Master Degree Project in Finance

Environmentally Responsible Investing in the Nordic Stock Market

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Abstract

The study uses positive screening technique to select equities with high environmental scores in the Nordic Stock market. Variant portfolios of the top 10 to 40 stocks were formed using different weighting schemes and their returns and risk measures compared to that of the OMX Nordic 40 Index. From 2007 to 2014, the strategy of weighting the largest 40 Nordic firms' stocks with their aggregate environmental scores earned a highly significant four-factor Carhart (1997) risk adjusted return of 8.2% per year and a raw return of 14.8% over the entire period of observation. That is, the environmentally friendly portfolio had higher return with lower risk than the benchmark index. Decarbonizing the top 40 portfolio with the same strategy achieved a statistically significant risk adjusted return of 7.9% per year and annualized return of 14.5%.

Keywords: Responsible Investing, Positive Screening, Decarbonization, Value-at-Risk, Expected Shortfall, Score-weighted Index

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1 Introduction

The recent United Nations Climate Change Conference held in Paris, has shed more light on the need for investors to reassess their investment strategies, particularly in the kind of assets they invest in. Parties at the conference agreed to consolidate their proposed carbon reduction policies with the main goal of limiting global temperature rise to below $2°C$ above pre-industrial levels with emission reduction specifically to $2°C$. The deal calls for countries to reassess their carbon reduction commitments every 5 years starting 2020 (Palmer, 2015). If the expectation of such conference is to be implemented, then certain companies which are not environmentally friendly might not be in existence in the near future. Additionally, there is an overwhelming pressure on companies to be socially and ethically responsible in terms of worker's relation, gender equality, anti-corruption, etc in their daily operations. In order to have sustainable investment, there is a need for corporations or firms to take into consideration the impact on the environment, governance as well as social responsibility with the aim of acquiring higher return. On the other hand, most firms and investors are concerned with investments which yield higher returns with lower risks and do not consider the environmental and social consequences of their actions. The implementation of the aforementioned responsible factors in investment decisions give rise to the concept of Responsible Investing.

Responsible Investing (RI) can be broadly defined as the consideration of environment, social and governance issues into investment decisions with the primary purpose of delivering higher risk-adjusted financial returns (Rieneke and Moon, 2012). The market for Responsible Investing has been growing rapidly worldwide. According to the Global Sustainable Investment Association Review report (2014), RI has grown in both absolute and relative terms, rising from $13.3 trillion at the outset of 2012 to $21.4 trillion at the start of 2014, and from 21.5 percent to 30.2 percent

of the professionally managed assets in the regions covered. This growth can be attributed partly to the ever increasing awareness of climate change which is deemed as the most significant environmental issue facing the global economy. As a result there is a high demand on the part of investors to invest in environmentally driven businesses (SIF, 2007).

The study uses screening strategy to incorporate environmental considerations into investment decisions. The screening strategy involves either selecting only firms that perform well on a specific standard of responsible investing issues or eliminating firms which do not comply with certain standards from the investable universe. The screening strategy consists of positive, best-in-class and negative approaches. In the positive screening approach, equities with the best metric ratings are selected. Selecting the best equities in terms of ratings in each industry is what is referred to as the best- in-class approach. The negative screening involves eliminating or excluding all firms belonging to controversial business areas or those which do not comply with the set standard upon which the ratings are conducted (Rieneke and Moon, 2012; Kempf and Osthof, 2007).

Studies on Responsible Investing have been carried out on individual as well as multiple countries. However, few are centered on regions. It is in view of this that the study focuses on the Nordic region. The Nordic countries comprise Sweden, Denmark, Norway, Finland and Iceland. The region is one of the leaders in the field of responsible investing where green investing is an important component. For instance, Sweden topped the RobescoSAM Country Sustainability Ranking which ranks 60 countries based on 17 environmental, social and governance indicators in 2015. Joined in the top 10 ranking list are fellow Scandinavian countries, Norway and Denmark[1]. It is therefore of interest to study the performance and risk measures

[1]Source: `http://www.robecosam.com/images/Country-Sustainability-Paper-en.pdf`

of a portfolio of stocks of firms in this region whose activities are characterised as environmentally friendly.

Being environmentally friendly in their investments implies that investors allocate a proportion of their assets or all their assets to green products. Green investment in this context refers to an investment overlay involving the integration of environmental issues in the general investment approach (Inderst, et al, 2012). Such investments focus on reducing waste, and emissions, using alternate energy source and producing natural products. The motivation for green investments are varied depending on the kind of firm or investment strategy. For institutional investors, green investment provides an alternative source for managing risks as well as maximize their returns. Others also go into green investment to enhance the firms' reputation by avoiding fines and liabilities (Covin and Miles, 2000; Klassen and MacLaughlin, 1996).

The research uses the positive screening technique to select equities which are not specifically involved in absolute green products in the Nordic Stock market but have high environmental scores. Such equities are deemed to be environmentally friendly since they were screened with various corporate environmental metrics. Variant portfolios of the top 10 to 40 stocks were formed using different weighting schemes and their performance and risk measures compared to that of the OMX Nordic 40 Index. From 2007 to 2014, the strategy of weighting the top 40 stocks with their composite environmental scores earned a highly significant four-factor Carhart (1997) risk adjusted return of 8.2% per year and a raw return of 14.8% over the entire period of observation. The top 40 Decarbonized portfolio also achieved a highly statistically significant risk adjusted return of 7.9% per year and annualized raw return of 14.5%. The portfolios also recorded lower risk measures in comparison to the OMX Nordic 40 Index.

In order to get another perspective of environmental friendliness in the Nordic region,

checks were done by selecting environmentally friendly equity mutual funds with geographical investment focus on the region. These funds are also available for sale in the region. Analyzing the return characteristics and performance gave similar results as in the case of our constructed stock portfolios.

