ESG-Based Factor Investing

ESG factors ability to enhance risk-adjusted returns in Smart Beta investment strategies

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Abstract

The purpose of this thesis is to examine if there is a cost, in terms of lower risk-adjusted returns, associated with using ESG factors in the portfolio creation process. The ability of using an ESG Smart Beta strategy, to outperform a passive cap-weighted index and a regular Smart Beta strategy in terms of risk-adjusted returns, was examined. By adopting a Smart Beta methodology, seven different portfolios were constructed, for which the Russell 3000 worked as the investment universe and benchmark. The portfolios consisted of two pure financial portfolios, and five portfolios utilizing ESG factors. The results indicate that it is possible to create excess returns and enhance risk-adjusted returns against a regular Smart Beta strategy and a benchmark index, by using ESG factors in combination with a fundamental investment strategy such as Smart Beta. Investors do not sacrifice any risk-adjusted returns, and the effects are particularly strong when ESG factors are combined with regular financial factors such as Value or Quality.

Keywords: ESG, Smart Beta, Factor Investing

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1. Introduction and Problem discussion

Over the last decade, the care for environmental questions has risen, and as a result, the focus on companies´ adoption of these questions is in the spotlight. This has commonly been unified under the category ESG, which stands for Environmental, Social and Governmental, aiming to capture the overall stand a company has taken in the sustainability aspects of its operations. ESG is a generic term when used in financial markets, often referred to as corporate responsibility or sustainability. The two main focal points of which ESG is used in finance are, risks caused by bad ESG performance and opportunities created by proactive ESG performance (DVFA, 2009). Investing based on ESG factors focuses on a non-financial dimension of stock performance and relies on a company's impact on the environment, the social dimension, and its governance. ESG investing relies on the thought that both investors and society will benefit by incorporating ESG factors into the investment process. Duuren, Plantinga, & Scholtens (2016) argue that investing based on ESG factors is highly similar to fundamental investing, since ESG information can be used for red-flagging and to manage risk. However, ESG investing does not come without controversy as many skeptics believe that it carries a burden in the investment process, by applying constraints to the decision process. Data from Bloomberg indicate that the amount of ESG data that investors demand has increased rapidly over the past decade, and that investors implement ESG factors into their portfolios to a higher extent today (Bloomberg L.P, 2019).

There are as many investment strategies as there are investors, but the one thing all investors have in common is that rational investors should act in a risk-averse manner to maximize the return given the lowest risk possible (Markowitz, 1952). The most common way of quantifying the performance of a portfolio is to measure its excess returns to a benchmark, most often referred to as "the market". Even if generating excess returns is the common objective for most investors, the portfolio construction approach might differ. Investors that believe that it is possible to earn higher returns by using their skills are referred to as active investors, whereas investors investing in the "market portfolio" are known as passive investors (Sorensen, Miller, & Samak, 1998).

In recent years, the concept of factor-based investing strategies has grown rapidly in terms of assets under management. Terms like "Smart Beta" and "Factor Investing" have become common phrases in finance, as these strategies have grown in popularity. Factor Investing is based on a systematic investment approach that measures specific attributes or “factors”, of the securities. Factor Investing could be seen as a mix of an active and a passive investment strategy, for which it enhances parts from both sides to harness market risk and capture a factor premium (Zaher, 2019). It has taken a long time for the investment community to embrace the factor-based strategies, and the financial industry has tried to define which factors to use when constructing the portfolios, common factors are Value, Quality, Momentum, Size, and Low volatility. Most factors-based strategies try to harness factor premia from financial factors, but few of them have tried to incorporate non-financial measures like ESG in the investment process. One reason for investors neglecting ESG factors in their investment process might be the controversy surrounding ESG investments, where some view it as a constraint, whereas others believe what is beneficial for society, also benefits the investors. These conflicting views lay the foundation for the research question and objective of this thesis.

The purpose of this thesis is to identify if there is a cost, in terms of risk-adjusted returns, associated with investing in ESG friendly portfolios, or if adding ESG factors can contribute to higher risk-adjusted returns, compared to a regular factor-based Smart Beta strategy and a passive cap-weighted index. This will be done by creating multiple Smart Beta factor portfolios consisting of the financial factors Value, Quality, and the non-financial ESG factors. This thesis aims to expand on existing literature, by implementing an already existing Smart Beta methodology and develop it by utilizing the non-financial ESG factors. The aim is to examine the ESG factors from an objective standpoint and not to evaluate the ESG factors' ability to create the most sustainable portfolio. The results indicate that it is possible to create excess returns and enhance risk-adjusted returns against a regular Smart Beta strategy and a benchmark index, by using ESG factors in combination with a fundamental investment strategy such as Smart Beta. Investors do not sacrifice any risk-adjusted returns, and the effects are particularly strong when ESG factors are combined with regular financial factors such as Value or Quality.

This thesis will be divided into seven sections starting with the introduction and problem discussion, followed by section two that presents the financial theories building the foundation for this paper. Section three presents the previous research on Factor Investing, Smart Beta, and ESG. In section four, the different factors are introduced along with the definitions of the portfolios, and in section five the data used is presented together with the methodology used to construct the portfolios. In section six the results are discussed, with a deeper examination of the individual portfolio's performance as well as the limitations of this paper, and in section seven, the conclusion and final suggestions for future research are presented.

2. Theory

This section covers well-known theories in financial markets and different asset pricing models. The efficient market hypothesis and the main criticism towards it is presented. Followed by three sections that provide a background of different asset pricing theories such as the Modern Portfolio Theory (MPT), the Capital Asset Pricing Model (CAPM), and the Arbitrage Pricing Theory (APT).

2.1. Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) states that financial markets are efficient, which implies that prices adjust immediately when new information becomes available. The true value is always reflected in the stock price, and it thereby becomes impossible to obtain abnormal returns using public information. Hence, only new information influences the current stock price (Fama, Fisher, Jensen & Roll, 1969). The EMH has been of great importance for subsequent research and the discussion about the market efficiency is still relevant.

Malkiel and Fama (1970) defined three different forms of market efficiency: weak, semi-strong, and strong form. In the weak form, only historical information is reflected in the stock price, and in the semi-strong form, both historical and all public information is reflected in the stock price. This form states that it is not possible to use fundamental analysis to create excess returns, as the stock price is immediately adjusted when new information becomes available. The strong form of market efficiency is when nonpublic information is reflected in the stock price, called insider information, which Malkiel and Fama argued is an extreme form that does not fully reflect reality.

Shiller (2003) criticises the EMH by stating that investors do not always act rationally, which can be seen in the stock market where historical crises and bubbles are considered as proof. Standard theoretical models do not fully reflect reality, because of how psychology and human factors affect investment decisions.

If all information is reflected in the market price, as Fama et al. (1969) argue, it would imply that investors cannot generate excess returns. By assuming that new information is unpredictable, the stock price can be considered a random walk which entails that it fluctuates like a sequence of random variables. In this setting, the stock price has no memory and it is impossible to predict future movements (Fama, 1995). Contradicting research claims, that it is possible to distinguish winners through a fundamental analysis, which can be regarded as criticism towards the strong and semi-strong market efficiency hypothesis. Abarbanell and Bushee (1998) stated that the market tends to underreact to information and that there is either mispricing or that the market is not completely efficient. Grossman and Stiglitz (1980) touched upon the same subject, that available information is not fully reflected in the stock price, enabling investors to generate excess returns at the expense of analyzing the information better than other investors. This thesis aims to construct portfolios that yield excess returns by using a fundamental Smart Beta investment strategy, and thereby test if the EMH holds.

2.2.Modern Portfolio Theory

In 1952 the Modern Portfolio Theory (MPT) was introduced by Harry Markowitz, to explain the relationship between expected return and the risk in a portfolio. According to this theory, a rational investor considers expected return as desirable and variance of the return as undesirable. Hence, the rational investor should be risk-averse, trying to maximize the return given the lowest possible risk.

Through the MPT, Markowitz (1952) showed that diversification in a portfolio could be used to optimize the portfolio. The underlying assumptions are that returns are normally distributed, the market is efficient, and all investors have access to identical information. The returns on an asset can be seen as a stochastic variable, and the weighted sum of several assets and their returns can therefore also be seen as a stochastic variable. By combining assets with a non-perfect correlation in a portfolio, the investor can reduce the risk to the same expected return, a so-called mean-variance-efficient portfolio. By applying this type of investment strategy, the idiosyncratic risk, which is the firm-specific risk, can be eliminated and the investor only bears the market risk, called the systematic risk.

2.3. Capital Asset Pricing Model

In the 1960s the MPT was developed into the Capital Asset Pricing Model known as CAPM, by Jack Treynor (1961), William Sharpe (1964), John Lintner (1965), and Jan Mossin (1966). The model is a one-factor model that explains the relationship between the expected return of a security and the level of risk by the following formula:

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

Where $E[R_i]$ is the expected return of asset i, R_f is the risk-free rate of return, β_i is the systematic risk factor, beta, for asset i and $E[R_m]$ the expected return of the market. The expression within the parentheses, $(E[R_m] - R_f)$, is known as the risk premium. As mentioned in the MPT by Markowitz (1952) a rational investor is assumed to be risk-averse and will only carry the portfolio with the highest expected return, given the level of risk. According to the risk premium, an investor must be compensated by a higher expected return in relation to the risk-free asset, in order to take on more risk and invest in the risky asset. The model suggests that the only way an investor can increase the return is to increase the exposure to the systematic risk, beta, and take on a higher level of risk. The CAPM model assumes that the investor can borrow and lend at the risk-free rate, that expectations are homogeneous, and no transaction costs are apparent. The model further assumes that the market portfolio is efficient and creates a linear security market line (SML), see Figure 1. This line describes the relationship between the securities' expected return and level of risk.

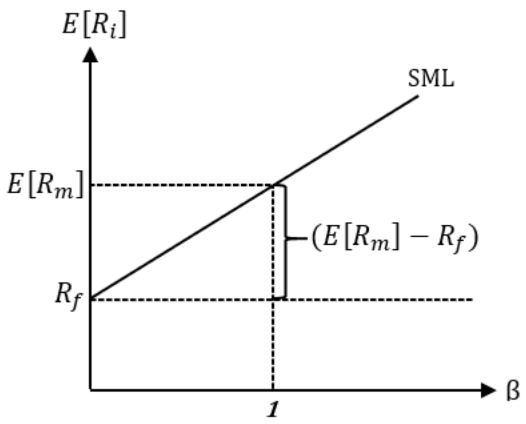


Figure 1: The Security market line

The risk, known as beta, indicates how volatile the security is in relation to the market portfolio and a beta equal to one, indicates that the security and the market portfolio are perfectly correlated and have the same expected return. A security with a higher (lower) beta than 1, implies a higher (lower) volatility compared to the market portfolio. If the security is above the SML, the individual security will generate a positive alpha and is over-performing compared to the market portfolio, the opposite is true for securities below the SML. The SML describes the relation between the risk and return of a security. In a portfolio of securities, this relationship describes the risk-adjusted return, or the Sharpe ratio, which should be constant regardless of portfolio composition. This relationship will be tested and compared for each of the Smart Beta portfolios constructed in this thesis, as it is of interest to examine the ESG factors' ability to enhance the risk-adjusted returns.

The main criticism of CAPM is the assumption that investors can borrow without costs and at the same interest rate, which may not always be the case. The model assumes that the investor can borrow unlimited capital at the risk-free interest rate, which results in an overestimated expected return in the model. Some of the assumptions, as the absence of taxes, should be considered as simplifications rather than realistic descriptions of the reality. Black (1972) questioned the assumption of unlimited borrowing at the risk-free interest rate and presented a more robust alternative model that does not assume the existence of a risk-free asset, called the Black CAPM or the zero-beta CAPM.

2.4. Arbitrage Pricing Theory

Influenced by the CAPM framework Stephen Ross established the Arbitrage Pricing Theory (APT) in 1976. The theory is, just like CAPM, an asset pricing model but instead of using a one-factor model, the APT includes several factors that explain the returns. Ross (1976) argues that there are both firm-specific variables, but also macroeconomic variables that explain the security's expected return and not only the market factor. APT predicts the security's expected return, as a linear function of several factors using the following formula:

$$E[R_i] = R_f + \beta_1 f_1 + \beta_2 f_2 + \cdots + \beta_n f_n \qquad (2)$$

Where the security's expected return, $E[R_i]$, depends on the risk-free rate, R_f, the sensitivity of assets i's price to a factor, β_n, and the risk premium associated with the factor, f_i. APT is a multifactor model, for which the variables are first determined (macroeconomic variables or firm-specific) and then the sensitivity to each factor is examined. The model is based on the same assumptions as the CAPM model, with frictionless and perfectly competitive capital markets and homogeneous expectations of investors. One of the main differences is that CAPM assumes that the market is efficient, while APT does not. Instead, the APT assumes that the security can be mispriced in the market and later corrects this mispricing as the security moves back to the fair value. Arthur, Carter, and Abizadeh (1988) concluded that APT, being a multifactor model, is more effective in explaining returns for the securities than the one-factor model CAPM. This in combination with fewer assumptions compared to CAPM, makes APT a more flexible model. Dhankar and Singh (2005) showed that the multifactor model APT predicts the expected return and the security's risk better compared to CAPM, which only uses the beta as the single measure of risk. This relationship will be examined in this thesis by using several underlying variables in each factor when creating the Smart Beta portfolios.

3. Previous Studies

This section will provide insight into previous research and their results which is relevant for this thesis. First, historical Factor Investing approaches are presented followed by studies regarding Smart Beta and ESG.

3.1. Factor Investing

In 1993, Fama and French introduced a fundamental Factor Investing model, called the Fama and French three-factor model. The model is an extension of the CAPM and in addition to the market risk factor in CAPM, the size risk and value risk factors are added to the model. The background to the model is Fama and French's (1992) results that high book-to-market (value) stocks outperformed those with low book-to-market (growth) stocks, known as the value premium. Another background is Banz’s (1981) results on the size premium, which suggests that smaller companies outperform in the long run. The Fama and French three-factor model is expressed by the following regression:

$$R_{i,t} - R_f = R_f + \beta_{i,t,}(R_m - R_f) + \beta_{i,t,SMB}SMB + \beta_{i,t,HML}HML + \varepsilon_{i,t} \qquad (3)$$

Where R_i is the portfolio return, R_f is the risk-free rate of return and R_m, is the market return. The first term in the formula is the original CAPM expression. SMB is a shortening for “small minus big” and refers to the size premium. It measures the excess return for small-cap companies over large-cap companies. The SMB states that an investor should buy small-cap companies and short-sell large-cap companies. The HML stands for “high minus low” and refers to the value premium, which can be seen as the spread in return for value stocks and growth stocks. In this factor, the investor should buy value stocks and short-sell growth stocks. The three-factor model showed that value stocks and small-cap companies outperform the market. According to Fama and French (1993), the results of the model do not violate the EMH and instead, the results are explained by a risk premium. These types of stocks are riskier, and therefore the investors require a higher return to accept the higher risk associated with these securities. By adding the size and value factor to the beta factor, the three-factor model could explain as much as 95% of the return, instead of 70% for the stand-alone beta factor.

