[
CFO = Net\ Income + Non\ Cash\ Items + Increase\ in\ Working\ Capital
\]  \hspace{1cm} (16)

D/E ratio

D/E measures the financial leverage of a company. It shows the degree to which a company is financing the business, either through debt or equity. A low D/E is an indication of a financially healthy company with low risk of solvency issues.

\[
D/E = \frac{Total\ Debt}{Total\ Shareholders'\ Equity}
\]  \hspace{1cm} (17)

Volatility

Volatility is the measure of dispersion in the returns. A low volatility is an indication of a low-risk stock. This paper used the volatility in a 100 day rolling window where it measures the degree of variation in the returns of 100 days.

\[
Volatility = Standard\ Deviation\ of\ returns \times \sqrt{100}
\]  \hspace{1cm} (18)
Appendix B

The standardization is a process of transforming variables into a mean of 0 and a standard deviation of 1. By doing this all variables will be put on the same scale, allowing for comparisons between the different type of variables (Anderson, Sweeney, Williams, Freeman, & Shoesmith, 2017).

When having a normal distribution with a mean of 0 and a standard deviation of 1 one can transform any X-value into a Z-score according to the formula below:

\[
Z = \frac{X - \mu}{\sigma} \sim (\mu, \sigma^2)
\]  

(19)

All variables have been scored by this standardization process and the top 30 scoring stocks for each factor are picked into their respective portfolios.
### Appendix C