The thesis seeks to provide answers to the following questions;
What return can be achieved by environmentally friendly investment in equities which are not specifically involved in absolute green products? Do the risk measures of portfolios of such stocks differ remarkably from those which are not?
The work differs from previous studies in several ways. The study is carried out in a region which has strong environmental values but has received less research on the issue of environmentally responsible investing. Research on portfolio decarbonization, waste generation and energy consumption of traded stocks is carried out for the first time in the Nordic stock market using the positive screening approach.

The study is organised as follows; the next chapter gives an overview of related literature on the performance of environmentally friendly indexes. Chapter 3 discusses the source of data, portfolio formation, the different weighting schemes employed, some selected environmentally friendly mutual funds and theoretical views on risk and performance measurement. Chapter 4 presents the results and findings. The final chapter gives the conclusion of the study.

2 Literature Review

The increasing demand by financiers of institutional investors such as pension funds to disclose the funds' degree of involvement in social, ethical and particularly environmental issues calls for studies in the RI industry. The 2015 proxy preview report shows that, there was an increase in the number of resolutions demanding more on carbon accounting and related risk management from the previous 66 proposals in 2014 to 76 in 2015[2]. This brings to the fore the importance investors attach to environmental issues. Apart from the above reason, the current low interest rate environment and weak economic growth prospects in the OECD countries is garnishing support for investments which can deliver steady income streams with low correlations to the returns of other investments. According to Kaminker and Stewart (2012), this can be achieved by investing either in clean energy projects or in green stocks.

Among the numerous studies carried out on environmentally responsible investing, Ito et al (2013) define three broad categories; (i) the performance of environmentally responsible indexes against stock market indexes where stocks in the former are selected using environmental screens, (ii) event studies which examine the impact of environmentally troubled firms' market valuation following news of the event, and (iii) studies comparing the performance of environmentally responsible funds with that of the conventional funds. Concerns have been raised against studies involving the last two categories. King and Lenox (2001) point out that event studies occur within a narrow time frame which enables the control of unobserved important differences among firms, however, the deficiency in its use is that the effects of the events are partially environmental in nature. Kempf and Osthof (2007) argue

[2]Source: The Proxy Preview is a nonprofit organization that promotes corporate responsibility. `http://www.asyousow.org/wp-content/uploads/2015/03/release-record-number-of-/social-and-environmental-shareholder-resolutions-filed-in-2015.pdf`

against the third category saying that, the performance of mutual funds depends to a large extent on managerial skills or the timing activities of the fund management but not the inclusion of environmentally responsible firms. Therefore, the current thesis concentrates on the performance of environmentally friendly indexes against a reference benchmark which falls under the first category.

Studies on environmentally responsible investing have been carried out on individual countries and on multiple countries (regional and continental levels) which have resulted in mixed findings. Some studies find that environmentally friendly funds and indexes underperform the conventional indexes or funds. Climent and Soriano (2011) for example used a CAPM-based methodology to analyse the performance of green mutual funds and concluded that in the 1987-2009 period, environmental funds achieved lower performance than conventional funds.

Others find no significant difference between environmental funds and their benchmarks. Climent and Soriano (2011) also noted that analyzing more recent period, green funds earned adjusted returns not significantly different from conventional funds. Ito et al (2013) analysed environmentally friendly funds in the US, EU and Japan applying a dynamic mean-variance model using the shortage function of Briec and Kerstens (2009) and concluded that environmentally friendly funds performed in manners equal or superior to conventional funds.

The last stream of studies find a significant difference between environmentally friendly indexes or funds and conventional funds. Klaussen and McLaughlin (1996) measured significant positive returns for strong environmental management as indicated by environmental performance awards. Cohen et al (1995) used an objective set of data detailing the environmental performance of the S&P 500 companies to construct two industry-balanced portfolios of firms, high polluter and low polluter portfolios. They found a positive return to green investing. A paper by White

(1996) examined the link between corporate environmental responsibility measured by environmental reputation indices and shareholder wealth. Using the CEP ratings of environmental performance, he found a significantly higher risk-adjusted return for a portfolio of green firms than either the overall market or portfolios composed of less environmentally-responsible firms. Guenster et al (2005) used eco-efficiency[3] scores to examine the relationship between corporate eco-efficiency and financial performance and found that virtues of a strong corporate eco-efficiency policy can be significant from a financial perspective. Cai & He (2014) screened green firms using data from 1992-2011. They came to the conclusion that an equally-weighted green portfolio exhibited significant risk-adjusted returns and outperformed the benchmark in the 4th to 7th year after screening. Another paper by Cai et al (2015) looks at corporate environmental responsibility and risk in U.S. public firms. Using econometric methods, principal component and measures of CAPM beta, Fama and French market beta, they empirically find that firm risk is significantly and negatively associated with corporate environmental responsibility engagement for all industries after controlling for firm characteristics. Their study shows that environmental initiatives are mostly linked to lower levels of firm risk for a company.

Finally, a recent paper by Andersson et al (2015) presents a strategy for hedging climate risk without sacrificing financial returns. They showed how AP4, the Fourth Swedish National Pension Fund hedged its carbon exposure on its US equity holdings in the S&P 500 index which has outperformed the index by about 24 basis points annually. They follow a decarbonization methodology similar to the one used in this thesis by screening firms based on their carbon footprint, which is the annualized greenhouse (GHG) emissions normalized by the firms' revenues or sales.

[3]Guenster et al (2005) define eco-efficiency as the ability to create more value using fewer environmental resources such as water, air , oil, coal and other limited natural endowments.