Carhart (1997) extended the three-factor model into a four-factor model including a momentum factor:

$$R_{i,t} - R_f = R_f + \beta_{i,t,}(R_m - R_f) + \beta_{i,t,SMB}SMB + B_{i,t,HML}HML + B_{i,t,MOM}WML + \varepsilon_{i,t} \qquad (4)$$

The WML stands for "winners minus losers" and refers to the tendency for a stock price to continue to rise if it has performed well in the past and continues to decline after a bad historical performance. Similar to the factors in the three-factor model, the WML is a zero-investment portfolio, where the investor buys stocks with positive momentum and shorts stocks with negative momentum. Carhart (1997) argued that stocks tend to follow their momentum, arguing that a positive 12-month average return indicates future positive returns and vice versa. The result of incorporating a momentum factor into the four-factor model indicated that it significantly explained the excess return of the model.

Piotroski (2000), Novy-Marx (2013), Fama and French (2015), and Asness, Frazzini, and Pedersen (2019) are some of the researchers that have investigated the quality factor. The quality factor refers to high-quality stocks with a strong balance sheet, higher margins, and stable earnings. Piotroski (2000) showed that a quality factor applied to value stocks outperform a portfolio consisting of only value stocks, making it important to sort out the high-quality stocks. Asness et. al. (2019) created a "quality minus junk" (QMJ) portfolio investing by short-selling low-quality stocks and buying high-quality. The ratios used were based on growth, profitability, and leverage and the portfolio created superior excess returns.

Another factor studied by financial researchers is the low volatility factor, for which Haugen and Heinz (1972) discovered that the relationship between risk and return was non-linear. Low-risk stocks had positive alpha and outperformed riskier stocks on a risk-adjusted basis. Kalesnik and Linnainmaa (2018) argue that the risk in Factor Investing is understated and because of the factor specific exposure, the diversification in a Factor Investing portfolio is often overstated. This suggests that the factor returns deviate from normality and the correlation between factors is non-constant over time, which results in that factor portfolios can have long periods of underperformance.

3.2. Smart Beta

The concept of Smart Beta is relatively new and what should be included in the category is rather vague, since very little research has been conducted on the subject. Smart Beta is a systematic investment approach which originates from Factor Investing, by targeting specific attributes of securities. However, Smart Beta differs from traditional cap-weighted strategies by tilting the portfolios towards the specific factors instead of only using market capitalization. Smart Beta emerged when practitioners started questioning the traditional indexation approach using market capitalization, as it assigns company weights in the portfolios proportional to their size. The larger the size of a company, the higher the allocation, which in turn could lead to allocation with a growth bias, or simply high allocation to large companies in terms of market capitalization. Smart Beta strategies challenge this by assigning security weights from individual factor scores, for which each factor captures the underlying performance of the company. Smart Beta further differs from traditional Factor Investing strategies by only constructing long portfolios, while traditional factor strategies commonly use a combination of long and short positions (Zaher, 2019).

Recent research by Martellini and Milhau (2018), tries to define the concept of Smart Beta by creating a comprehensive factor allocation framework to be used by institutional investors. Their research concludes that Smart Beta portfolios outperformed cap-weighted indices like Russell 3000, by reducing unrewarded risk and improving the Sharpe ratios. The results indicated that one could expect higher Sharpe ratios by implementing a smart weighting scheme.

Amenc, Goltz, and Shah (2013) published their work *Smart Beta 2.0*, which allows investors to both assess and control risks associated with investments in Smart Beta indices. The outcome of their research was a comprehensive framework on how to implement Smart Beta strategies, which points out and controls systematic risks. The research proposes not only that Smart Beta indices are likely to outperform cap-weighted indices over the long term, but also highlights both structural (factor tilting) and factor specific (input specific) risks associated with Smart Beta strategies that should not be disregarded. Further arguing that Smart Beta indices might suffer from severe underperformance over long periods.

Cai, Jin, Qi, and Xu (2018) implemented a Smart Beta strategy by applying portfolio weights using five different approaches: equal weighting, fundamental indexation, mean-variance optimization, low volatility, and minimum variance portfolio. Each portfolio was benchmarked against the Shanghai stock exchange (SSE 50 index) and the results indicated that each of the portfolios outperformed the cap-weighted index in terms of returns and higher Sharpe ratios. This provides further evidence for the argument that Smart Beta indices outperform cap-weighted indices as proposed by both Amenc, Goltz, and Shah (2013) and Martellini and Milhau (2018).

3.3. ESG

Over the past decade, investors and corporate executives have increasingly embraced the importance of ESG information. Questions like resource efficiency, healthy communication relationships, educating the workforce, and board of directors, might directly impact companies' reputation, value, and performance. Most governments and regulatory authorities encourage an increased ESG disclosure and work for standardization of the ESG data disclosure (Bloomberg L.P, 2019).

Doyle (2018) reviewed 4 different ESG rating agencies and the implementation of their ESG scores, in order to examine individual company events related to ESG factors. The subjective nature of current ESG ratings were examined, as each rating agency has its own ESG scoring method. Further problems associated with ESG data is the lack of regulations and auditing when companies disclose their ESG data. This potentially opens up for companies to manipulate the disclosure processes, making ESG ratings victims of institutional bias. Doyle finds three different biases associated with ESG data; *Larger companies obtain higher ESG ratings*, as a result of stronger ESG alignment or simply that larger companies can dedicate more resources when submitting ESG data. *Geographical bias toward companies in regions with high reporting requirements*, caused by the problems associated with comparing ESG ratings across different geographical regions. This as the data might not truly reflect the ESG practices and rather reflects the quality of the reporting, which depends on the local requirements. This is due to that ESG disclosure requirements vary significantly by country and region. *ESG rating agencies oversimplify industry weighting and company alignment*, which stems from rating agencies claiming to normalize by industry. However, the company-specific risks are often disregarded when assigning weights and scores. This might lead to companies getting a biased rating based on the industry, as opposed to their company-specific risk. The paper concludes that the non-standardized ESG disclosure limits the usefulness of ESG scores for institutional investors and that ESG scores should be standardized in the regulatory filings in order to incorporate risk. ESG ratings should be adjusted for geographical, size, and industry, to become less subjective (Doyle, 2018).

Hamilton, Jo, and Statman (1993) stated that the financial market responds to Corporate Social Responsibility (CSR) information in three different ways. The first hypothesis says that the market does not incorporate CSR and the securities have the same return as others, all else equal. In contradiction to the first hypothesis, the second declared that CSR creates value for the investor. The strong social or environmental performance prompts the investors to regard these securities as less risky, and according to the CAPM model, demanding a lower expected return due to the lower risk. This can be linked to Nofsinger and Varma's (2014) result that the ESG companies have lower downside risk in market crises and this comes at the cost of underperformance during non-crisis periods. Investors searching for downside protection would value those securities higher and accept the cost of a lower expected return. The third hypothesis stated that the EMH is violated in practice and the market does not price CSR securities efficiently.

Kempf and Osthof (2008) studied the multitude of Socially Responsible Investment (SRI) criteria by constructing equity screens based on positive and negative social responsibility scores. The research tried to answer if SRI proponents are not correctly priced by the markets and could potentially generate positive abnormal returns in the long run, thereby contradicting the EMH. This was done by constructing a Carhart four-factor model, which controlled for risk and stylized factors. The main findings indicate that investors do not sacrifice any return performance by investing in SRI friendly portfolios and that investors should be careful investing in low SRI portfolios due to their inferior returns. White (1996) finds that a "green" portfolio yields a significant positive risk-adjusted return, while a "brown" portfolio does not. In contradiction, Hong and Kacperczyk (2009) argued instead that public traded companies in industries like alcohol, tobacco, and gaming, called "sin" stocks have higher expected returns compared to ESG companies. This is due to regulations where norm-constraint institutions are prohibited from investing in "sin" stocks, and therefore, have less coverage by analysts. Resulting in that the constraint institutions pay a financial cost when excluding "sin" stocks.

4. Factors

In this section, each Smart Beta factor used in this thesis is described. First, “the market” is defined followed by the different factors, which are Value, Quality, and ESG. After each factor, the portfolios are defined according to their respective factors.

4.1. Market

Factor Investing is an investment approach for which different quantifiable fundamental characteristics or “factors” of each security can explain the difference in risk and performance. In the single factor model CAPM, the expected future performance of the security is explained by the exposure to the market portfolio, known as the systematic risk. In this thesis, the cap-weighted index Russell 3000 is used as the market portfolio and as the benchmark. Russell 3000 consists of the 3000 biggest U.S. companies in terms of market capitalization, which gives a good representation of the market.

4.2. Value

Value is one of the most traditional factor strategies among academics since Graham, in the 1930s, introduced a factor-based strategy with several different ratios for value stocks. The strategy is about buying stocks that are trading below the intrinsic value. In order to find value stocks, it is common for investors to use a fundamental investing approach by looking at different price-to-fundamentals ratios. These accounting ratios try to capture the intrinsic value of a stock and the economic intuition is that a relatively low (high) value indicates an undervalued (overvalued) stock. Basu (1977) found that a portfolio of low price-to-earnings (P/E), on average, outperformed a portfolio of high P/E securities and earned a higher risk-adjusted rate of return. The result showed that the ratio was not fully reflected in the security’s price as the semi-strong form of the EMH suggested and a disequilibrium persisted.

In 1985 Rosenberg, Reid, and Lanstein found the importance of another value factor in the explanation of future returns, which was the price-to-book (P/B) ratio. A portfolio based on a low P/B ratio outperformed other portfolios. Fama and French (1992) showed the relative success of using a value factor to explain average return compared to the market return and the low P/B portfolio showed a difference in returns compared to those based on a high P/B ratio.

The value investor invests in companies that others have overlooked, with poor historical performance and with low future expectations. De Bondt and Thaler (1985) constructed an extreme “loser” portfolio based on bad historical performance and a “winner” portfolio based on good historical performance. The result showed that the “loser” portfolio, which was represented by value stocks, outperformed the “winner” portfolio when reverting towards the long-term mean.

The dividend as a value factor can be associated with the *Dogs of the Dow,* which is a strategy of buying the highest-yielding stocks from the Dow Jones Industrial index. The portfolio often includes the previous year’s worst performer, which can be linked to De Bondt and Thaler’s (1985) study that historical losers outperform the winners. Domian and Louton (1998) linked it to the market overreaction hypothesis and showed that after a market crash losers became winners and outperformed the market the previous years. Black and McMillian (2005) found that the value factor is highly sensitive to changes in economic conditions over the business cycle compared to other factors. Some of the differences in returns for a value factor portfolio can be explained by the change in macroeconomic conditions. The result showed that, on average, value stocks showed greater responsiveness to economic shocks and had higher volatility.

4.2.1. Definition of Value portfolio

Several variables that have been defined as value factors in the academics are used, in order to capture the desirable attributes. The Value Smart Beta factor will be defined using four variables, including: Dividend yield, Price-to-earnings (P/E), Price-to-book (P/B), and Price-to-cash-flow (P/CF), see Appendix B: Value variables. Each security will have a weight in the portfolio according to their value score, in relation to the total sum of scores in the value portfolio. The value score is defined as the following:

$$Value\ Score_i = \frac{1}{n}\left(Z_{DivY_i} - Z_{PE_i} - Z_{PB_i} - Z_{PCF_i}\right),\ \ n = 4 \qquad (5)$$

Where Z is the standardized value for the specific variable for security i. For example, Z_{DivY_i} is the standardized value for the dividend yield for security i. Each variable is given equal weight in the total value score, and the 50 securities with the highest score will be weighed into the Value portfolio. Each portfolio will consist of 50 securities, in order to decrease the firm-specific risk in the portfolios. According to Campell, Lettau, and Malkiel's (2001) the correlation between securities in a portfolio has decreased lately, leading to a lower diversification effect. Their suggestion is therefore that a portfolio should hold at least 50 securities in order to obtain a sufficient diversification effect.

4.3. Quality

Companies with superior internal governance tend to yield excess returns and perform better compared to others. The relationship is most apparent when the market sentiment turns bad, after a long period of rising bull markets with low volatility. This phenomenon is known as "flight to quality" for which the popularity of higher-quality companies increases during financial downturns. Quality investors search for companies that generate great cash-flows combined with low leverage. This type of firm is less risky, yields a higher return, and performs better during market downturns when the risk aversion is high (Brooke, Docherty, Psaros & Seamer, 2018).

Low leverage is considered as an indication of a high-quality firm by many academics. For example, Altman (1968) showed that companies with high leverage have higher credit risk and therefore the probability of default is higher. George and Hwang (2010) showed that a stable leverage ratio relative to equity tends to generate an excess return in the long run.

Piotroski (2000) constructed a quality factor-based strategy with a fundamental analysis model called F_SCORE which includes several ratios. By using the quality model, it was possible to separate the future winners and losers and increase the market-adjusted return. When buying expected winners and shorting expected losers, the market-adjusted return increased. In the F_SCORE, the companies were ranked based on nine parameters in the categories: profitability, financial leverage/liquidity, and efficiency. The model is binary and if the company meets the criteria in one of the nine parameters it attains one point, else zero. The aggregate sum of signals can, therefore, range from 0 to 9. The profitability category measures the company's ability to generate funds internally consisting of ratios such as the return on asset and cash flow generated by the firm. In the second category, financial leverage/liquidity, the ratios are designed to measure changes in capital structure and the company's ability to meet future debt obligations. The ratios in this category are based on different debt ratios and changes in the number of shares outstanding. In the last category, efficiency, the efficiency of the company's operations is measured by using the change in gross margin and asset turnover, compared to the previous year. The F_SCORE is designed to measure the overall quality of the firm's financial position and the decision to purchase is only based on the aggregated signal.

Novy-Marx (2013) found that companies with high gross profitability outperformed the benchmark over long periods. By using the gross profitability in relation to total assets, one shows the "true economic profitability" of a company. Fama and French (2015) suggested a profitability measure to explain the returns, but instead of using gross profitability, the operating profit was suggested to measure the performance of a company.

4.3.1. Definition of Quality portfolio

Similar to the value factor, the Quality factor portfolio uses several variables that have been defined by previous studies, to capture the desirable requirements. In order to identify a high-quality company, the same methodology as Piotroski's (2000) will be used, which is an aggregated sum of signals in the categories: profitability, financial leverage, and efficiency. The quality factor is defined as the weighted sum of four variables, which including the profitability measures, return on asset (ROA) and return on equity (ROE), the efficiency ratio asset turnover and the leverage ratio debt-to-Equity (D/E), see Appendix B: Quality variables. The quality score for asset *i* is calculated as follows:

$$Quality\ Score_i = \frac{1}{n}\left(Z_{ROA_i} + Z_{ROE_i} + Z_{AssTurn_i} - Z_{DE_i}\right),\ \ n = 4 \qquad (6)$$

Where Z is the standardized value for the specific variable for security i. Each variable attains equal weight in the total quality score and the 50 securities with the highest score will be weighed into the Quality portfolio.