#### Value Portfolio

<table>
<thead>
<tr>
<th></th>
<th>Div. Yield</th>
<th>P/E</th>
<th>P/B</th>
<th>Score</th>
<th>Score</th>
<th>Factor</th>
<th>Score</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tele2 B</td>
<td>11.0%</td>
<td>24.7</td>
<td>2.1</td>
<td>4.21</td>
<td>0.22</td>
<td>-0.25</td>
<td>1.41</td>
</tr>
<tr>
<td>2</td>
<td>Electra Gruppen</td>
<td>9.3%</td>
<td>11.9</td>
<td>1.5</td>
<td>3.25</td>
<td>-0.41</td>
<td>-0.49</td>
<td>1.38</td>
</tr>
<tr>
<td>3</td>
<td>Rottneros</td>
<td>6.0%</td>
<td>0.9</td>
<td>0.7</td>
<td>1.46</td>
<td>-0.95</td>
<td>-0.85</td>
<td>1.09</td>
</tr>
<tr>
<td>4</td>
<td>Lundin Petroleum</td>
<td>3.3%</td>
<td>23.1</td>
<td>-4.7</td>
<td>-0.05</td>
<td>0.14</td>
<td>-3.06</td>
<td>0.96</td>
</tr>
<tr>
<td>5</td>
<td>Oresund</td>
<td>6.0%</td>
<td>6.1</td>
<td>1.1</td>
<td>1.48</td>
<td>-0.70</td>
<td>-0.67</td>
<td>0.95</td>
</tr>
<tr>
<td>6</td>
<td>Bure Equity</td>
<td>5.5%</td>
<td>2.4</td>
<td>0.9</td>
<td>1.18</td>
<td>-0.88</td>
<td>-0.76</td>
<td>0.94</td>
</tr>
<tr>
<td>7</td>
<td>Enea</td>
<td>7.5%</td>
<td>14.4</td>
<td>2.1</td>
<td>2.28</td>
<td>-0.29</td>
<td>-0.24</td>
<td>0.94</td>
</tr>
<tr>
<td>8</td>
<td>Softronic</td>
<td>6.6%</td>
<td>13.8</td>
<td>1.9</td>
<td>1.78</td>
<td>-0.32</td>
<td>-0.34</td>
<td>0.81</td>
</tr>
<tr>
<td>9</td>
<td>Björn Borg</td>
<td>7.6%</td>
<td>17.9</td>
<td>2.7</td>
<td>2.33</td>
<td>-0.12</td>
<td>0.00</td>
<td>0.81</td>
</tr>
<tr>
<td>10</td>
<td>Swedbank</td>
<td>5.8%</td>
<td>10.0</td>
<td>1.3</td>
<td>1.33</td>
<td>-0.51</td>
<td>-0.57</td>
<td>0.80</td>
</tr>
<tr>
<td>11</td>
<td>Diös</td>
<td>5.1%</td>
<td>7.8</td>
<td>1.0</td>
<td>0.95</td>
<td>-0.61</td>
<td>-0.73</td>
<td>0.76</td>
</tr>
<tr>
<td>12</td>
<td>Bilia</td>
<td>6.5%</td>
<td>11.6</td>
<td>2.4</td>
<td>1.74</td>
<td>-0.43</td>
<td>-0.14</td>
<td>0.77</td>
</tr>
<tr>
<td>13</td>
<td>Stora Enso R</td>
<td>4.4%</td>
<td>3.6</td>
<td>1.0</td>
<td>0.59</td>
<td>-0.82</td>
<td>-0.70</td>
<td>0.70</td>
</tr>
<tr>
<td>14</td>
<td>Acando</td>
<td>5.9%</td>
<td>17.7</td>
<td>1.7</td>
<td>1.42</td>
<td>-0.13</td>
<td>-0.43</td>
<td>0.66</td>
</tr>
<tr>
<td>15</td>
<td>Malmbergs Elktriska</td>
<td>6.1%</td>
<td>14.5</td>
<td>2.4</td>
<td>1.51</td>
<td>-0.28</td>
<td>-0.13</td>
<td>0.64</td>
</tr>
<tr>
<td>16</td>
<td>Handelsbanken A</td>
<td>5.2%</td>
<td>12.0</td>
<td>1.5</td>
<td>1.00</td>
<td>-0.40</td>
<td>-0.51</td>
<td>0.64</td>
</tr>
<tr>
<td>17</td>
<td>Industrivärdern C</td>
<td>3.9%</td>
<td>5.5</td>
<td>0.8</td>
<td>0.30</td>
<td>-0.72</td>
<td>-0.77</td>
<td>0.60</td>
</tr>
<tr>
<td>18</td>
<td>Nolato</td>
<td>5.9%</td>
<td>13.0</td>
<td>2.7</td>
<td>1.39</td>
<td>-0.36</td>
<td>-0.02</td>
<td>0.59</td>
</tr>
<tr>
<td>19</td>
<td>Kungsleden</td>
<td>4.1%</td>
<td>9.5</td>
<td>0.9</td>
<td>0.43</td>
<td>-0.53</td>
<td>-0.76</td>
<td>0.57</td>
</tr>
<tr>
<td>20</td>
<td>NCC B</td>
<td>5.5%</td>
<td>7.5</td>
<td>2.8</td>
<td>1.16</td>
<td>-0.63</td>
<td>0.05</td>
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| ... | ...        | ... | ... | ... | ... | ... | ... | ... | ...
| 176| Poolia     | 2.3% | 213.9 | 3.2 | -0.58 | 9.53 | 0.19 | -3.43 | N/A |

#### Standard Deviation

- **Mean**: 3.4% | **20.26** | 2.71 |
- **Standard Deviation**: 1.8% | **20.32** | 2.41 |

**Sum of top 30 scores**: 22.07

*Complete Value Portfolio. All calculations are made in Excel.*
## Quality Portfolio

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<tr>
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<th>ROE</th>
<th>CFO</th>
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<th>Score ROE</th>
<th>Score CFO</th>
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... ... ... ... ... ... ... ... ...