3 Data and Methodology

This section discusses the source of data, the methodology used in deriving the rankings as well as how the portfolios were formed. The section will emphasize the different weighting schemes used and also present an overview of some selected environmental mutual funds within the Nordic region. Furthermore, the section will provide theoretical insight on risk and performance measurements used to assess the portfolios of stocks.

The primary source of data is Bloomberg. The terminal has an ESG function where several environmental, social and governance data for firms have been captured. As far as the environmental metrics are concerned, the captured data provide information on Certification, Damages, Emission, Resource Consumption, Waste Management, Audit/Verification, Industry Specific Issues (Efforts to help improve the environment) and many other metrics. In this study we use a positive screening approach that takes into account firms' efforts to preserve the environment. As such, the metrics to be used must reward the individual companies for their contributions. To achieve this, the above environmental metrics were analysed to see which of them are common across industries. Four of them came up on top and data was sampled from those metrics which include; Emission, Waste Management, Resource Consumption and Industry Specific Issues.

Table 1 provides the environmental metrics used, and the description of each metric. The environmental metrics are classified into two main categories; qualitative and quantitative metrics. The qualitative metrics are dichotomous questions which consider firms' policies and initiatives put in place to reduce harmful environmental effects in their operations. These comprise environmental metrics 3, 5 and 7 given in the Table.

Environmental Metric	Description of Metric
1. Total GHG CO_2 Emission Intensity per sales **Category : Emission**	Ratio of Total greenhouse gas if available, else total carbon dioxide intensity calculated as metric tonnes of greenhouse gases, if available, else CO_2 emitted to sales revenue in the company's reporting currency[4].
2. GHG Intensity per EBITDA **Category : Emission**	Similar to criteria 1 but in terms of GHG and EBITDA.
3. Emission reduction initiative **Category : Emission**	Indicates whether the company has implemented any initiative to reduce its environmental emissions to air
4. Waste generated per sales **Category : Waste Management**	This refers to waste generated per sales calculated as metric tons of waste, both hazardous and non-hazardous, per million of sales revenue in the company's reporting currency.
5. Waste reduction policy **Category : Waste Management**	Indicates whether the company has implemented any initiative to reduce the waste generated during the course of its operations.
6. Energy Intensity per sales **Category : Resource Consumption**	This is calculated as megawatt hours of energy consumed per million of sales revenue in the company's reporting currency.
7. Environmental Quality Management Policy **Category : Industry Specific**	Indicates whether the company has introduced any kind of environmental quality and or environmental management system to help reduce the environmental footprint of its operation

Table 1

The quantitative metrics are the environmental effects produced by companies normalized by their sales (revenues) or EBITDA (earnings before interest, tax, depreciation and amortization). Environmental metrics 1, 2, 4 and 6 are the quantitative metrics. According to the National Academy of Engineering and National Research Council (1999), these selected qualitative and quantitative metrics provide vital information on firms' operations and management to corporate managers and also to external stakeholders such as investors (those who are environmentally conscious), customers, regulators and environmental groups.

3.1 Analysing the Quantitative Metrics

Environmental friendliness of a firm is considered to be a broad category. Therefore, there is the need to analyse the metrics separately and find out if environmental friendliness is sensitive to the metrics used. Moreover, the findings from these quantitative models will highlight which aspects of the environment in the Nordic stock market are worth investing in. We consider the quantitative categories of the metrics and analyse them separately by assigning 100% weight to each metric. Scoring models for the various metrics were set up in Bloomberg terminal to screen and rank the stocks[5]. For a particular firm to be ranked highly or to receive higher rank score, the quantitative ratio must be as low as possible. Thus lower quantitative ratio is deemed better in the scoring model.

The firms were screened[6] based on these selected metrics (factors) for calendar years starting from 2007 until the end of 2014. The coverage area of the screening consists

[4]In order to compare different firms from different countries, the sales/revenues for each firm were converted to the US dollar for all computations

[5] Scoring model for environmental metric 1 is referred to as Decarbonized score, that of 4 is the Waste generation score and 6 is the Energy consumption score.

[6] Screening was carried out in Bloomberg Terminal using the Equity screening engine **EQS**.

of stocks traded in all the five Nordic countries mostly the OMX Indexes[7] in each country, except Norway, where screening was done on the OBX Stock Index. The initial number of screened stocks based on the specified metrics included multiplicity of companies in and across countries. Having cleaned the data of multiplicity, the total number of stocks which featured in our rankings ranged between 100 and 145 depending on the quantitative metric used [8].

3.2 Environmental Score Metrics

With the idea generated from the subsidiary quantitative metrics, we form a composite ranking involving both the qualitative and quantitative metrics by assigning different weights to each metric given in Table 1. The metric obtained from the aggregate score of all the subordinate metrics is referred to as the Environmental Score metrics.

We set up a similar scoring model as previously in Bloomberg terminal to screen and rank the stocks from 2007 to 2014 calendar years. The coverage area of the screening remains the same as in section 3.1.

Research in this area requires current and precise data, hence companies which fail to provide data on any of the assigned metrics are penalized for doing so. They simply get a rank value of zero for the metrics with missing data. Respective portfolios of the top 10 to 40 stocks were formed. We set the maximum composition to 40 so as to make it comparable to the benchmark OMX Nordic 40 Index.

[7] OMX Copenhagen Index from Denmark, OMX Helsinki Index from Finland, OMX Iceland 6 PI Index from Iceland, and OMX Stockholm All-Share Index from Sweden.

[8] In Bloomberg Terminal, if we screen for stocks domiciled only in the Nordic countries, some companies which trade on the selected indexes are excluded, hence we chose all companies which operate in these countries instead. Screens based on companies domiciled in the Nordic region excludes companies like AstraZeneca and ABB.