4.4. ESG

The ESG discussion in the financial market has grown rapidly in recent years and researchers have different opinions on whether it can be considered a specific factor or not. Some researchers believe that ESG factors contribute positively to the firm's financial performance, while others state the opposite, believing it becomes a constraint. Feldman, Soyka, and Ameer (1996) studied the environmental part of the ESG and argued that environmentally corporations create value for the stakeholders due to lower risk which leads to a lower cost of capital. This can be linked to the research by Kumar, Smith, Badis, Wang, Ambrosy, and Tavares (2016) that ESG factors bring lower volatility in the stock returns and therefore earn a higher risk-adjusted return compared to the companies in the same industry.

Al-Tuwaijria, Christensen, and Hughes (2004) argue that environment pollution represents resources that have been used inefficiently, and by controlling for this, the company can increase their efficiency. The result indicated that good environmental performance and economic profitability is associated with each other.

Tsoutsoura (2004) tested if corporate social performance is linked to financial performance and found a positive relationship. The argument is that firms with solid financial performance can invest more in social performance and have a long-term strategy, whereas those suffering from financial distress have a more short-term myopic investment behavior. Social responsibility companies have a positive reputation among customers, a stronger brand image, and attract skilled employees. Those types of companies have less risk of negatively surprising events and according to Tsoutsoura (2004), this social responsibility can generate financial benefits for the company in the long run. This aligns with Gillan, Hartzell, Koch, and Starks (2010) in that ESG companies have higher efficiency and higher valuation compared to their peers, but which mechanism in the ESG factor has the highest impact on the stock price is hard to distinguish, and therefore, an aggregated sum of the ESG factor is recommended.

Gompers, Ishii, and Metrick (2003) built an index called a Governance index in which the relationship between managers and shareholders of the firm was measured. The relationship between this index, future stock returns, and the firm value was analyzed. The findings were that corporate governance is strongly correlated with stock returns when purchasing firms with the strongest shareholders' rights and short-selling those with weakest shareholders' rights. The result also indicated that the Governance index was highly correlated with firm value and that weaker shareholders' rights are associated with lower sales growth, lower profit, and higher capital expenditures.

4.4.1. Definition of ESG portfolio

Bloomberg is used as the source when collecting data for ESG scores on a company level. The ESG data is collected from company-sourced filings that consists of corporate social responsibility reports, annual reports, the company website, and specific surveys. Bloomberg provides scores for each specific factor i.e. one for Environmental, one for Social, and one for

Governance. Each factor consists of several subcategories, in order to generate a full perspective on the actions of a corporate regarding ESG practices. The environmental score is for example based on factors such as carbon emissions, the social score on human rights, and the governance on executive compensation among others (Table 1).

Table 1: Definition of the three pillars in the Bloomberg ESG score (Bloomberg L.P, 2019).

Bloomberg ESG Scores		
Environmental	**Social**	**Governance**
Carbon Emissions	Supply chain	Cumulative voting
Climate change effects	Discrimination	Executive compensation
Pollution	Political contributions	Shareholders' rights
Waste disposal	Diversity	Takeover defence
Renewable energy	Human rights	Staggered boards
Resource deplation	Community relations	Independent directors

Bloomberg collects data on each of the parts within the ESG measurement, to provide a comprehensive measurement when scoring each factor. Each ESG factor score is based on the extent of a company's ESG disclosure. The score ranges from 0.1 for companies that disclose the minimum amount of ESG data and 100 for those who disclose every data point collected by Bloomberg, companies that do not disclose any ESG information are excluded from the scoring. Each data point is weighted in terms of ESG importance, for instance, data such as greenhouse gas attains a greater weight than other measurements. The score is normalized by industry-specific operating data, to only include relevant data points, for example, gas companies report the amount of gas produced in millions of barrels, for Bloomberg to calculate the greenhouse gas emissions per barrel oil. The industry sectors are grouped into broad categories for metrics selection, for which the environmental factor is divided into high, medium, and low environmental impact, the social into higher and lower social impact, whereas the governance factor is the same for all industries. Each company is only evaluated in terms of the amount of data reported, and not in performance to each measurement (Bloomberg L.P, 2019).

To capture the desirable attributes, each of the three components of the ESG Score is used, collecting scores for each factor individually. The ESG Smart Beta factor will be defined using three variables, including Environment, Social, and Governance. Each security will have a weight in the portfolio according to their ESG score in relation to the total sum of scores in the ESG portfolio. The ESG score is defined as follows:

$$ESG\ Score_i = \frac{1}{n}(Z_{Env_i} + Z_{Soc_i} + Z_{Gov_i}), \quad n = 3 \tag{7}$$

Where Z is the standardized value for the specific variable for security i. Each variable is given equal weight in the total ESG score. The 50 securities with the highest ESG score will be weighed into the ESG portfolio and the 50 securities with the lowest ESG score will be weighed into the Low ESG portfolio.

4.4.2. Definition of the Combined ESG portfolios

The two main reasons for constructing the combined Smart Beta factor portfolios are, firstly to evaluate each standalone factor towards its representative combined portfolio, for example, the Value factor against ESG and Value factors used in combination. Secondly, to test if a multifactor model utilizing ESG factors can capture unexplained firm-specific factors that are not priced by the market, as explained in the APT, and if ESG factors contribute to enhanced risk-adjusted returns.

The combined portfolios will utilize the same factors as the previous portfolios, but the composition will differ due to consisting of a mix, combining the financial factors with the ESG factors. This is done to analyze the effect of using non-financial ESG factors, in combination with other more traditional financial factors. The following combined ESG portfolios are defined:

- ESG & Value
- ESG & Quality,
- Multifactor (ESG, Value & Quality)

The ESG & Value score will be a combination of equation (5) and (7), ESG & Quality equation (6) and (7) and the Multifactor will combine equation (5), (6) and (7). Each factor is given equal weight in the total score, and the 50 securities with the highest score will be weighed into the respective combined portfolio.

5. Data and Methodology

The following section will describe the methodology of this thesis and how the data is collected. The first part is regarding the portfolio generation, which includes the security selection, scoring, and weighting process. The second part presents the relevant performance measures being used in the empirical analysis.

5.1. Thesis data

The data used is collected from Bloomberg including relevant information between the time-period 2008-05-01 to 2020-05-01, for the index Russell 3000, the U.S. 3-month T-Bill as the risk-free rate, and all the securities included. The motivation for the chosen time period is that the amount of company-specific ESG data is limited before 2008, and by choosing this as the starting point the amount of excluded companies is limited in the portfolio creation process. The annual return calculations and rebalancing of the portfolios take place in the fifth month of each year, to ensure that necessary annual financial information should be available at the time of the portfolio formation. The Russell 3000 is used as the investment universe for the portfolio construction process. This is a capitalization-weighted index that tries to benchmark the entire U.S. stock market, representing approximately 98% of the American equity market and includes the 3000 largest public firms according to market capitalization. The tool used in Bloomberg to collect factor-specific data is Watchlist Analytics which is used to get the relevant key ratios for each company. If a company lacks more than 50 % of its data, it is excluded from the dataset.

5.1.1. Scoring

The first step is to use Bloomberg Watchlist Analytics to collect the factor-specific raw data of each variable, for each specific security as shown in Figure 2.

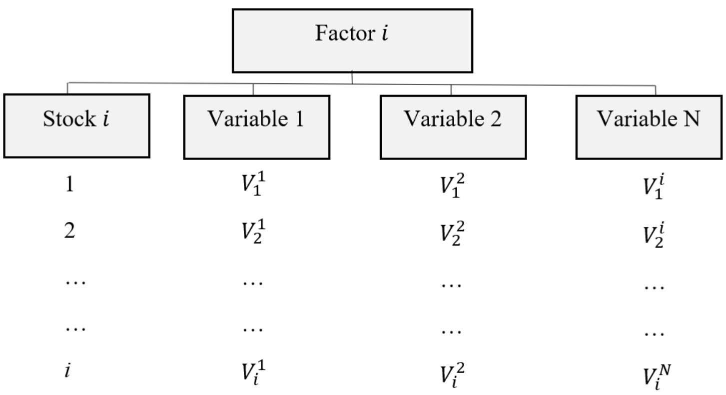


Figure 2: Raw data collected from Bloomberg Factors consists of Value, Quality and ESG.

The Smart Beta factor portfolios have different variables belonging to each factor portfolio. The ESG factor portfolio, for example, has three different variables according to the pillar's Environment, Social, and Governance. The variables across the different portfolios are measured in different units, thereby making them incomparable. Hence, the second step is to make them comparable by standardizing each security's variable to create an equal framework, see Appendix A: Standardized score. The following formula is used in the procedure of standardizing the variables:

$$Z_i^N = \frac{X_i^N - \mu_N}{\sigma_N} \tag{8}$$

The standardized score (Z_i^N) for variable N of security i, is obtained by subtracting the observed mean (μ_N) from the observed raw data (X_i^N) for variable N of security i, and then divide it by the standard deviation of the variable N, (σ_N). This procedure is repeated for all securities (Figure 3), and by using this approach the standardized variable attains a mean of zero and a variance of one.

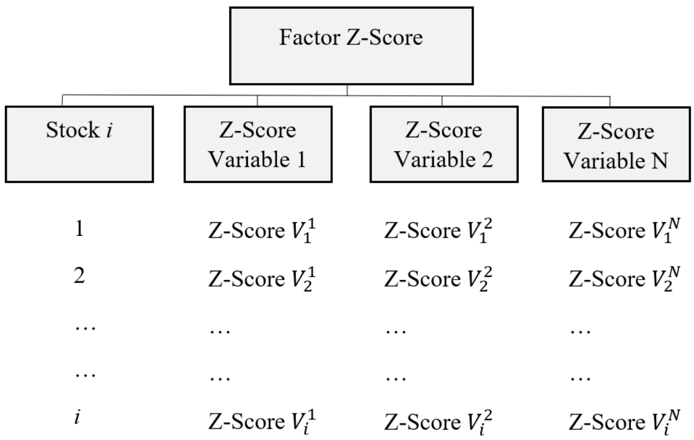


Figure 3: Each variable is standardized according to equation (8), to obtain the Factor Z-score.

The average of all standardized variables is then calculated, to obtain the overall standardized score for each security. The following formula is used for the overall standardized Factor Score:

$$Factor\ Score_i = \frac{1}{n}\sum_{i=1}^{n} Z_i^N \tag{9}$$

Where Z_i^N is the standardized score for variable N of security i. By using this method, it becomes possible to rank each security with a factor-specific score and sort out the 50 securities with the highest standardized Factor Score for each Smart Beta portfolio (Figure 3). To limit the effect of outliers the Winsorize method of the standardized scores is used, see Appendix A: The Winsorize method. The certain threshold is +/- 3 standard deviations from the mean, and all outliers in the dataset are capped at this level.

5.1.2. Weighting

After finishing the ranking of each security with a factor-specific standardized score, the 50 best-performing securities according to their score are sorted out. To make sure one individual security does not have a too large weight and to keep the diversification effect in each portfolio, the European Commission requirements in liquidity and portfolio diversification are used. The Undertaking for the Collective Investment of Transferable Securities (UCITS), limits an individual security's weight to five percent of the total portfolio (Muller & Ruttiens, 2013). To determine each security's portfolio weight relative to the whole Smart Beta portfolio, the total sum of all the scores in the portfolio is calculated. Each security then attains a weight taking their score relative to the total sum of scores in the portfolio using the following formula:

$$W_i = \frac{Factor\ Score_i}{\sum_{i=1}^{50} Factor\ Score_i} \tag{10}$$

And:

$$\sum_{i=1}^{50} W_i = 1 \tag{11}$$

Where W_i is the weight for security i and $Factor\ Score_i$ is the Factor Score for security i. By using this procedure, one assures that the total sum of all weight in the respective portfolio must be equal to 1.

5.2. Performance analysis

To make a comparison between each Smart Beta portfolio and against the benchmark index, different performance measures are used. As a consequence of that the underlying variable for each company changes over time, every portfolio must be rebalanced to retain its attributes associated with the respective factor. The rebalancing takes place the fifth month every year and the performance measurements used are: Return, Volatility, Downside Volatility, Jensen's alpha, Sharpe ratio, and Sortino ratio.

5.2.1. Portfolio return

The cumulative portfolio return R_i^p, is calculated as the return of the asset *i*, R_i, times the weight associated with that asset, W_i, and then summed for all securities in the portfolio:

$$R_i^p = \sum_{i=1}^{n} [\, R_i w_i \,] \tag{12}$$

Where daily returns are calculated using the following formula:

$$R_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \tag{13}$$

Where $P_{i,t}$ is the price at time t, and $P_{i,t-1}$ the price at time t-1.

5.2.2. Market-adjusted return

The market-adjusted portfolio return, R_t^{aP}, is defined as the difference in return between the portfolio and the benchmark index, measured as follows:

$$R_t^{aP} = R_t^P - R_t^M \tag{14}$$

Where R_t^P, is the return of portfolio *P* at time *t*, and R_t^M is the return of the benchmark index a time *t*.

5.2.3. Volatility

The volatility is defined as the annualized volatility of the daily returns over a year, which is expressed mathematically with the following two formulas:

$$\sigma_i^p = \sqrt{\frac{\sum_{i=1}^{N} (R_{i,t} - \bar{R}_i)^2}{N - 1}} \tag{15}$$

$$\sigma_{Annual}^P = \sigma_i^P * \sqrt{252} \tag{16}$$

Where, σ_i^p, is the standard deviation of the daily returns over a year, $R_{i,t}$, is the observed return of security *i*, at time *t* and $\bar{R}_i$, is the mean return. By multiplying with the square root of 252, the daily return annualized volatility, σ_{Annual}^P, is received.

5.2.4. Jensen's alpha

Jensen's alpha measures the average return on a portfolio in addition to the predicted return by CAPM, given the portfolio's beta and the average return of the market. The performance measure evaluates the portfolio performance in relation to the market, on a risk-adjusted basis. A positive (negative) alpha indicates that the portfolio has outperformed (underperformed) the theoretical performance estimated by the CAPM model. Jensen's alpha is calculated with the following formula:

$$\alpha_p = R_p - \left[R_f + \beta_p\left(R_M - R_f\right)\right] \tag{17}$$

Where α_p, is the alpha of the portfolio, R_p is the average return of the portfolio, R_f the risk-free rate, β_p the beta for the portfolio and R_M the average return of the market. Jensen's alpha utilizes a t-test to determine if the alpha is significantly different from 0 (five percent significance level will be used), by using the following hypotheses:

$$H_0: \alpha_p = 0$$
$$H_1: \alpha_p \neq 0$$

5.2.5. Sharpe ratio

The Sharpe ratio is determined by the excess return over the risk-free rate, per unit of risk, and is defined as:

$$SR_p = \frac{(R_p - R_f)}{\sigma_p} \tag{18}$$

Where, R_p, is the portfolio return, R_f, the risk-free rate measured by the 3-month U.S. Treasury Bill, see Appendix C: Figure 13, and, σ_p , is the portfolio volatility.