176 MQ | 0.3% | -1.1% | 97.7 | 0.9 | -1.36 | -1.72 | -0.38 | -0.21 | -0.81 | N/A |

| Mean | 6.36% | 13.77% | 2308 | 2.1 |
| Standard Deviation | 4.43% | 8.65% | 5861 | 5.8 |

| Σ W=1 | Sum of top 30 scores | 25.43 |

Complete Quality Portfolio. All calculations are made in Excel.
## Low Volatility Portfolio

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<td>Diös</td>
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<td>Sum of top 30 scores</td>
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</table>

Complete Low Volatility Portfolio. All calculations are made in Excel.
**Scoring- and weighting procedure**

**Scoring calculations in details for Tele2 B in Value Portfolio:**

\[
\text{Score Dividend Yield} = \frac{11.0\% - 3.4\%}{1.8\%} = 4.21
\]

\[
\text{Score } P/E = \frac{24.7 - 20.26}{20.32} = 0.22
\]

\[
\text{Score } P/B = \frac{2.1 - 2.71}{2.41} = -0.25
\]

\[
\text{Factor Score} = \frac{4.21 - 0.22 - (-0.25)}{3} = 1.41
\]

**Weighting calculation in details for Tele2 B in Value Portfolio:**

\[
\text{Weight} = \frac{1.41}{22.07} = 6.40\%
\]

**Scoring calculation in details for Hennes & Mauritz in Quality Portfolio:**

\[
\text{Score ROA} = \frac{21.7\% - 6.36\%}{4.43\%} = 3.47
\]

\[
\text{Score ROE} = \frac{32.9\% - 13.77\%}{8.65\%} = 2.21
\]

\[
\text{Score CFO} = \frac{21868 - 2308}{5861} = 3.34
\]

\[
\text{Score } D/E = \frac{0.6 - 2.1}{5.8} = -0.26
\]

\[
\text{Factor Score} = \frac{3.47 + 2.21 + 3.34 - (-0.26)}{4} = 2.32
\]

**Weighting calculation in details for Hennes & Mauritz in Quality Portfolio:**

\[
\text{Weight} = \frac{2.32}{25.43} = 9.12\%
\]

**Scoring calculation in details for Castellum in Low Volatility Portfolio:**

\[
\text{Score Volatility} = -\frac{15.2 - 37.8}{20.3} = 1.13
\]

\[
\text{Factor Score} = \frac{1.13}{1} = 1.13
\]

**Weighting calculation in details for Castellum in Low Volatility Portfolio:**

\[
\text{Weight} = \frac{1.13}{25.43} = 9.12\%
\]
Jensen’s Alpha Test Step-by-Step Procedure - Value Portfolio

\[ \alpha = r_p - \left[ r_f + \beta_p (r_M - r_f) \right] \]

Step 1: Download historical prices

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<tr>
<th>Date</th>
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<th>W=6.40%</th>
<th>...</th>
<th>Mycronic</th>
<th>W=2.37%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Adj. Close</td>
<td>Return (Ri)</td>
<td>...</td>
<td>Adj. Close</td>
<td>Return (Ri)</td>
</tr>
<tr>
<td>2008-01-02</td>
<td>72.92</td>
<td>0</td>
<td>...</td>
<td>24.88</td>
<td>0</td>
</tr>
<tr>
<td>2008-01-03</td>
<td>72.50</td>
<td>-0.58%</td>
<td>...</td>
<td>23.92</td>
<td>-3.87%</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>2017-12-28</td>
<td>98.90</td>
<td>-1.44%</td>
<td>...</td>
<td>84.06</td>
<td>0.29%</td>
</tr>
<tr>
<td>2017-12-29</td>
<td>97.25</td>
<td>-1.66%</td>
<td>...</td>
<td>82.84</td>
<td>-1.45%</td>
</tr>
<tr>
<td>Avg. Return</td>
<td>0.03%</td>
<td>...</td>
<td>...</td>
<td>0.09%</td>
<td></td>
</tr>
<tr>
<td>Beta ((\beta_i))</td>
<td>0.80</td>
<td>...</td>
<td>...</td>
<td>0.71</td>
<td></td>
</tr>
</tbody>
</table>