3.3 Portfolio Formation

We follow Kempf and Osthof (2007) in using the positive screening approach[9]. We used the day to day gross returns of all the stocks which are featured in our rankings from 2008 to 2015. At the end of year $t-1$, we rank all stocks with our environmental metrics. Ranking is done at the end of the year before the portfolio is formed since it is assumed that companies would provide data in their financial statements and reports by the end of each year, latest December. This gives time for the information to be factored into the stock price. A portfolio is formed based on the ranking at the beginning of year t and we hold the portfolio unchanged until the end of year t. The top 10 to 40 stocks with the highest rank scores were selected to form a portfolio by recording their respective daily returns for year t. These stocks are assumed to have the highest contribution to reducing emissions, waste generation and resource (energy) consumption, with their revenues being environmentally friendly or simply climate-change related in year t. A new ranking is constructed for the following year and the portfolio is restructured since we expect to see some slight changes in the composition. The procedure is repeated until the end of 2015. Putting together the various returns, we get a time-series of returns for the entire portfolio over the given period[10]. For instance, our ranking for 2007 is used to form the portfolio for 2008 by using January to December 2008 returns. This is repeated for subsequent years until we get to 2015. The constructed portfolios do not take into account transaction costs associated with actual set up.

[9]According to Kempf and Osthof (2007), the positive screening policy does not lead to an exclusion of all companies belonging to controversial business areas, but rates all companies based on a set of criteria (such as community, diversity, employee relations, environment, human rights, and product). Investors then choose from the companies with the highest ratings.

[10]Where a company has a subsidiary in the same country, the one with the highest turnover is selected in the rankings, moreover if a company has a subsidiary in one or more countries, the parent firm is the one to be used.

3.3.1 The Weighting Schemes

This subsection highlights the different weighting schemes applied to the portfolios in order to make them comparable to the benchmark index. The weighting schemes we consider in the thesis include the Market capitalization (Cap) weighted index, the Equally-weighted index and the Score-weighted index.

OMX Nordic 40 Index

The OMX Nordic 40 Index is the benchmark for our study. It consists of the 40 largest and most actively traded stocks on the NASDAQ Nordic Exchange and is a market capitalization weighted price index. The Index was set up to track equities from all the Nordic countries except Norway. A careful analysis of the constituents reveals no equity from Iceland. The composition is revised twice a year [11].

Market Capitalization Weighted Index

To make our portfolios comparable to other standardized indexes in the Nordic region, we weigh the constituent firms by their market capitalization (market cap). The market cap is calculated by multiplying the number of shares outstanding by their prevailing price per share[12]. The weight of each stock in the constructed index is given by $w_i = \frac{\text{Market } Cap_i}{\text{Total Market Cap}}$.

Equally-Weighted Index

The portfolios under this index weigh each stock equally regardless of their market

[11] Source: (`$https://indexes.nasdaqomx.com/docs/Methodology_NORDIC.pdf$`)

[12] We use the calender year market capitalization for each company for the entire period. Thus we sample from Bloomberg terminal, the market cap for the years 2008 up to 2015 the same period when returns of stocks were selected.

capitalization. We do not re-balance the constructed portfolio constantly because the composition of the stocks, based on the ranking is done once a year and is expected to remain constant unless a ranked firm goes bankrupt. When this happens, the firm which is next in line replaces the bankrupted firm. The index is highly diversified with all the stocks in our investable universe having the same weight[13]. Moreover, this weighting scheme aids in determining the significant contribution a firm makes towards reducing environmental hazards during their investment operations.

Score-Weighted Index

The previous two approaches can lead to investing in small firms. This might be a problem since investing in small firms bears several limitations, such as low trading liquidity resulting in higher transaction cost. Moreover, it is difficult to secure financing for smaller firms. Therefore in another approach, we take only the large firms and let environmental-friendliness determine the weights in what is referred to as the Score- weighted strategy. The strategy is consistent with some well-known green indexes. For instance, WilderHill Clean Energy Index (ECO) weighs constituent firms based on their rankings in the clean tech industry[14]. In this strategy, all the stocks in the Nordic region are ranked in terms of their calendar year market capitalization with the same time period as before. Using the daily returns, portfolios are constructed in the same manner as in section 3.3 by selecting the top 10 to 40 largest stocks. The portfolios are then weighted with their corresponding environmental and quantitative rank scores[15]. This results in four variant portfolios; top 10 to 40 portfolios weighted by their environmental scores and the top 10

[13]Source: `http://valueweightedindex.com/IndexComparison/EquallyWeighted/`
[14]Source: Andersson et al, (2014)
[15]The score here represents the numerical value of the rankings.

to 40 portfolios weighted by their decarbonized, Waste generation and Energy consumption scores[16]. A company which appears in the market capitalization rankings but fails to record a score in the environmental or quantitative metric rankings gets zero weighting. In this way, a firm's score determines the weight implying a low environmental or quantitative ranking results in less investment. The design also punishes polluting companies by weighting them less and justifies our choice of positive screening. This is because the largest proportion of the environmental score rankings are attributed to GHG emissions [17].

Suppose w_k are stock weights of each of the three variant quantitative market capitalization portfolios and w_j are the overall metric portfolios, then $w_k = \frac{\text{Quantitative Score}_k}{\text{Total Quantitative Scores}}$ and $w_j = \frac{\text{Environmental Score}_j}{\text{Total Environmental Scores}}$. We then compare their risk and performance measures to the benchmark under this and the other previous weighting schemes.