5.2.6. Sortino ratio

The Sortino ratio is similar to the Sharpe ratio, but instead utilizes the return in excess of the risk-free rate, per unit of downside risk, and is defined as:

$$ST_p = \frac{(R_p - R_f)}{\sigma_{Dp}} \tag{19}$$

Where, R_p, is the portfolio return, R_f, the risk-free rate measured by the 3-month U.S. Treasury Bill, see Appendix C: Figure 13, and, σ_{Dp} , is the portfolio downside volatility. The downside volatility is the standard deviation of the negative excess returns over the risk-free rate.

6. Empirical analysis

The results for the portfolios are measured from the 1st of May 2008 to the 1st of May 2020, and each portfolio is evaluated against the Russell 3000 index as the benchmark. The results are compared across the portfolios, to evaluate the ESG based portfolios' performances as well as each portfolio's performance. The evaluated portfolios are Value, Quality, ESG, ESG & Value, ESG & Quality, Low ESG, and Multifactor. The portfolios will be tested in terms of correlation, total return, market-adjusted return, risk-adjusted return, volatility, downside volatility, and alpha.

6.1. Summary results

When evaluating the portfolio returns one can see that the combined ESG & Quality portfolio performed best in terms of both average annual returns and total cumulative return (Table 2; Figure 4), closely followed by the Quality portfolio. Both portfolios managed to outperform the benchmark Russell 3000 index in terms of total returns by approximately 40 and 32 percentage points respectively. One can see that all of the ESG portfolios (including Low ESG), manage to yield higher average annual returns and higher total cumulative returns compared to the benchmark Russell 3000 index.

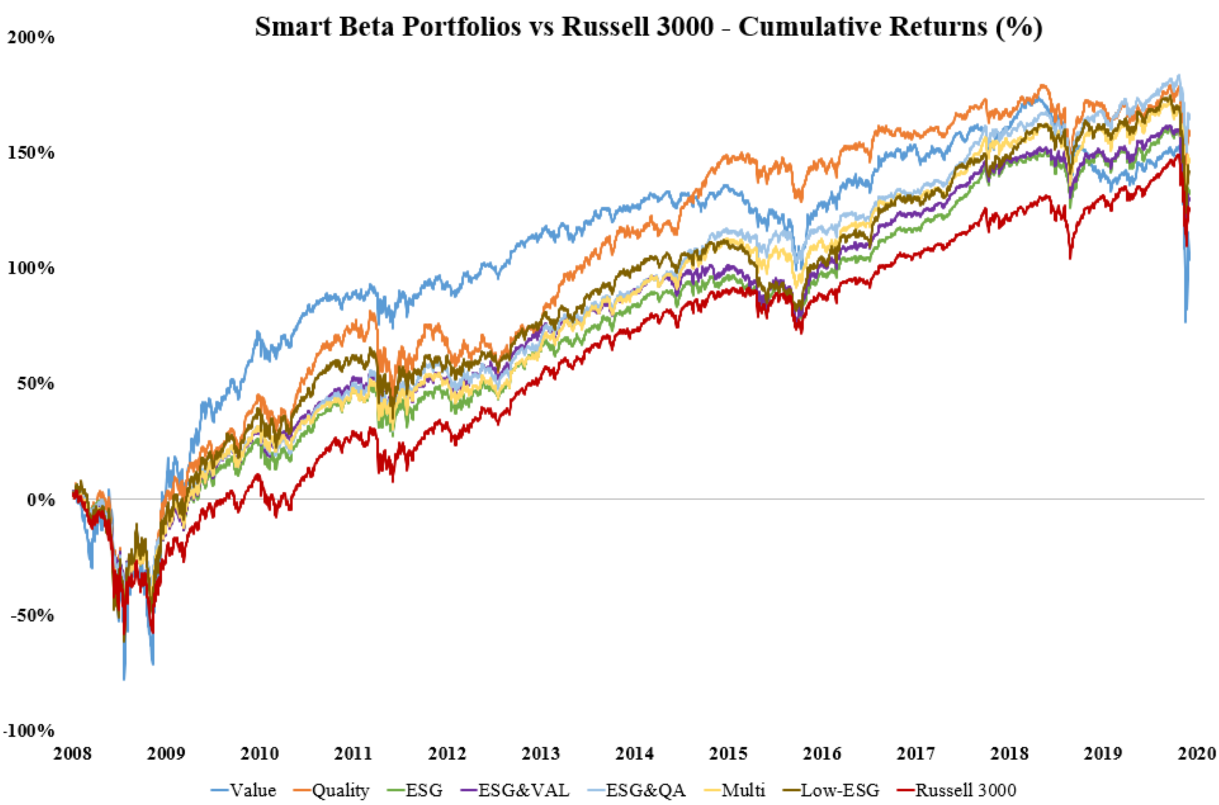


Figure 4:Smart Beta Portfolios: Cumulative returns vs Russell 3000.

Furthermore, the combined ESG portfolios, ESG & Value, and ESG & Quality manage to outperform the individual standalone factors Value and Quality. The Value portfolio was the only portfolio to underperform against the benchmark in terms of average annual and total cumulative returns.

All the ESG portfolios (excluding Low ESG) have lower volatility and downside volatility than the benchmark, whereas all of the non-ESG (including Low ESG) have higher volatility and downside volatility compared to the benchmark. The portfolios' betas further indicate the ESG factors lower volatility compared to the market, where all ESG portfolios have a beta lower than one, whereas all the non-ESG portfolios have a beta above one. In terms of risk-adjusted returns measured by the Sharpe and Sortino ratio, one can see that the ESG portfolios once again outperform the benchmark and the non-ESG portfolios. The combined ESG & Quality portfolio is the best individual performer in terms of risk-adjusted return, with a Sharpe ratio of 1,05 and a Sortino ratio of 1,50 (Table 2). Notably is that in terms of total returns the combined ESG & Quality portfolio and the Quality portfolio were the best performers. While taking the risk-adjusted return in consideration, the ESG & Quality performed best, followed by the other ESG friendly portfolios. In contrast, the Quality portfolio was the third-worst risk-adjusted performer, underperforming the benchmark.

Table 2: Summary statistics for the Smart Beta portfolios and the benchmark index Russell 3000. All values represent average annual over the period, except for cumulative returns, which are in total. (= P-Value < 0.05).*

Summary Statistics - Portfolios vs. Russell 3000

Measurement	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
Average Annual Return (%)	8,64	13,08	11,00	10,76	13,69	12,12	11,83	10,39
Cumulative Return (%)	103,69	156,94	131,98	129,15	164,23	145,48	141,90	124,68
Volatility (%)	24,81	21,52	18,13	18,07	18,41	18,50	21,18	18,88
Downside volatility (%)	17,69	15,55	13,10	13,02	13,20	13,31	15,20	13,75
Beta	1,22	1,04	0,93	0,92	0,94	0,94	1,08	1,00
Sharpe ratio	0,58	0,86	0,99	0,97	1,05	1,00	0,84	0,89
Sortino ratio	0,87	1,25	1,41	1,40	1,50	1,43	1,21	1,26
Jensen's Alpha	-0,014	0,009	0,005	0,004	0,015	0,009	0,003	
P-value	0,478	0,391	0,414	0,532	0,011*	0,180	0,774	

Another interesting finding is that on a standalone basis the Value portfolio has the highest volatility, while the combined ESG & Value portfolio has the lowest volatility overall. This might be to a diversification effect or due to that ESG factors lower the volatility and increase the risk-adjusted returns. This will be further examined and discussed in the individual portfolio results. Examining the Jensen’s alpha test statistic, the only portfolio with both a positive alpha and statistical significance at the 5 percent level is the ESG & Quality portfolio. Hence, this is the only portfolio that statistically has an alpha different from zero during the 12-year examination period. Indicating that the ESG & Quality portfolio manages to outperform the benchmark Russell 3000 index in terms of risk-adjusted returns, according to Jensen's alpha test.

6.1.1. Portfolio correlation

The ESG & Quality and the ESG portfolio has the highest correlation with the benchmark index (both 0,97) (Table 3). One explanation for this could be that the underlying fundamental factors that define the Quality portfolio, are common in large-cap companies that have a higher representation in the benchmark index. Both portfolios with the highest correlation to the benchmark index contain the ESG factors, and this makes us question current ESG measurements' ability to reflect true parameters of ESG friendly corporates, due to the subjective nature of how it is measured. This as companies are measured by the amount of data provided, rather than the performance of each measurement.

Table 3 Correlation matrix for the Smart Beta portfolios and the benchmark index Russell 3000.

Correlation Matrix								
	Value	Quality	ESG	ESG&VA	ESG&QA	Multi	Low ESG	Russell 3000
Value	1,00							
Quality	0,82	1,00						
ESG	0,80	0,89	1,00					
ESG & Value	0,81	0,87	0,99	1,00				
ESG & QA	0,79	0,94	0,97	0,95	1,00			
Multifactor	0,80	0,91	0,97	0,97	0,98	1,00		
Low ESG	0,86	0,91	0,92	0,92	0,92	0,92	1,00	
Russell 3000	0,83	0,92	0,97	0,96	0,97	0,96	0,94	1,00

The results are further confirmed by examining the correlation between the securities factor scores and market capitalizations, as well as the portfolios' average market capitalizations, see Appendix C: Table 12 & 13. All the portfolios containing the ESG factors suffer from significantly higher correlations between the individual securities factor score and market capitalization. Furthermore, the ESG portfolios also have a higher average market capitalization, compared to the Value and Quality portfolios. Both these findings indicate that the ESG portfolios have a "size" bias towards large corporations, and thereby becomes closer to a cap-weighted portfolio. However, the ESG portfolios tend to have higher risk-adjusted returns than the cap-weighted benchmark, indicating that the ESG portfolios contribute to enhance performance, despite having a bias towards large corporates. As discussed by Doyle

(2018), ESG data can be a victim to institutional bias, due to that large companies obtain higher ESG ratings, a result of stronger ESG alignment, which our results confirm. The portfolio with the lowest correlation to the benchmark is the Value portfolio. One reason for this could be the significantly higher volatility of the Value portfolio, compared to the benchmark, and that the Value portfolio consists of a higher degree of financially distressed securities, relative to the weight in the cap-weighted Russell 3000. The portfolios with the lowest correlation against each other are the ESG & Quality and the Value portfolio, which is also clearly seen when studying their correlation to the benchmark, 0.97 and 0.83 respectively.

6.2. Individual portfolio results

The purpose of this thesis is to evaluate the performance of ESG factors and how the results compare to traditional Smart Beta portfolios. To evaluate the performance, the results from both the pure financial Smart Beta portfolios Value and Quality, as well as the non-financial ESG portfolio and the combined portfolios are examined. Starting by analyzing the results of the financial Smart Beta portfolios, followed by the ESG portfolios.

6.2.1. Value and Quality portfolios

When comparing the two traditional types of financial Factor Investing as the value and quality factor, the Quality portfolio outperforms the Value portfolio, both when it comes to annual average return and total cumulative return. Compared to the benchmark the Value portfolio had a negative market-adjusted return of nearly 21 percentage points lower cumulative return relative to the Russell 3000 index, for the analyzed period. For the same period, the Quality portfolio outperformed the benchmark with more than 32 percentage points (Table 2).

This result is in line with Piotroski's (2000) result that the market-adjusted return can be increased by sorting out the high-quality stocks. Fama and French (1993) showed the existence of the value premium, for which investors were compensated by higher returns when investing in the riskier value stocks. However, our results indicate a higher risk associated with the value stocks, but not due to an increased return. The Value portfolio had the lowest total cumulative return of all the portfolios analyzed and was the only one that underperformed against the benchmark. This result can be linked to what Kalesnik and Linnainmaa (2018) stated, that Factor Investing can have long periods of underperformance and that the diversification effect is often overstated, which is the case for the Value portfolio.

By looking at the risk measures (Table 2), both the Value and Quality portfolio has higher volatility than the benchmark, which also can be seen in their beta's. The Value and Quality portfolio had an annualized volatility of 24.81 and 21.52 percent respectively, compared to the 18.88 percent of the Russel 3000. When comparing the Value and Quality portfolio results, it aligns with the research of Black and McMillian (2005) that the value factor is highly sensitive to changes in economic conditions over the business cycle compared to other factors. Their results further showed that value stocks have greater responsiveness to economic shocks by having higher volatility. This can be observed in the Value portfolio, clearly having the highest volatility of all the portfolios analyzed. The high volatility has an immense impact on the overall performance, in terms of total cumulative return. As a result, the Value portfolio has a lower average risk-adjusted return, compared to the Quality portfolio and the benchmark. The Quality portfolio has instead a higher average risk-adjusted return compared to the Value portfolio, but lower compared to the benchmark, both in terms of the Sharpe and the Sortino ratio.

The volatility of the Value portfolio is higher when the market sentiment is bad, like the financial crisis 2008, the correction 2015, and the Corona pandemic 2020 (Figure 5). In those periods, the Quality portfolio outperformed the Value portfolio. This can be associated with the well-known term "flight to quality", for which the popularity of high-quality companies increases under financial crises.

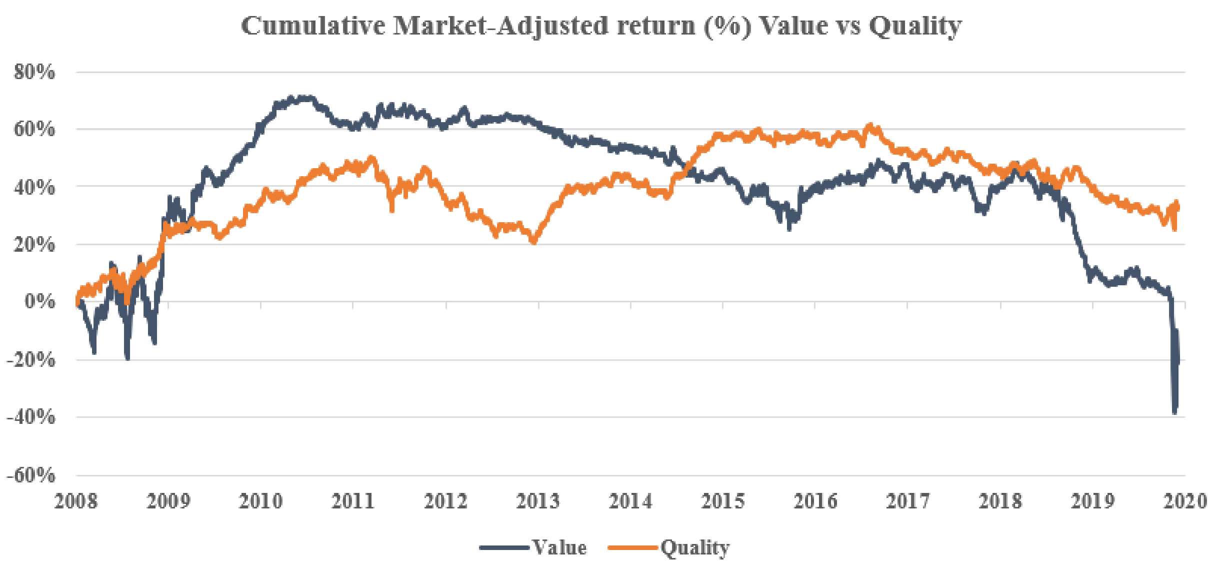


Figure 5: Smart Beta Portfolios: Cumulative market-adjusted returns Value vs Quality.