Snapshot of Value Portfolio Excel Sheet

<table>
<thead>
<tr>
<th>Date</th>
<th>OMXS30</th>
<th>Swe. 3-month Bond Yield</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>Return (Rm)</td>
<td>Return (Rf)</td>
</tr>
<tr>
<td>2008-01-02</td>
<td>0</td>
<td>0.05%</td>
</tr>
<tr>
<td>2008-01-03</td>
<td>-0.58%</td>
<td>0.05%</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>2017-12-28</td>
<td>-1.44%</td>
<td>-0.01%</td>
</tr>
<tr>
<td>2017-12-29</td>
<td>-1.66%</td>
<td>-0.01%</td>
</tr>
<tr>
<td>Avg. Return</td>
<td>0.03%</td>
<td>0.01%</td>
</tr>
</tbody>
</table>

Snapshot of Value Portfolio Excel Sheet

Step 2: Calculate Return of Portfolio, Market and Risk-free.

\[ r_p = \sum_{t=1}^{30} W_t * R_t \]

2008-01-03: \( r_p = (6.40\% * -0.58\%) + \cdots + (2.37\% * -3.87\%) = 0.27\% \)

... 

2017-12-29: \( r_p = (6.40\% * -1.66\%) + \cdots + (2.37\% * -1.45\%) = -0.28\% \)

Average \( r_p = 0.07\% \) \quad Average \( r_M = 0.03\% \) \quad Average \( r_f = 0.01\% \)
Step 3: Calculate Beta of Portfolio

\[
\beta_p = \sum_{i=1}^{30} W_i \beta_i
\]

\[
\beta_p = (6.40\% \times 0.80) + \cdots + (2.37\% \times 0.71) = 0.665
\]

Step 4: Compute Alpha

\[
\alpha = r_p - [r_f + \beta_p(r_M - r_f)] = 0.07\% - [0.01\% + 0.665(0.03\% - 0.01\%)] = 0.047\%
\]

Jensen’s Alpha Test Step-by-Step Procedure - Quality Portfolio

\[
\alpha = r_p - [r_f + \beta_p(r_M - r_f)]
\]

Step 1: Download historical prices

<table>
<thead>
<tr>
<th>Date</th>
<th>H&amp;M Adj. Close</th>
<th>Return (Ri)</th>
<th>Alfa Laval Adj. Close</th>
<th>Return (Ri)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-01-02</td>
<td>109.01</td>
<td>0</td>
<td>61.98</td>
<td>0</td>
</tr>
<tr>
<td>2008-01-03</td>
<td>105.76</td>
<td>-2.98%</td>
<td>60.92</td>
<td>-1.71%</td>
</tr>
<tr>
<td>2017-12-28</td>
<td>160.08</td>
<td>0.29%</td>
<td>191.66</td>
<td>-0.81%</td>
</tr>
<tr>
<td>2017-12-29</td>
<td>158.77</td>
<td>-0.82%</td>
<td>190.09</td>
<td>-0.82%</td>
</tr>
</tbody>
</table>

| Avg. Return | 0.03\% | 0.07\% |

| Beta (βi) | 0.79 | 1.09 |

Snapshot of Quality Portfolio Excel Sheet

<table>
<thead>
<tr>
<th>Date</th>
<th>OMXS30 Return (Rm)</th>
<th>Swe. 3-month Bond Yield Return (Rf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-01-02</td>
<td>0</td>
<td>0.05%</td>
</tr>
<tr>
<td>2008-01-03</td>
<td>-0.58%</td>
<td>0.05%</td>
</tr>
<tr>
<td>2017-12-28</td>
<td>-1.44%</td>
<td>-0.01%</td>
</tr>
<tr>
<td>2017-12-29</td>
<td>-1.66%</td>
<td>-0.01%</td>
</tr>
</tbody>
</table>

| Avg. Return | 0.03% | 0.01% |
Step 2: Calculate Return of Portfolio, Market and Risk-free.

\[ r_p = \sum_{i=1}^{30} W_i \cdot R_i \]

2008-01-03: \( r_p = (9.12\% \times -2.98\%) + \cdots + (1.41\% \times -1.71\%) = -0.41\% \)

\( \cdots \)

2017-12-29: \( r_p = (9.12\% \times -0.82\%) + \cdots + (1.41\% \times -0.82\%) = -0.38\% \)