3.3.2 Decarbonized Portfolios

We form a ranking which considers only the Total Greenhouse gas or Carbon dioxide emission intensity normalized by sales or revenue of a company. According to the Carbon Disclosure Project (CDP), decarbonization is the process through which investors reduce portfolio exposure to GHG-emissions and align their portfolios with the climate economy of the future. We employ the positive screening approach to create market cap, equally and score weighted portfolios for all the stocks in our rankings. The mechanism and the period of estimation are the same as discussed in section 3.3. The portfolio is constructed based only on the first environmental metric in Table 1 by assigning 100% weight to that factor for scoring and ranking.

[16]The author considers three out of the four quantitative metrics since the second metric in Table 1 is similar to the decarbonized score or rankings.

[17] The reader is referred to subsection 3.3.4 for the overall weights assigned to each category and metric

If a firm obtains a lower ratio, it is an indication that the firm contributes a small proportion of GHG CO_2 emissions to the environment and as such, this firm will be ranked higher. However, any company which fails to provide data on its Total GHG CO_2 emission Intensity per sales revenue obtains a numeric value of zero as the the score for the ranking (self-exclusion). The top 10 to 40 stocks in the rankings are selected to form the Decarbonized (Dec) portfolio. This portfolio considers carbon emission to the environment and can be equated to the carbon footprint. In all, the total number of stocks used in this ranking was 145.

3.3.3 Waste Generation and Energy Consumption Portfolios

The Waste Generation portfolio is the portfolio formed based on metric 4 from Table 1 which is defined as the firms' generated hazardous and non-hazardous waste normalized by sales revenue. The lower the ratio, the higher the rank. If a firm ranks high, it suggests that the firm produces less environmental waste in its production and manufacturing activities. As highlighted earlier, refusal to submit data on the firm's waste implies self exclusion from the rankings. The total number of stocks which featured in this ranking is 100 for the entire period of studies. We follow the same procedures shown in section 3.3 as well as the positive screening technique to replicate market cap, equally and score weighted portfolios for the stocks.

For the Energy Consumption portfolio, we screen and rank stocks in relation to metric 6 from Table 1. This portfolio ensures that firms manage energy consumption efficiently in their production lines. A firm using less energy to produce goods and having higher sales revenue will have a lower ratio. Hence, such a firm will rank higher. The total number of stocks in the region which are featured in our rankings is 134. We go through the same formalities as before to construct market cap, equally and score weighted portfolios of different sizes as in section 3.3.

3.3.4 Environmental Score Portfolios

The portfolio generated based on a firms' score in a ranking where all the environmental metrics in Table 2 were used with the given weights is referred to as the Environmental Score (ES) portfolio. The portfolio is the final output of the aggregate scores of both the quantitative and qualitative metrics. The choice of weights assigned is subject to the investors' risk preference. However, with the incessant pressure on firms to reduce their emission impact on the environment, a larger proportion of the weight of the composite portfolio was assigned to emission related issues. Therefore, emission related data is ranked the topmost agenda and given an overall weight of 60%, 20% to Waste Management, 15% to Resource Consumption and 5% to Industry Specific Issues. Moreover, the three qualitative metrics accounted for 15% of the overall weight with the remaining 85% being quantitative. Using stocks with the highest ES, We construct portfolios with the top 10, 20, 30 and 40 stocks respectively according to the market cap, equally and score weighted schemes.

A notable observation is that the investable universe increased over time. As awareness of climate change increased, companies began to join the train and incorporated environmental issues into their operations. For instance, in 2007, there were about 101 stocks providing data for at least one of the set environmental metrics. This number increased over the years to 170 in 2014 and 176 in 2015. Taking into consideration some companies which might have not been in existence till 2015, the final investable universe for the portfolio contained 179 stocks. This represents the largest stocks in comparison to the number of stocks used in each of the subsidiary quantitative metric portfolios and these stocks are representative of all sectors[18] in the Nordic region.

[18] The sectors are categorized according to the Industry Classification Benchmark (ICB).

Environmental Metric	**Weight**
1. Total GHG CO_2 Emission Intensity per sales **Category : Emission**	50%
2. GHG Intensity per EBITDA **Category : Emission**	5%
3. Emission reduction initiative **Category : Emission**	5%
4. Waste generated per sales **Category : Waste Management**	15%
5. Waste reduction policy **Category : Waste Management**	5%
6. Energy Intensity per sales **Category : Resource Consumption**	15%
7. Environmental Quality Management Policy **Category : Industry Specific**	5%

Table 2

3.4 Mutual Funds

To have a different perspective of environmental friendliness in the Nordic region, we sampled open ended environmentally friendly mutual funds with asset class focusing on equity. We consider funds domiciled in western Europe but available for sale in the Nordic region. Moreover we look at funds that invest their assets in equities located in the Nordic region and whose daily return series match the time period used for our constructed stock portfolios. With these characteristics, we relied on Bloomberg fund search engine **FSRC**, to screen environmentally friendly funds in the region and four of such funds were found. These comprised SEB Ostersjofond/WWF, Delphi Nordic Fund, DNB Norden and DNB Norden III labelled as fund 1, 2, 3 and 4 respectively.

Although arguments have been raised against the choice of comparing mutual funds

performance to an index by Kempf and Osthof (2007), the highlighted problem is catered for in this thesis by choosing the day to day gross returns of equity mutual funds whose performance can not be influenced by managerial skills with the same time frame as our stock portfolios. Since these funds invest almost 100% in equities in the region, we expect their holdings to have parallel compositions as our portfolios. In this way, we are able to observe the performance of our constructed portfolios with that of the funds and compare them to the benchmark index.

3.5 Risk and Performance measurement

We use several risk measures to assess the different portfolios constructed and the screened funds. Amongst them are the Sharpe ratio, Value at Risk (VaR), and the Expected Shortfall (ESh). Performance of the different portfolios and funds will also be assessed using the Cahart (1997) four-factor Model.