When the risk aversion is high the investors have a higher demand for less risky firms that generate cash-flows and have low leverage (quality stocks). Those firms generate a higher return and perform better under market downturns (Brooke, et al., 2018). This can be one explanation for the result of the Quality and Value portfolio under bad economic conditions in this thesis. In contradiction, we see that the Value portfolio outperforms the Quality portfolio the years after the financial crisis of 2008. One explanation of the results could be Domian and Louton's (1998) market overreaction hypothesis, that after a market crash the "losers" (referring to value stocks) became the winners and outperformed other factors the previous years. Martellini and Milhau (2018) stated that Smart Beta indices outperform cap-weighted indices and when it comes to the Value and Quality portfolio, it is true for the Quality portfolio, but not for the Value portfolio, in terms of total cumulative return. Examining the risk-adjusted returns, the benchmark outperforms the Smart Beta portfolios with both higher Sortino and Sharpe ratios (Table 2).

6.2.2. ESG as a Standalone Smart Beta Factor

The ESG factors used as a standalone Smart Beta portfolio manages to outperform the cap-weighted Russell 3000 index, in terms of total cumulative returns, as well as average annual returns. The ESG portfolio yielded a cumulative return of approximately 132 percent, compared to the benchmark's return of approximately 125 percent (Table 2). The average volatility and downside volatility of the ESG portfolio, 18.13 and 13.10 percent respectively, is lower than the 18.88 and 13.75 percent of Russell 3000. The ESG portfolio has a beta below 1, indicating that the ESG portfolio moves less than the benchmark, where a 1 percent move in the market, results in a 0.93 percent move in the ESG portfolio.

The higher performance in terms of returns and lower volatility is further reflected from the measurements controlling for risk-adjusted returns. The ESG portfolio yields a Sharpe and Sortino ratio of 0.99 and 1.41 respectively, compared to 0.89 and 1.26 of Russell 3000. This aligns well with Martellini and Milhau (2018), which concluded that Smart Beta portfolios outperformed cap-weighted indices like Russell 3000, by reducing unrewarded risk and improving the Sharpe ratios. The higher Sharpe and Sortino ratios further confirm the results of Kumar et al. (2016) in that ESG factors reduce volatility and enhance the risk-adjusted returns. The lower volatility and downside volatility can also be linked to the results of Tsoutsoura (2004) in that ESG companies have less risk in terms of negative surprise events, due to their transparent reporting, leading to lower downside risk. The overall improvements in the measures controlling for risk indicate that ESG factors can be used in the portfolio creation process of Smart Beta portfolios to increase the risk-adjusted returns.

However, the results from Jensen's alpha test fails to reject the null of alpha equaling zero at a 5 percent significance level (Table 2). The alpha is greater than zero, but the p-value is clearly above 0,05, which makes the results statistically insignificant. Indicating that the ESG portfolio is unable to yield market excess returns versus the Russell 3000 index, according to Jensen's alpha t-test.

Comparing the ESG portfolios' cumulative and average annual returns with the financial Smart Beta portfolios Value and Quality, one can see that the ESG portfolio underperforms the Quality portfolio but outperformed the Value portfolio (Table 2; Figure 4). The ESG portfolio has higher Sharpe and Sortino ratios than both the Value and Quality portfolio, which gives further evidence for the ESG factor's ability to enhance the risk-adjusted returns. By observing the cumulative market-adjusted returns (Figure 6), one can see that the ESG portfolios return is less volatile compared to the Value and Quality portfolios, contributing to the higher risk-adjusted returns.

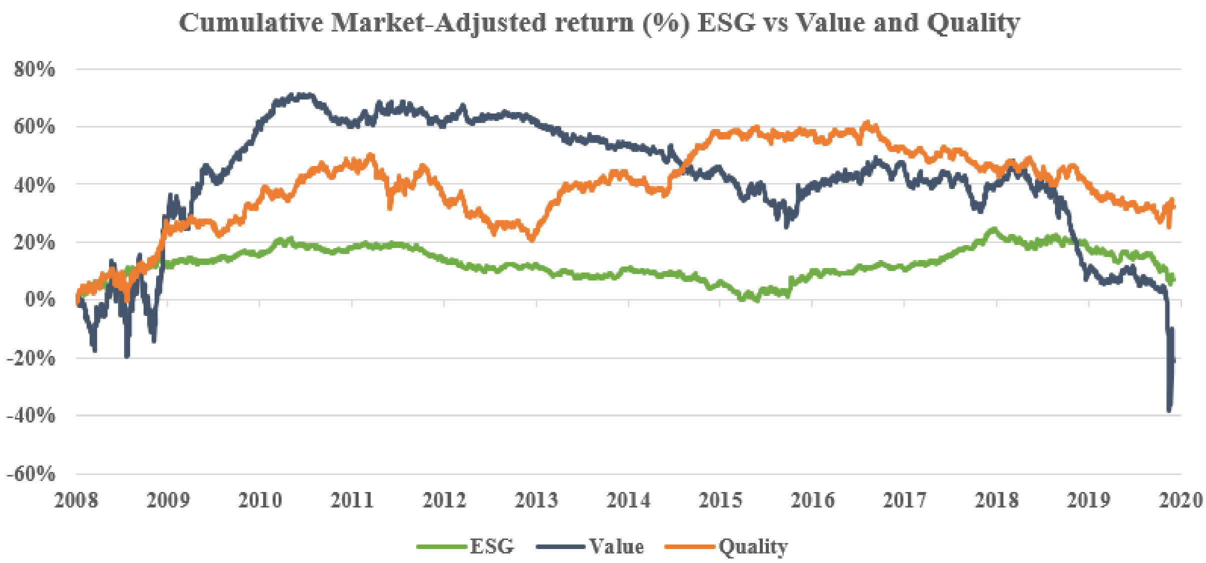


Figure 6: Smart Beta Portfolios: Cumulative market-adjusted returns: ESG vs Value and Quality.

Notable is also the smaller drawdowns in times of crisis periods (2008 & 2020) as well as the underperformance in times of non-crisis periods (Figure 6), aligning with the findings of Nofsinger and Varma's (2014), in that ESG companies have lower downside risk in market crises, at the expense of underperformance during non-crisis periods. Hence, investors searching for downside protection could invest using ESG Smart-Beta factors, accepting the cost of a lower expected return. This can be seen by the relationship between the expected return and the level of risk described in the CAPM model. When investing in an ESG portfolio, the level of risk is lower and therefore the expected return should also be lower.

When comparing the ESG portfolio with the Low ESG portfolio we see that the Low ESG outperforms the ESG portfolio when it comes to average annual return and total cumulative market-adjusted return for the period (Table 2; Figure 7).

Figure 7: Smart Beta Portfolios: Cumulative market-adjusted returns: ESG vs Low ESG.

This is in line with Hong and Kacperczyk (2009) result, that "sin" stocks (Low ESG) have higher expected returns compared to ESG companies, because those are less held by norm-constrained institutions and have less coverage, therefore, the institutions pay a financial cost in the form of declining higher returns when giving up on these companies. According to the volatility and downside volatility, the ESG portfolio has lower risk and the Low ESG instead has a higher risk relative to the market. In contrast to the total cumulative returns, the ESG portfolio outperforms the Low ESG portfolio when examining the risk-adjusted measures, which can be explained by the lower risk and over-performance during bad economic conditions.

6.2.3. ESG in Combined Smart Beta portfolios

Evaluating the results of using the ESG factors in combination with the financial Smart Beta factors, it becomes evident that ESG factors contribute to enhanced performance in terms of risk-adjusted returns, see Appendix C, Table 10 & 11. Evaluating the portfolio returns one can see that the best performer overall out of the 7 portfolios, is the ESG & Quality portfolio. The combined ESG & Quality portfolio has the best results in terms of average annual, cumulative and risk-adjusted returns, and it is the only portfolio that attains significant positive alpha in the Jensen's alpha test (Table 2). The statistically significant positive alpha indicates that the ESG & Quality portfolio manages to yield a higher return than what is expected by the CAPM model. It is thereby the only portfolio to indicate an ability to outperform the benchmark, in all the performance measurements. Comparing the results between the standalone Quality portfolio, and the combined ESG & Quality portfolio, one can see a significant difference. Not only does the combined portfolio yield higher average annual and total cumulative returns, but it also has lower annual volatility than the standalone portfolio (Table 2). Examining the cumulative market-adjusted returns of the ESG & Quality, one can observe the same pattern as with the ESG portfolio, that it exhibits smaller drawdowns in times of crisis (2008 & 2020) and underperforms in non-crisis periods compared to the standalone Quality factors (Figure 8). Indicating the ESG-factors ability to lower the volatility and enhancing the risk-adjusted returns. Another interesting finding is the clear negative correlation between the portfolios at the end of the sample period (beginning of Corona pandemic), where the Quality portfolio has severe drawdowns whereas the ESG & Quality portfolio exhibits positive cumulative market-adjusted returns.

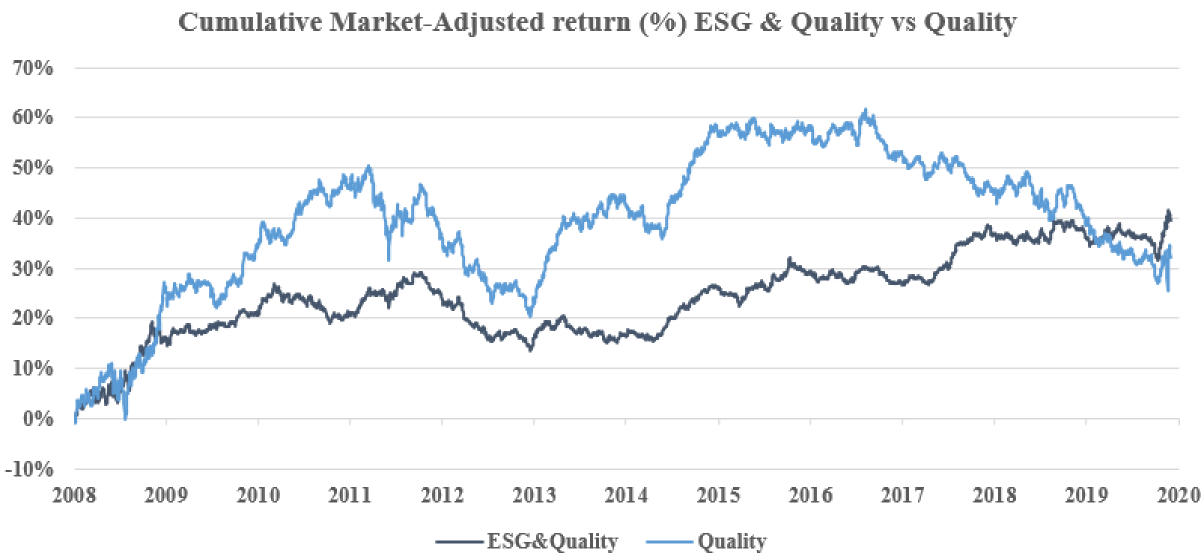


Figure 8: Smart Beta Portfolios: Cumulative Market-adjusted returns: ESG vs ESG & Quality.

The ability of the combined ESG & Quality portfolio in generating higher risk-adjusted returns highlights ESG factors strength in improving overall portfolio performance of Smart Beta portfolios when used in combination with regular financial factors.

The results from the combined ESG & Value portfolio indicate the same as of the ESG & Quality, that ESG in combination with an additional factor such as Value enhances the performance compared to the factor on a standalone basis. For instance, the Value factor has the lowest cumulative and average annual return of the seven different portfolios and underperformed compared to the benchmark index (Table 2). Whereas the combined ESG & Value portfolio managed to outperform the benchmark, for which a significant effect is seen in terms of volatility and downside volatility, as well as the change in Sharpe and Sortino ratios. The combined ESG & Value portfolio has the lowest observed volatility and downside volatility, in contrast to the standalone Value portfolio, which has the highest observed values on average, see Appendix C, Figures 7 & 8. The lowered volatility of the combined ESG & Value portfolio can be caused by a diversification effect, indicated by the lower volatility of the combined ESG & Value portfolio, compared to the ESG and Value portfolios on a standalone basis (Figure 9). Resulting in higher Sharpe and Sortino ratios, indicating higher risk-adjusted returns of the combined portfolio (Table 2).

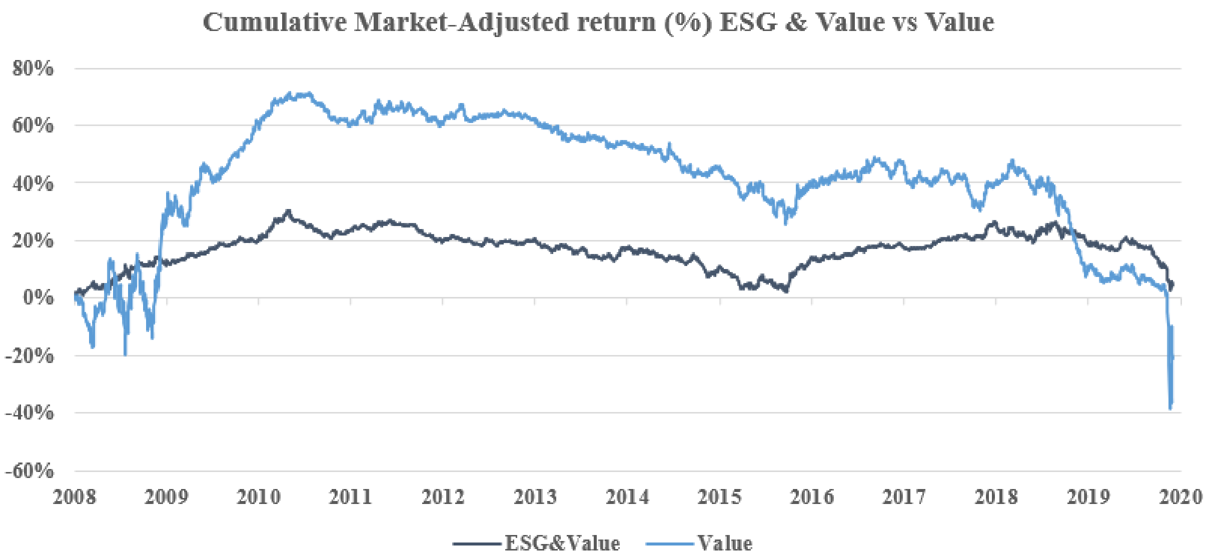


Figure 9: Smart Beta Portfolios: Cumulative Market-adjusted returns: ESG vs ESG & Value.