Average \( r_p = 0.08\% \quad \text{Average } r_M = 0.03\% \quad \text{Average } r_f = 0.01\% \)

Step 3: Calculate Beta of Portfolio

\[ \beta_p = \sum_{i=1}^{30} W_i \cdot \beta_i \]

\[ \beta_p = (9.12\% \times 0.79) + \cdots + (1.41\% \times 1.09) = 0.662 \]

Step 4: Compute Alpha

\[ \alpha = r_p - [r_f + \beta_p (r_M - r_f)] = 0.08\% - [0.01\% + 0.662(0.03\% - 0.01\%)] = 0.059\% \]
Jensen’s Alpha Test Step-by-Step Procedure – Low Volatility Portfolio

\[ \alpha = r_p - [r_f + \beta_p(r_M - r_f)] \]

Step 1: Download historical prices

<table>
<thead>
<tr>
<th>Date</th>
<th>Castellum Ajd. Close</th>
<th>Return (Ri)</th>
<th>…</th>
<th>NCC Ajd. Close</th>
<th>Return (Ri)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-01-02</td>
<td>32.56</td>
<td>0</td>
<td>…</td>
<td>36.25</td>
<td>0</td>
</tr>
<tr>
<td>2008-01-03</td>
<td>32.81</td>
<td>0.76%</td>
<td>…</td>
<td>35.72</td>
<td>-1.45%</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>2017-12-28</td>
<td>128.13</td>
<td>0.44%</td>
<td>…</td>
<td>144.68</td>
<td>-0.26%</td>
</tr>
<tr>
<td>2017-12-29</td>
<td>128.97</td>
<td>0.65%</td>
<td>…</td>
<td>146.74</td>
<td>1.42%</td>
</tr>
<tr>
<td>Avg. Return</td>
<td>0.07%</td>
<td>…</td>
<td>0.08%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beta ((\beta))</td>
<td>0.75</td>
<td>…</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Snapshot of Low Volatility Portfolio Excel Sheet

<table>
<thead>
<tr>
<th>Date</th>
<th>OMXS30 Return (Rm)</th>
<th>Swed. 3-month Bond Yield Return (Rf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008-01-02</td>
<td>0</td>
<td>0.05%</td>
</tr>
<tr>
<td>2008-01-03</td>
<td>-0.58%</td>
<td>0.05%</td>
</tr>
<tr>
<td>…</td>
<td>…</td>
<td>…</td>
</tr>
<tr>
<td>2017-12-28</td>
<td>-1.44%</td>
<td>-0.01%</td>
</tr>
<tr>
<td>2017-12-29</td>
<td>-1.66%</td>
<td>-0.01%</td>
</tr>
<tr>
<td>Avg. Return</td>
<td>0.03%</td>
<td>0.01%</td>
</tr>
</tbody>
</table>

Snapshot of Low Volatility Portfolio Excel Sheet

Step 2: Calculate Return of Portfolio, Market and Risk-free.

\[ r_p = \sum_{i=1}^{30} W_i \cdot R_i \]

2008-01-03: \( r_p = (4.08\% \times 0.76\%) + \cdots + (2.62\% \times -1.45\%) = -0.27\% \)

…

2017-12-29: \( r_p = (4.08\% \times 0.65\%) + \cdots + (2.62\% \times 1.42\%) = -0.13\% \)

Average \( r_p = 0.17\% \)  Average \( r_M = 0.03\% \)  Average \( r_f = 0.01\% \)
Step 3: Calculate Beta of Portfolio

\[ \beta_p = \sum_{i=1}^{30} W_i \beta_i \]

\[ \beta_p = (4.08\% \times 0.75) + \cdots + (2.62\% \times 1.00) = 0.659 \]

Step 4: Compute Alpha

\[ \alpha = r_p - [r_f + \beta_p (r_M - r_f)] = 0.17\% - [0.01\% + 0.659(0.03\% - 0.01\%)] = 0.146\% \]
Appendix D

Figure 13: All real-estate companies in the Low Volatility Portfolio