The Sharpe ratio is the average return in excess of the risk-free rate per unit of portfolio volatility. Mathematically, it is given by

$$S = \frac{\bar{r_p} - r_f}{\sigma_p}$$

where $\bar{r_p}$ = portfolio expected return
r_f = risk free rate
σ_p = portfolio standard deviation

VaR is used by investors and asset managers to capture the downside risk of their portfolios. It is the quantile of the loss distribution of portfolio returns for a given confidence level and a specified time interval. More specifically, VaR at a confidence level α and a loss distribution (L) is the smallest number y such that the probability

that the loss exceeds y is not larger than $1-\alpha$. That is

$$VaR_\alpha(L) = inf\{y \in \mathbb{R} : F_L(y) \geq \alpha\}$$

where $F_L(y)$ is the cumulative distribution function of (L). The time horizon we use for this study is one day and $\alpha = 0.95$.

We also use the Expected Shortfall (ESh) which gives the expected loss when things get bad. For a given confidence level of $\alpha \in (0,1)$, the expected shortfall is defined as

$$ESh_\alpha(L) = E[L \mid L \geq VaR_\alpha(L)]$$

The values of both VaR and the expected shortfall in this thesis are calculated using the empirical method. The method finds the quantile of the negative returns without necessarily making any assumption on the return distribution. The quantile used in the thesis is the 95th percentile ($\alpha = 0.95$).

The Carhart (1997) model is one of the most important benchmarks in asset pricing. It introduces an extra factor loading to the Fama-French (1993) model. The model captures the impact of the sensitivity of the market, the size factor, the value factor and the momentum effect on returns. It is given by running a regression on the following equation

$$R^e_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{iSMB}SMB_t + \beta_{iHML}HML_t + \beta_{iWML}WML_t + u_{it}$$

The dependent variable R^e_{it} is the monthly return[19] of portfolio i in month t in excess of the risk free rate. The independent variables are the returns of the European

[19] Daily returns were converted to monthly returns in order to use the model.

factors and these factors including the risk free rate were obtained from the Kenneth R. French data library. The market portfolio R_{Mt} is the return of the OMX Nordic 40 Index. The risk-free rate is the US one month T-bill rate. $R_{Mt} - R_{ft}$ is the excess return of the market portfolio over the risk free rate. SMB_t represents the return difference between small and big stocks in month t. Similarly, HML_t is the return difference between high and a low book-to-market portfolios in month t. A stock is said to be a growth stock if it has a low book-to-market ratio and similarly a value stock is the one with a high book-to-market ratio (Kempf and Osthof, 2007). WML_t is the momentum factor and it denotes the return on a strategy that buys winner stocks and sells loser stocks where winner (loser) stocks are those that had the highest (lowest) return over the last twelve months. Finally, α_i denotes the risk adjusted return or the abnormal return of portfolio i.

4 Results

The section provides results and analysis of the performance of the various portfolios under the three weighting schemes. Further, detailed analysis of the results of the environmentally friendly mutual funds are provided. We also discuss if the obtained results are dependent on stocks from a particular or oil rich country such as Norway.

4.1 Cap-weighted Index

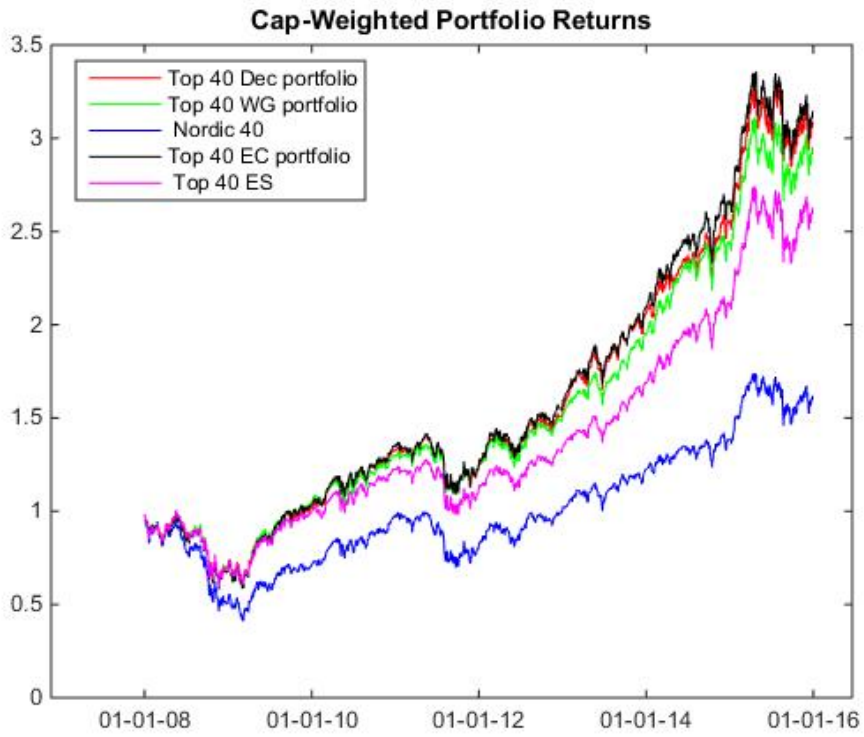

Figure 1: Top 40 Portfolios against the benchmark over the entire period

Figure 1 shows the evolution of returns over the entire period. The blue line represents the OMX Nordic 40 Index, the red line is the top 40 Dec portfolio, the black

line represents the top 40 EC portfolio, the top 40 WG portfolio is illustrated by the green line with the magenta line representing the top 40 ES portfolio. All the portfolios recorded their lowest returns between 2008 and 2010 due to the financial crisis, and their highest returns in 2015. At the start, all portfolios virtually moved along the same trajectory until the latter part of 2009, where the subsidiary portfolios as well as the ES portfolio started to earn higher returns than the Index. From hindsight, it can be noted that both the top 40 Dec and EC portfolios delivered the highest return, followed by the top 40 WG and ES portfolios respectively. The OMX Nordic 40 Index on the other hand achieved the lowest return over the entire sample period. However, to properly assess the performance of these portfolios, we cannot look at their returns in isolation, we also have to consider their riskiness.