The Multifactor portfolio manages to outperform the benchmark in terms of average annual, and total cumulative returns, and ranks as number three due to lower performance than both the Quality and the combined ESG & Quality portfolio (Table 2). When instead, analyzing the risk-adjusted performance measures the Multifactor is the second-best performer, in terms of average Sortino and Sharpe ratios. As seen in the cumulative market-adjusted return for the ESG & Value and the ESG & Quality, the portfolios exhibit negative correlation moving in opposite directions during 2015, and at the beginning of 2020 (Figure 10). This aligns with

Kalesnik and Linnainmaa (2018), in that the correlation between factors is non-constant over time, highlighting the positive effect of diversification that Markowitz (1952) showed through the MPT. The results of the multifactor portfolio demonstrate the diversification effect of using a multifactor model when constructing Smart Beta portfolios, exhibiting higher performance in terms of risk-adjusted returns, lower volatility, and downside volatility, reducing the overall portfolio risk. Furthermore, the results from the multifactor model align with the results of Dhankar and Singh (2005), that a multifactor model, as the APT, predicts expected return better compared to a single factor model, and that securities can be mispriced. The results indicate that a multifactor model utilizing ESG factors can capture unexplained firm-specific factors that are not priced by the market, which could be one of the factors contributing to the enhanced risk-adjusted returns.

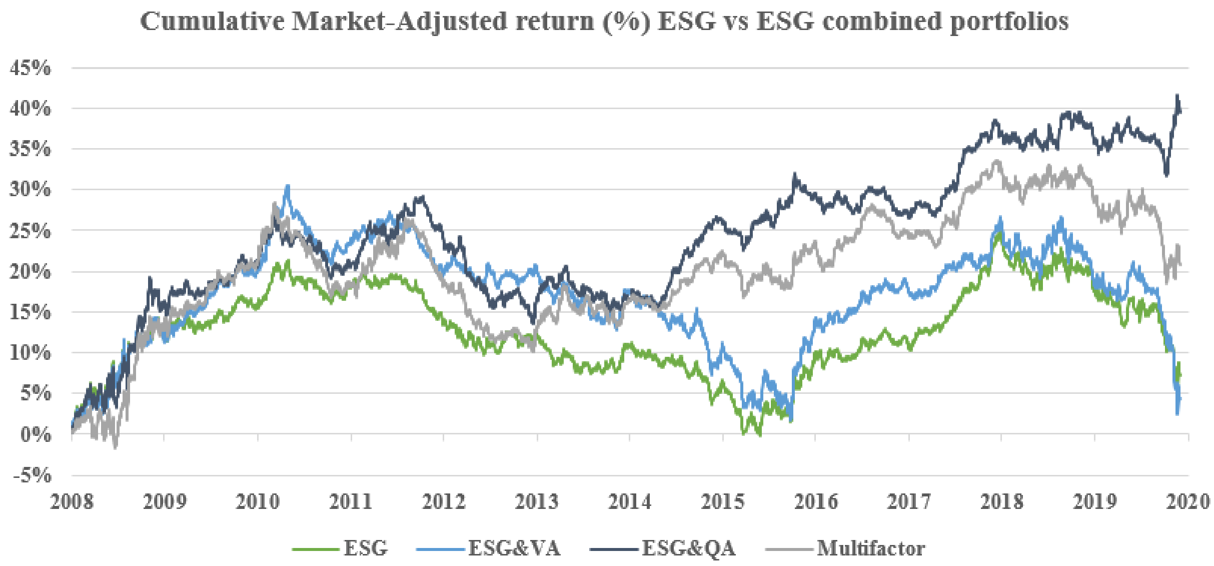


Figure 10: Smart Beta Portfolios: Cumulative Market-adjusted return: ESG vs ESG-combined portfolios.

The main takeaway looking at the overall results is that ESG factors tend to enhance the risk-adjusted returns, by lowering volatility and downside volatility, resulting in increased Sharpe and Sortino ratios. The Smart Beta portfolios using ESG components, tend to have smaller drawdowns during periods of crisis, as seen in the beginning and at the end of our timeline. Furthermore, the portfolios combining financial factors such as Quality and Value, with ESG factors outperform the portfolios using standalone financial factors, in terms of risk-adjusted returns. All the ESG portfolios managed to outperform the Russell 3000 index, however, the combined ESG & Quality portfolio was the only one with a statistically significant alpha, using the Jensen's alpha test. The results align well with the theory of Martellini and Milhau (2018) in that Smart Beta portfolios outperformed cap-weighted indices like Russell 3000, by reducing unrewarded risk and improving the Sharpe ratios. Our results indicate that Smart Beta portfolios utilizing ESG factors, improve the results even further, compared to only using financial factors in the portfolio creation process.

The results in this thesis are limited for several reasons. Due to the small amount of ESG data before 2008, the time period for this study gets rather limited. The results might therefore not fully reflect the true performance of the ESG measures, as the performance can be affected by the specific period chosen. Further limitations might be associated with common problems related to analyzing historical data, such as the survivorship bias, which might lead to skewness in the dataset. The results are also affected by the lack of adjustment for transaction costs, taxes, and other fees, which is a simplification, even though an active investment strategy such as Smart Beta is used. Another thing worth mentioning is that historical performance may not be indicative of future performance.

7. Conclusion

The past decade has been influenced by increased awareness about the environment, resulting in an increased need for companies to align with questions related to ESG. Investors' demand for ESG data has surged, but within the financial industry, ESG is used as a rather generic term. ESG investing does not come without controversy, where skeptics believe that it applies constraints to the portfolio creation process, whereas optimists believe what is beneficial for the environment does also benefit companies and society.

The purpose of this thesis was to examine if there is a cost in terms of lower risk-adjusted returns, associated with using ESG factors when implementing a factor-based Smart Beta investment approach. Furthermore, the ability to use an ESG Smart Beta strategy, to outperform a passive cap-weighted index as well as a regular Smart Beta strategy, in terms of risk-adjusted returns, was examined. To answer the research question, seven different Smart Beta portfolios were constructed, using the Russell 3000 as the investment universe and benchmark. The portfolios consisted of two pure financial portfolios, and five portfolios utilizing ESG factors, either on a standalone basis or in a mixed setting.

Out of the seven portfolios constructed, four portfolios managed to outperform the benchmark index in terms of risk-adjusted returns, and remarkably, all those four portfolios were ESG friendly. The results show strong evidence that ESG factors contribute to increased risk-adjusted returns and that there is no cost, in terms of risk-adjusted returns, associated with investing in ESG Smart Beta portfolios. Investors do not sacrifice any risk-adjusted returns, and the effects are particularly strong when ESG factors are used in combination with a regular financial factor such as Value or Quality. Furthermore, the Smart Beta portfolios using ESG components, have smaller drawdowns during periods of crisis, seen in the beginning, and at the end of the timeline of this study.

The results in this thesis indicate that it is possible to create excess returns and enhance risk-adjusted returns against a benchmark index, by using a fundamental investment strategy such as Smart Beta in combination with ESG factors. This leaves us to question the efficiency of the market, as our results contradict the EMH. However, only one out of the seven portfolios show statistically significant results, in terms of positive non-zero alpha. Thereby, it is hard to draw any strong conclusions on whether the market is efficient or not, and further research must be conducted to do so.

This study does not aim to provide direct insight into the true ESG performance of a company and evaluates the portfolio performance using existing ESG measurements. However, one can question current ESG measurements' ability to reflect true parameters of ESG friendly corporates, due to the subjective nature of how it is measured. This as companies are measured by the amount of data provided, rather than the performance of each measurement. This makes ESG data a victim to institutional bias, due to that large companies obtain higher ESG ratings, a result of stronger ESG alignment. Our results indicate an institutional bias to some degree, where the ESG portfolios possess a high correlation with the cap-weighted benchmark index representing the market. When further examining the correlations, it could be concluded that the securities in all the ESG portfolios possessed a significantly higher correlation between their factors score and market capitalization and that the ESG portfolios possessed a higher average portfolio market cap, indicating a possible bias towards larger corporates.

To expand on the research conducted in this thesis, one could use the same methodology and try combing other financial factors with the ESG factors. Alternatively, use the same type of financial portfolios Value and Quality, but change the factor specific variables. Future researchers are also encouraged to use other data sources for the ESG factors, due to the subjective nature of ESG data. One could also try tilting the variables within the factors, giving a higher weight to variables that better represent the returns of the portfolios. This study was conducted using the U.S. market, and we suggest expanding on other markets globally and compare to our results. In time, when more ESG data is available, one could analyze the ESG Smart Beta investment strategy over a longer period to see how the result differs from our result and over different business cycles. One could also test the ESG factors solely under market downturns to see if the lower downside volatility is a temporary phenomenon in this thesis, or if it lasts over time for an ESG Smart Beta portfolio.

References

Abarbanell, J. S. & Bushee, B. J., 1998. Abnormal returns to a fundamental analysis strategy. *Accounting Review*, vol.73, no.1, pp.19-45.

Altman, D. G. & Bland, J., 1995. Statistics notes: the normal distribution. *Bmj*, vol.310, pp.298.

Altman, E. I., 1968. Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *The Journal of Finance*, vol.23, no.4, pp.589-609.

Al-Tuwaijri, S. A., Christensen, T. E. & Hughes, L. K., 2004. The relations among environmental disclosure, environmental performance, and economic performance: a simultaneous equations approach. *Accounting, Organizations and Society*, vol.29, no.5-6, pp.447-471.

Amenc, N. & Goltz, F., 2013. Smart Beta 2.0. *The Journal of Index Investing*, vol.4, no.3, pp.15-23.

Arthur, L. M., Carter, C. A. & Abizadeh, F., 1988. Arbitrage pricing, capital asset pricing, and agricultural assets. *American Journal of Agricultural Economics*, vol.70, no.2, pp.359-365.

Asness, C. S., Frazzini, A. & Pedersen, L. H., 2019. Quality minus junk. *Review of Accounting Studies*, vol.24, no.1, pp.34-112.

Banz, R. W., 1981. The relationship between return and market value of common stocks. *Journal of Financial Economics*, vol.9, no.1, pp.3-18.

Basu, S., 1977. Investment performance of common stocks in relation to their price-earnings ratios: A test of the efficient market hypothesis. *The Journal of Finance*, vol.32, no.3, pp.663-682.

Black, A. J. & McMillan, D. G., 2005. Value and growth stocks and cyclical asymmetries. *Journal of Asset Management*, vol.6, no.2, pp.104-116.

Black, F., Jensen, M. C. & Scholes, M., 1972. The capital asset pricing model: Some empirical tests. *Studies in the Theory of Capital Markets*, vol.81, no.3, pp.79-121.

Bloomberg L.P, 2019. *Bloomberg Impact Report 2019: The world is changing*, London: Bloomberg L.P.

Brooke, P. G., Docherty, P., Psaros, J. & Seamer, M., 2018. Internal Governance Does Matter to Equity Returns but Much More So During "Flights to Quality". *Journal of Applied Corporate Finance*, vol.30, no.1, pp.39-52.

Cai, L., Jin, Y., Qi, Q. & Xu, X., 2018. A comprehensive study on smart beta strategies in the A-share market. *Applied Economics*, vol.50, no.55, pp.6024-6033.

Campbell, J. Y., Lettau, M., Malkiel, B. G. & Xu, Y., 2001. Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk. *The Journal of Finance*, vol.56, no.1, pp.1-43.

Carhart, M. M., 1997. On persistence in mutual fund performance. *The Journal of Finance*, vol.52, no.1, pp.57-82.

De Bondt, W. F. & Thaler, R., 1985. Does the stock market overreact?. *The Journal of Finance,* vol.40, no.3, pp.793-805.

Dhankar, R. S. & Singh, R., 2005. Arbitrage pricing theory and the capital asset pricing model-evidence from the Indian stock market. *Journal of Financial Management & Analysis*, vol.18, no.1.

Dixon, W. J., 1960. Simplified estimation from censored normal samples. *The Annals of Mathematical Statistics*, vol.31, no.2, pp.385-391.

Domian, D. L., Louton, D. A. & Mossman, C. E., 1998. The rise and fall of the "Dogs of the Dow". *Financial Services Review*, vol.7, no.3, pp.145-159.

Doyle, T., 2018. *Ratings that Don't Rate: The Subjective World of ESG Ratings Agencies,* Washington D.C: Report, American Council for Capital Formation.

DVFA, E., 2009. *KPIs for ESG: A Guide for the integration of ESG into Financial Analysis and Corporate Valuation,* Frankfurt: DVFA/EFFAS: The European Federation of Financial Analysts Societies.

Fama, E. F., 1995. Random walks in stock market prices. *Financial Analysts Journal*, vol.51, no.1, pp.75-80.

Fama, E. F., Fischer, L., Jensen, M. C. & Roll, R., 1969. The adjustment of stock prices to new information. *International Economic Review*, vol.10, no.1, pp.1-21.

Fama, E. F. & French, K. R., 1992. The cross-section of expected stock returns. *The Journal of Finance,* vol.47, no.2, pp.427-465.

Fama, E. F. & French, K. R., 1993. Common risk factors in the returns on stocks and bonds. *Journal of Financial Economics*, vol.33, pp. 3-56.

Fama, E. F. & French, K. R., 2015. A five-factor asset pricing model. *Journal of Financial Economics*, vol.116, no.1, pp.1-22.

Feldman, S. J., Soyka, P. A. & Ameer, P., 1996. Does improving a firm's environmental management system and environmental performance result in a higher stock price?. *Washington, DC:* ICF Kaiser.

George, T. J. & Hwang, C. Y., 2010. A resolution of the distress risk and leverage puzzles in the cross section of stock returns. *Journal of Financial Economics*, vol.96, no.1, pp.56-79.

Gillan, S., Hartzell, J. C., Koch, A. & Starks, L. T., 2010. Firms' environmental, social and governance (ESG) choices, performance and managerial motivation. *Unpublished working paper*.

Gompers, P., Ishii, J. & Metrick, A., 2003. Corporate governance and equity prices. *The Quarterly Journal of Economics*, vol.118, no.1, pp.107-156.

Graham, B. & Dodd, D. L., 1934. *Security Analysis*. New York: McGraw-Hill.

Hamilton, S., Jo, H. & Statman, M., 1993. Doing well while doing good? The investment performance of socially responsible mutual funds. *Financial Analysts Journal*, vol.49, no.6, pp.62-66.

Haugen, R. A. & Heins, J. A., 1972. On the evidence supporting the existence of risk premiums in the capital market. *Working Paper, unpublished*.

Hong, H. & Kacperczyk, M., 2009. The price of sin: The effects of social norms on markets. *Journal of Financial Economics*, vol.93, no.1, pp.15-36.

Kalesnik, V. & Linnainmaa, J., 2018. Ignored Risks of Factor Investing. *Research Affiliates*.

Kempf, A. & Osthoff, P., 2008. SRI funds: Nomen est omen. *Journal of Business Finance & Accounting*, vol.35, no.9-10, pp.1276-1294.

Kumar, A. N. et al., 2016. ESG factors and risk-adjusted performance: a new quantitative model. *Journal of Sustainable Finance & Investment*, vol.6, no.4, pp.292-300.

Lintner , J., 1965. The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgets. *The Review of Economics and Statistics*, vol.47, pp.13-37.

Malkiel, B. G. & Fama, E. F., 1970. Efficient capital markets: A review of theory and empirical work. *The journal of Finance*, vol.25, no.2, pp.383-417.

Markowitz, H., 1952. Portfolio Selection. *The Journal of Finance*, vol.7, pp.77-91.

Martellini, L. & Milhau, V., 2018. Smart Beta and Beyond: Maximising the Benefits of Factor Investing. *EDHEC-Risk Institute*.

Mossin, J., 1966. Equilibrium in a capital asset market. *Econometrica: Journal of the Econometric Society*, vol.66, pp.768-783.

Muller, C. & Ruttiens, A., 2013. *A practical guide to UCITS funds and their risk management.* Belgium: Edi Pro.

Nofsinger, J. & Varma, A., 2014. Socially responsible funds and market crises. *Journal of Banking & Finance*, vol.48, pp.180-193.

Novy-Marx, R., 2013. The other side of value: The gross profitability premium. *Journal of Financial Economics*, vol.108, no.1, pp.1-28.

Piotroski, J. D., 2000. Value investing: The use of historical financial statement inormation to separate winners from losers. *Journal of Accounting Researsch*, vol.38, pp.1-52.

Rosenberg, B., Reid, K. & Lanstein, R., 1985. Persuasive evidence of market inefficiency. *Journal of Portfolio Management*, vol.11, pp.9-17.

Ross, S., 1976. The arbitrage theory of capital asset pricing. *Journal of Economic Theory*, vol.13, no.3, pp.341-360.

Sharpe, W. F., 1964. CAPITAL ASSET PRICES: A Theory of Market Equilibrium under conditions of Risk. *The Journal of Finance*, vol.19, no.3, pp.425-442.

Shiller, R. J., 2003. From efficient markets theory to behavioral finance. *Journal of Economic Perspectives*, vol.17, no.1, pp.83-104.

Sorensen, E. H., Miller, K. L. & Samak, V., 1998. Allocating between Active and Passive Management. *Financial Analysts Journal*, vol.54, no.5, pp.13-31.

Stiglitz, J. E. & Grossman, S. J., 1980. On the impossibility of informationally efficient markets. *The American Economic Review*, vol.70, no.3, pp.393-408.

Treynor, J. L., 1961. Toward a theory of market value of risky assets. *Unpublished manuscript*, pp. 95-209.

Tsoutsoura, M., 2004. Corporate social responsibility and financial performance. *Working Paper Series*.

Van Duuren, E., Plantinga, A. & Scholtens, B., 2016. ESG Intergration and the Investment Management Process: Fundamental Investing Reinvented. *Journal of Business Ethics,* vol.138, no.3, pp.525-533.

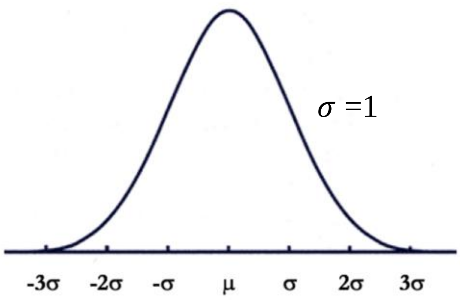
White, M., 1996. Corporate environmental performance and shareholder value. *Working paper*.

Zaher, F., 2019. *Index Fund Management: A Practical Guide to Smart Beta, Factor Investing and Risk Premia.* London: Springer Nature Switzerland AG.

Appendix A

Standardized score

To make the variables of each security comparable and to have an identical scale, a standardized score is used, for which each variable is transformed into a mean of 0 and a standard deviation of 1 (Altman & Bland, 1995). According to the large dataset used it is possible to assume that each variable of the securities following a normal distribution:



Normal distribution (the classic bell-shaped curve), where mean is 0 and standard deviation is 1.

By assuming that the variable follows a normal distribution, one can calculate the standardized score for each variable in the individual security. First, the mean and the standard deviation for all securities is calculated for the specific variable. When this is done, the following formula is used to standardize the value into a Z-score:

$$Z = \frac{X - \mu}{\sigma} \sim (0,1) \tag{20}$$

As seen in the formula, the mean, μ, of all the variables in that factor, is subtracted from the value of each specific security X, which is then divided with the standard deviation σ of all variables. This method gives a standardized number and makes it possible to compare and rank each of the securities variables with an identical scale. The procedure is done for each variable and gives the variables equal weight in the overall standardized Factor Score for security i:

$$Factor\ Score_i = \frac{1}{n}\sum_{i=1}^{n} Z_i^N \tag{21}$$

Where Z_i^N is the standardized score for variable N of security i.

The 50 best stocks are then sorted out using the total standardized Factor Score for each Smart Beta portfolio, based on the underlying variables in that specific factor. Each security then attains a weight, equal to their score relative to the total sum of scores in the portfolio.

The Winsorize method

Two well-known statistics methods are trimming and the Winsorize method. Trimming is about removing data that is not reliable and the Winzorize method is about to limit extreme values to a certain threshold (Dixon, 1960). In this thesis, the raw data is first trimmed by removing data that is clearly not reliable. Securities that miss at least 50% of the data are removed from the dataset. In the second step, the Winsorize method is used, for which the threshold is set to ± 3 standard deviations to limit the effect of extreme values by setting the outlier to the highest (lowest) value that is not considered as an outlier. The Winsorize method is done on the overall standardized scores of all the individual securities. The motivation for the method used is to ensure that the diversification effect is kept in each portfolio, without excluding securities that have a high overall standardized score and therefore have performed well based on the underlying factors.

Appendix B

Value variables

P/E ratio

The price-to-earnings ratio (P/E) is defined as the security's share price in relation to its earnings per share (EPS), calculated as follows:

$$P/E = \frac{Share\ Price}{Earnings\ per\ share} \tag{22}$$

P/B ratio

The price-to-book ratio (P/B) is defined as the security's share price relative to its book value per share and is expressed as:

$$P/B = \frac{Share\ Price}{Book\ Value\ per\ share} \tag{23}$$

P/CF ratio

The price-to-cash-flow (P/CF) is explained as the security's share price in relation to its operating cash flow per share, defined as:

$$P/CF = \frac{Share\ Price}{Operating\ cash\ flow\ per\ share} \tag{24}$$

Dividend yield

The dividend yield, expressed in percentage, is the security's yearly dividend per share in relation to its share price and is defined as follows:

$$Dividend\ yield = \frac{Dividend\ per\ share}{Share\ Price} \tag{25}$$

Quality variables

D/E ratio

The debt-to-equity ratio (D/E) is a measure of the financial leverage of the company. This is expressed as the total debt in relation to the total equity, defined as:

$$D/E = \frac{Total\ debt}{Total\ equity} \tag{26}$$

Return on assets (ROA)

Return on assets (ROA) is a measure of the profitability of a company. The ratio is the net income of the company in relation to the total assets, expressed as:

$$ROE = \frac{Net\ Income}{Total\ assets} \tag{27}$$

Return on equity (ROE)

Return on assets (ROA) is also a profitability measure, but here it is the net income of the company with respect to the total equity, defined by the following formula:

$$ROE = \frac{Net\ Income}{Total\ equity} \tag{28}$$

Asset turnover

The asset turnover ratio is a measure of the efficiency of a company where the revenue is divided by the total asset, defined as:

$$Asset\ turnover = \frac{Total\ revenue}{Total\ assets} \tag{29}$$

Appendix C

Yearly Returns (%)								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	2,11	0,85	-13,03	-13,19	-9,25	-11,89	-7,45	-25,30
2009	66,81	41,44	37,42	41,82	38,68	41,43	44,17	33,65
2010	20,96	33,29	22,95	24,06	20,82	18,29	25,80	21,04
2011	4,28	-6,43	-0,89	-0,33	6,57	3,57	-1,09	3,26
2012	21,06	7,32	18,84	21,09	12,37	14,44	15,20	20,23
2013	11,33	39,22	18,91	17,26	20,71	23,90	22,95	20,38
2014	8,25	29,40	11,42	9,52	25,13	21,53	10,25	15,67
2015	-7,43	0,21	1,84	1,47	1,82	-0,23	-5,90	-1,58
2016	24,86	13,11	19,37	22,06	15,94	19,20	25,62	18,45
2017	8,20	7,09	28,11	23,29	24,68	23,47	17,61	14,95
2018	-18,30	4,41	4,15	3,32	9,91	6,50	14,12	10,48
2019	-38,45	-12,97	-17,13	-21,22	-3,14	-14,75	-19,39	-6,55
Average	8,64	13,08	11,00	10,76	13,69	12,12	11,83	10,39

Table 4: Yearly returns and average yearly returns for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Yearly Market-Adjusted Returns (%)							
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG
2008	27,41	26,14	12,27	12,11	16,05	13,41	17,85
2009	33,15	7,79	3,77	8,17	5,03	7,78	10,52
2010	-0,08	12,25	1,91	3,01	-0,22	-2,75	4,76
2011	1,02	-9,69	-4,15	-3,59	3,31	0,31	-4,35
2012	0,83	-12,91	-1,39	0,86	-7,86	-5,79	-5,02
2013	-9,05	18,84	-1,47	-3,12	0,33	3,52	2,56
2014	-7,42	13,73	-4,25	-6,16	9,46	5,86	-5,42
2015	-5,85	1,79	3,43	3,05	3,40	1,35	-4,32
2016	6,41	-5,34	0,92	3,61	-2,51	0,75	7,17
2017	-6,75	-7,86	13,16	8,34	9,73	8,52	2,66
2018	-28,77	-6,07	-6,32	-7,16	-0,57	-3,98	3,65
2019	-31,90	-6,41	-10,58	-14,66	3,41	-8,19	-12,84
Average	-1,75	2,69	0,61	0,37	3,30	1,73	1,44

Table 5: Yearly market-adjusted returns and average yearly market-adjusted returns for the Smart Beta portfolios from 2008 to 2019.

Daily Standard Deviation of Returns (%)								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	4,93	3,08	2,63	2,65	2,65	2,77	3,58	2,83
2009	1,97	1,16	1,11	1,19	1,14	1,20	1,39	1,15
2010	1,12	1,19	1,04	0,94	0,99	0,90	1,32	1,14
2011	1,63	2,05	1,45	1,37	1,53	1,37	1,79	1,52
2012	0,72	1,02	0,89	0,79	0,89	0,85	0,90	0,82
2013	0,80	0,96	0,70	0,70	0,75	0,76	0,80	0,73
2014	0,66	0,89	0,72	0,74	0,74	0,72	0,75	0,73
2015	1,30	1,10	1,05	1,14	0,98	1,06	1,02	1,05
2016	0,94	0,88	0,59	0,64	0,64	0,69	0,87	0,64
2017	0,81	0,74	0,65	0,65	0,73	0,75	0,78	0,75
2018	0,93	1,14	0,81	0,77	0,93	0,89	0,88	0,97
2019	2,96	2,07	2,07	2,06	1,94	2,04	1,93	1,95
Average	1,56	1,36	1,14	1,14	1,16	1,17	1,33	1,19

Table 6: Daily standard deviation of the returns and average daily standard deviation of the returns for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Annualized Volatility (%)								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	78,20	48,90	41,72	42,02	42,09	43,98	56,82	44,92
2009	31,26	18,37	17,57	18,95	18,05	18,99	22,06	18,30
2010	17,77	18,86	16,56	14,97	15,70	14,21	20,94	18,09
2011	25,81	32,51	22,98	21,79	24,30	21,82	28,48	24,09
2012	11,45	16,24	14,13	12,60	14,12	13,42	14,23	12,95
2013	12,63	15,16	11,14	11,10	11,95	12,01	12,69	11,55
2014	10,43	14,19	11,42	11,79	11,72	11,35	11,96	11,66
2015	20,59	17,52	16,71	18,14	15,51	16,84	16,11	16,68
2016	14,88	13,91	9,40	10,14	10,11	10,88	13,84	10,14
2017	12,90	11,72	10,25	10,32	11,63	11,91	12,45	11,90
2018	14,83	18,02	12,88	12,30	14,83	14,18	14,02	15,41
2019	46,95	32,85	32,85	32,67	30,86	32,42	30,57	30,91
Average	24,81	21,52	18,13	18,07	18,41	18,50	21,18	18,88

Table 7: Annualized volatility of the returns and average annualized volatility of the returns for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Annualized Downside Volatility (%)								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	54,78	34,80	30,26	30,41	30,32	31,61	41,26	33,12
2009	20,26	12,82	12,14	12,93	12,50	13,06	14,98	12,78
2010	12,41	12,93	11,21	10,08	10,75	9,82	13,98	12,56
2011	18,63	23,95	17,27	16,33	17,85	16,08	20,47	17,94
2012	7,89	11,92	9,69	8,40	9,96	9,38	10,06	8,81
2013	9,32	10,21	7,97	7,92	8,31	8,48	8,78	8,24
2014	7,13	9,45	8,17	8,31	7,76	7,66	8,05	8,13
2015	14,75	13,07	12,04	13,01	11,33	12,23	11,74	12,29
2016	10,30	10,04	6,47	7,02	7,20	7,63	9,63	7,10
2017	9,53	9,12	7,62	7,58	8,78	8,98	9,23	9,30
2018	11,76	13,56	9,62	9,15	11,05	10,65	10,51	11,57
2019	35,49	24,79	24,75	25,13	22,60	24,11	23,65	23,20
Average	17,69	15,55	13,10	13,02	13,20	13,31	15,20	13,75

Table 8: Annualized downside volatility of the returns and average annualized downside volatility of the returns for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Excess Returns (%)								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	2,10	0,84	-13,04	-13,20	-9,26	-11,90	-7,46	-25,31
2009	66,80	41,44	37,42	41,82	38,68	41,43	44,17	33,65
2010	20,96	33,29	22,95	24,05	20,82	18,29	25,80	21,04
2011	4,28	-6,43	-0,89	-0,33	6,57	3,57	-1,09	3,26
2012	21,06	7,32	18,84	21,09	12,36	14,44	15,20	20,23
2013	11,33	39,22	18,91	17,26	20,71	23,90	22,95	20,38
2014	8,25	29,40	11,42	9,52	25,13	21,53	10,25	15,67
2015	-7,43	0,21	1,84	1,46	1,82	-0,23	-5,90	-1,58
2016	24,86	13,11	19,37	22,06	15,93	19,20	25,61	18,44
2017	8,19	7,07	28,10	23,28	24,66	23,46	17,60	14,94
2018	-18,32	4,38	4,13	3,29	9,88	6,47	14,10	10,45
2019	-38,47	-12,98	-17,15	-21,24	-3,16	-14,76	-19,41	-6,57
Average	8,63	13,07	10,99	10,76	13,68	12,12	11,82	10,38