Table 3 presents the annualized return, annualized standard deviation, Sharpe ratio, the Value at Risk, and the Expected Shortfall of the different categories of portfolios under the Cap-weighted Index. Looking at the ES portfolios, Table 3 reveals that they not only recorded higher returns than the benchmark, but at the same time had lower risks. The top 40 ES portfolio had 14.2% annualized return with a portfolio volatility of 21.2% resulting in a portfolio Sharpe ratio of 0.67, the highest among the various ES portfolios. Within the same period, the OMX Nordic 40 Index recorded an annualized return of 9.2%, with a volatility of 25.5%, culminating in a Sharpe ratio of 0.36. The top 40 ES portfolio also had lower tail risk than the benchmark. With a probability of 0.05, the portfolio fell by more than 2.04% over one day and the size of the loss on average was 3.06%. The recorded VaR for the top 40 ES portfolio is the lowest over the entire period. The OMX Nordic 40 Index on the other hand, had 2.52% losses in terms of VaR and 3.76% when the VaR was exceeded. The results in Table 3 suggest that investors in the Nordic region can achieve higher returns with lower risks when they use environmental screens in their investment decisions. We also examine the returns and risks of the top 10 to the

top 30 ES portfolios. A similar pattern of higher returns and lower risks than the benchmark is observed. All the top ES portfolios performed better than the OMX Nordic 40 Index.

ES Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	13.1	13.2	15.6	14.2	9.2
annualized standard deviation (%)	23.1	21.5	21.2	21.2	25.5
Sharpe Ratio	0.57	0.62	0.73	0.67	0.36
$\text{VaR}_{0.95}$	2.25	2.07	2.05	2.04	2.52
$\text{ESh}_{0.95}$	3.28	3.08	3.03	3.06	3.76

Dec Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	13.3	13.2	17.5	16.2	9.2
annualized standard deviation (%)	27.2	24.8	22.7	21.1	25.5
Sharpe Ratio	0.49	0.53	0.77	0.77	0.36
$\text{VaR}_{0.95}$	2.63	2.39	2.25	2.05	2.52
$\text{ESh}_{0.95}$	3.96	3.58	3.26	3.07	3.76

WG Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	12.0	14.1	15.2	15.8	9.2
annualized standard deviation (%)	28.2	22.1	22.1	22.0	25.5
Sharpe Ratio	0.42	0.64	0.69	0.72	0.36
$\text{VaR}_{0.95}$	2.65	2.10	2.08	2.05	2.52
$\text{ESh}_{0.95}$	4.11	3.17	3.18	3.17	3.76

EC Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	13.2	16.7	16.0	16.5	9.2
annualized standard deviation (%)	28.6	25.3	21.8	21.7	25.5
Sharpe Ratio	0.46	0.66	0.73	0.76	0.36
$\text{VaR}_{0.95}$	2.76	2.41	2.10	2.07	2.52
$\text{ESh}_{0.95}$	4.16	3.58	3.13	3.12	3.76

Table 3: returns and risk measures of portfolios under the Cap-weighted Index

The lower part of Table 3 shows the corresponding results for the Decarbonized, Waste Generation and Energy Consumption portfolios. The top 30 and 40 Dec portfolios had higher returns than the benchmark OMX Nordic 40 Index and at the

same time they were less risky. The top 40 Dec portfolio had an annualized return of 16.2%, and a volatility of 21.1%, resulting in Sharpe ratio of 0.77. In comparison, the benchmark portfolio delivered a Sharpe ratio of 0.36. The top 40 Dec portfolio also had a lower tail risk than the OMX Nordic 40 Index. The top 40 Dec portfolio lost more than 2.05% over a day with a probability of 0.05% and the size of the loss on average was 3.07%. Whilst the benchmark at the same time lost more than 2.52%, with an average loss size of 3.76%. The top 10 and 20 Dec portfolios also did well. Both portfolios yielded returns higher than the Index with corresponding higher risks. The top 10 Dec portfolio had risks higher than that of the OMX Nordic 40 Index. The higher volatilities and returns resulted in Sharpe ratios of 0.49 and 0.53 for the top 10 and 20 Dec portfolios respectively.

The top 40 WG like the ES and Dec portfolios recorded higher returns and lower risks than the OMX Nordic 40 index. It had the highest annualized return of 15.8% with the lowest annualized standard deviation of 22.0% in that sub-category of portfolios. This resulted in portfolio Sharpe ratio of 0.72 which is twice the Sharpe ratio of the benchmark. The portfolio had a lower tail risk than the index. With a probability of 0.05%, the top 40 WG portfolio lost 2.05% over a day and the size of the loss on average was 3.17%. The estimated VaR and the size of its average loss are lower than that of the benchmark.

A closer look at the EC portfolios reveals similar patterns observed in the previous categories of portfolios. Thus higher returns and lower risks were recorded for all the portfolios except the top 10 which recorded higher risk than the benchmark. The top 40 EC portfolio achieved an annualized return of 16.5% and a corresponding annualized standard deviation of 21.7% over the entire period of observation. A Sharpe ratio of 0.76 was recorded which turns out to be more than two times the Sharpe ratio of the OMX Nordic 40 index. The reported one day portfolio VaR and

ESh for the top 40 EC portfolio were lower than that of the index.