Table 9: Excess returns (from risk-free) and average excess return for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Sharpe Ratio								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	0,03	0,02	-0,31	-0,31	-0,22	-0,27	-0,13	-0,56
2009	2,14	2,26	2,13	2,21	2,14	2,18	2,00	1,84
2010	1,18	1,76	1,39	1,61	1,33	1,29	1,23	1,16
2011	0,17	-0,20	-0,04	-0,02	0,27	0,16	-0,04	0,14
2012	1,84	0,45	1,33	1,67	0,88	1,08	1,07	1,56
2013	0,90	2,59	1,70	1,56	1,73	1,99	1,81	1,76
2014	0,79	2,07	1,00	0,81	2,15	1,90	0,86	1,34
2015	-0,36	0,01	0,11	0,08	0,12	-0,01	-0,37	-0,09
2016	1,67	0,94	2,06	2,18	1,58	1,76	1,85	1,82
2017	0,63	0,60	2,74	2,26	2,12	1,97	1,41	1,25
2018	-1,24	0,24	0,32	0,27	0,67	0,46	1,01	0,68
2019	-0,82	-0,40	-0,52	-0,65	-0,10	-0,46	-0,63	-0,21
Average	0,58	0,86	0,99	0,97	1,05	1,00	0,84	0,89

Table 10: Sharpe ratio and average Sharpe ratio for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Sortino Ratio								
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multifactor	Low ESG	Russell 3000
2008	0,04	0,02	-0,43	-0,43	-0,31	-0,38	-0,18	-0,76
2009	3,30	3,23	3,08	3,24	3,09	3,17	2,95	2,63
2010	1,69	2,58	2,05	2,39	1,94	1,86	1,85	1,67
2011	0,23	-0,27	-0,05	-0,02	0,37	0,22	-0,05	0,18
2012	2,67	0,61	1,94	2,51	1,24	1,54	1,51	2,30
2013	1,22	3,84	2,37	2,18	2,49	2,82	2,61	2,47
2014	1,16	3,11	1,40	1,15	3,24	2,81	1,27	1,93
2015	-0,50	0,02	0,15	0,11	0,16	-0,02	-0,50	-0,13
2016	2,41	1,31	3,00	3,14	2,21	2,52	2,66	2,60
2017	0,86	0,78	3,69	3,07	2,81	2,61	1,91	1,61
2018	-1,56	0,32	0,43	0,36	0,89	0,61	1,34	0,90
2019	-1,08	-0,52	-0,69	-0,85	-0,14	-0,61	-0,82	-0,28
Average	0,87	1,25	1,41	1,40	1,50	1,43	1,21	1,26

Table 11: Sortino ratio and average Sortino ratio for the Smart Beta portfolios and the Russell 3000 from 2008 to 2019.

Average Portfolio Market-Cap (Billion U.S. Dollar)								
Year	Value	Quality	ESG	Low-ESG	ESG&VA	QA&ESG	Multi	Russell 3000
2008	5,92	6,91	65,01	1,29	67,11	60,03	54,44	122,57
2009	5,24	3,97	35,42	0,90	36,49	39,72	41,53	87,29
2010	6,89	4,38	34,65	0,45	42,36	37,23	36,46	98,78
2011	1,92	4,34	41,80	2,57	46,58	42,41	43,12	113,97
2012	2,26	5,16	40,80	5,58	46,65	48,34	43,34	118,26
2013	1,89	5,44	54,00	5,74	48,86	56,94	55,68	132,80
2014	3,18	7,13	66,81	3,48	60,05	53,06	67,52	167,87
2015	1,72	7,94	76,50	6,35	74,57	62,09	67,01	181,70
2016	3,91	9,86	70,71	3,97	66,14	63,73	73,11	193,12
2017	2,39	14,89	69,94	3,02	66,33	61,13	70,87	196,30
2018	2,82	12,51	82,82	1,51	68,83	56,79	66,65	232,65
2019	2,88	19,29	80,84	1,77	57,47	66,69	60,86	243,20
Average	**3,42**	**8,48**	**59,94**	**3,05**	**56,79**	**54,01**	**56,72**	**157,38**

Table 12: Average market capitalization for the Smart Beta portfolios, measured in billions of U.S. Dollars.

Correlation Factor-score and Market-cap						
Year	Value	Quality	ESG	ESG&VA	ESG&QA	Multi
2008	0,02	0,07	0,50	0,38	0,39	0,36
2009	0,02	0,08	0,44	0,34	0,36	0,32
2010	0,04	0,04	0,47	0,37	0,37	0,34
2011	0,03	0,05	0,44	0,34	0,34	0,31
2012	0,05	0,05	0,41	0,33	0,33	0,32
2013	0,01	0,06	0,39	0,28	0,32	0,28
2014	0,03	0,06	0,43	0,36	0,35	0,35
2015	0,00	0,06	0,42	0,34	0,34	0,33
2016	-0,04	0,06	0,39	0,27	0,33	0,27
2017	-0,01	0,07	0,39	0,28	0,32	0,27
2018	-0,04	0,06	0,36	0,24	0,29	0,24
2019	-0,05	0,06	0,33	0,21	0,28	0,22
Average	**0,01**	**0,06**	**0,41**	**0,31**	**0,33**	**0,30**

Table 13: Average correlation between the Market Capitalization and the Factor-score for each portfolio.

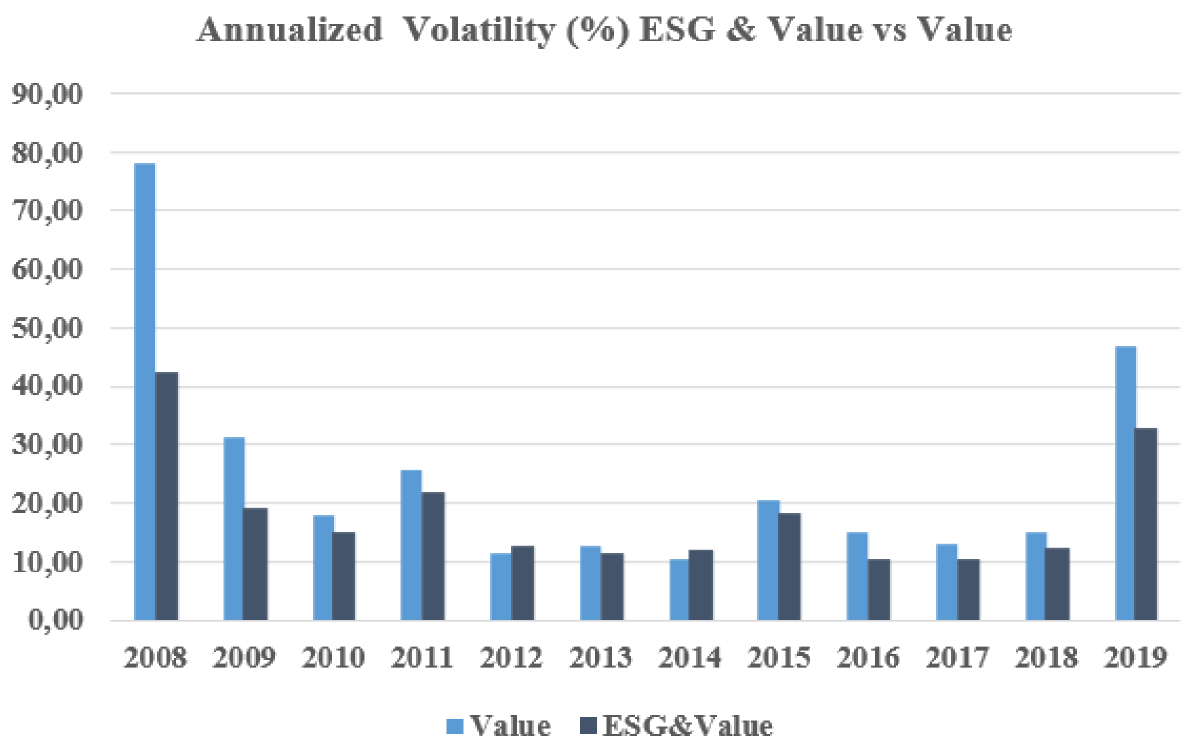


Figure 11: Annualized volatility for the Value portfolio and the ESG & Value portfolio from 2008 to 2019.

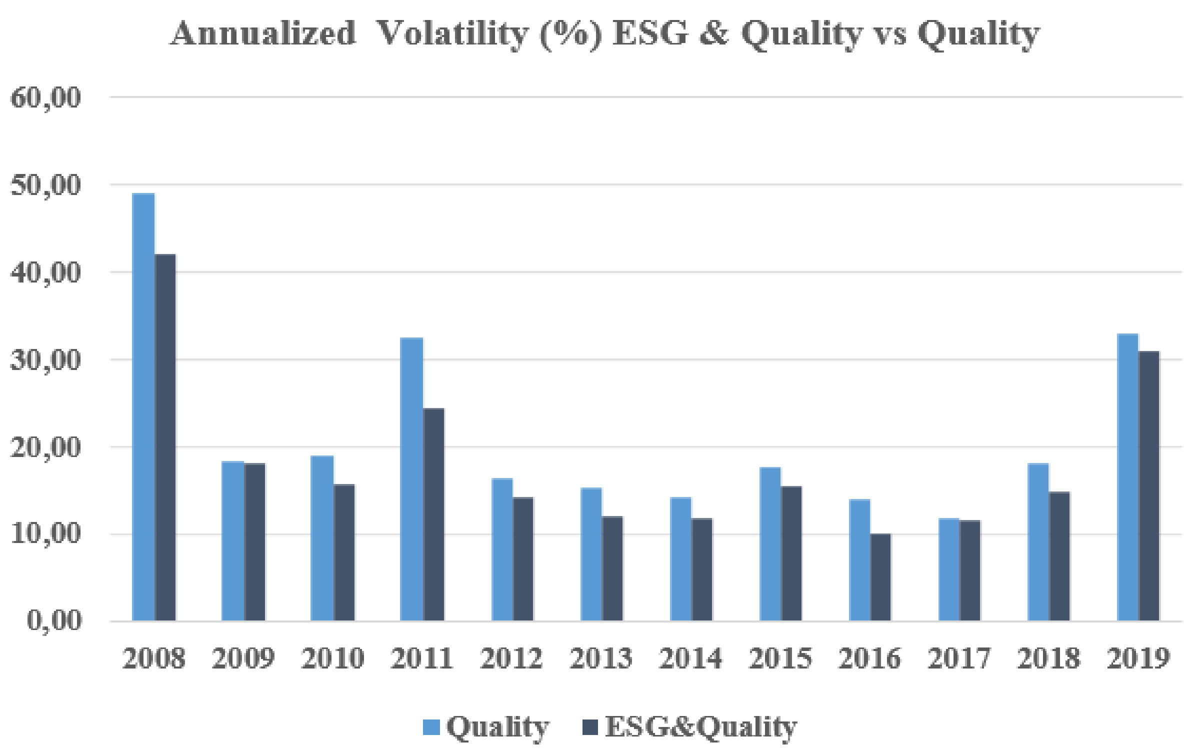


Figure 12: Annualized volatility for the ESG & Quality portfolio and the Quality portfolio from 2008 to 2019.

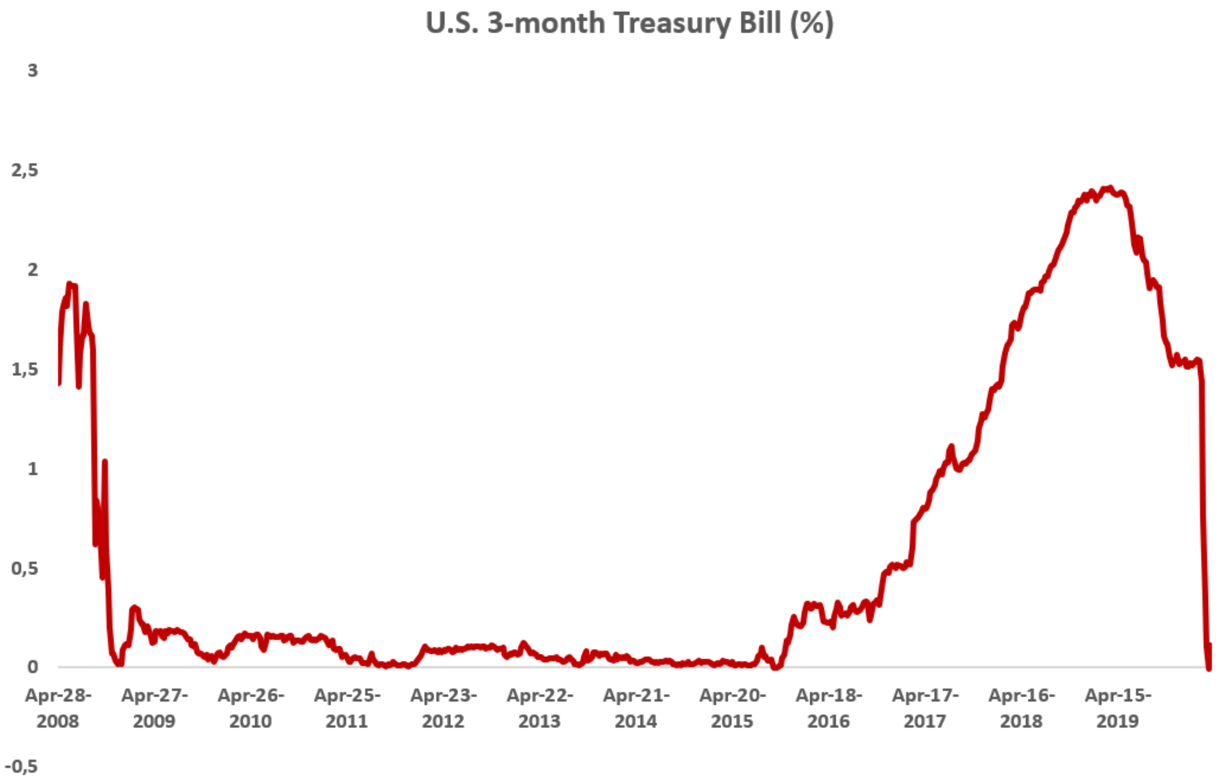


Figure 13: The U.S. 3-month Treasury Bill (referred to as the risk-free rate) from 2008 to 2019, (Source: Bloomberg L.P.)