In general, all the top 40 portfolios under the different quantitative metrics as well as the top 40 ES portfolio performed better than the OMX Nordic 40 Index in terms of return, portfolio volatility and all the other estimated risk measures. These results suggest that being environmentally proactive in one's investment decisions in the Nordic region does not sacrifice performance and that investing in environmentally friendly portfolios is optimal for investors in comparison to the benchmark OMX Nordic 40 Index. As can be noted, the annualized returns of the subsidiary top 40 portfolios were higher than that of the aggregate top 40 ES portfolio, an indication that the assigned weights have significant effects on the overall portfolio. It also signifies that focusing on a specific environmental factor is more productive than taking a general environmental view. However, the latter still performs better than the Index in terms of return and risks. In other words, it suggests that no matter how the definition of environmental friendliness maybe in the Nordic Stock market, their portfolio returns and risks are superior to the benchmark Index.

The results of the Decarbonized portfolios show that investors of firms who aim to keep greenhouse emission on the minimum are holding a free option on carbon risk[20] and their efforts will result in much higher returns when the market starts pricing carbon risk as envisaged by Andersson et al (2015).

[20]Carbon risk is the risk associated with holding or investing in assets deemed to have high carbon content.

ES Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.57*(0.31)	0.62***(0.21)	0.77***(0.17)	0.60***(0.16)
Market	0.71***(0.06)	0.74***(0.04)	0.76***(0.04)	0.77***(0.03)
SMB	-0.34**(0.15)	-0.22**(0.10)	-0.19**(0.08)	-0.11(0.08)
HML	-0.03(0.14)	-0.07(0.10)	-0.05(0.08)	-0.01 (0.07)
MOM	-0.01(0.08)	-0.10(0.06)	-0.04(0.05)	0.01 (0.04)
R^2	0.696	0.845	0.893	0.904
Adj.R^2	0.682	0.838	0.888	0.899

Dec Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.62**(0.28)	0.62***(0.23)	0.90***(0.17)	0.77***(0.14)
Market	0.91***(0.05)	0.82***(0.04)	0.85***(0.03)	0.80***(0.03)
SMB	0.07(0.13)	-0.01(0.11)	-0.01(0.08)	-0.01(0.07)
HML	0.57***(0.13)	0.38***(0.10)	0.22***(0.08)	0.09(0.07)
MOM	-0.03(0.08)	-0.04(0.06)	0.02(0.05)	0.03(0.04)
R^2	0.852	0.87	0.913	0.928
Adj.R^2	0.845	0.864	0.909	0.925

WG Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.70**(0.30)	0.78***(0.23)	0.77***(0.18)	0.81***(0.17)
Market	0.90***(0.06)	0.73***(0.04)	0.76***(0.03)	0.77***(0.03)
SMB	-0.22(0.15)	-0.29**(0.11)	-0.22**(0.09)	-0.16*(0.08)
HML	0.24*(0.14)	0.08(0.10)	0.01(0.09)	-0.02(0.08)
MOM	-0.37***(0.08)	-0.11*(0.06)	-0.07(0.05)	-0.09**(0.05)
R^2	0.847	0.838	0.884	0.904
Adj.R^2	0.841	0.83	0.879	0.90

EC Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.66**(0.27)	0.92***(0.22)	0.80***(0.15)	0.84***(0.15)
Market	0.93***(0.05)	0.87***(0.04)	0.82***(0.03)	0.80***(0.03)
SMB	0.07(0.13)	-0.03(0.11)	-0.05(0.07)	-0.05(0.07)
HML	0.30**(0.13)	0.28***(0.10)	0.06(0.07)	0.03(0.07)
MOM	-0.26***(0.07)	-0.13**(0.06)	-0.05(0.04)	-0.05(0.04)
R^2	0.872	0.885	0.926	0.925
Adj.R^2	0.866	0.88	0.923	0.922

Table 4: Results of the Carhart four-factor model of portfolios under the Cap-weighted Index.
Values in parenthesis represent the standard errors.*** for significance at 1%, ** for significance at 5% and * for significance at 10% .

Table 4 provides the results of the Carhart (1997) four-factor model of portfolios under the Cap-weighted Index. The table shows the R^2, Adjusted R^2, risk adjusted returns (abnormal returns) and the factor sensitivities of the portfolios. The R^2 values range between 0.696 and 0.928 for the different categories of portfolios. This indicates that between 69.6% and 92.8% of the portfolios' monthly excess returns are explained by the factors.

All portfolios had significant systematic risk in relation to the market. The top 40 ES and WG portfolios recorded the lowest market beta with the top 40 Dec and EC portfolios having the highest. All other constructed portfolios had market beta ranging between 0.71 and 0.93. Comparatively, the top ES portfolios attained much lower market risks than that of the subsidiary portfolios. The market beta of all the environmentally friendly portfolios are significantly lower than one (1) which is consistent with the findings of Cai et al (2015). Significant loadings on size were recorded for all the ES portfolios except the top 40, and this shows that big stocks are more dominant. Thus the constituent stocks in those portfolios are primarily large cap. The WG portfolios apart from the top 10 recorded statistically significant size factors. We find insignificant factor loadings for HML_t on the ES portfolios but significant loadings for some of the corresponding subordinate portfolios. The significant and positive loadings show that they invest more in value stocks. The momentum factor loadings for all ES portfolios are not statistically significant whilst there are mix results for the auxiliary portfolios.

All portfolios yielded significant positive risk adjusted returns or positive alphas. These significant alphas range between 0.57% and 0.92% per month. The positive and significant risk adjusted return is an indication that these portfolios indeed performed better than the benchmark and investors could earn a risk adjusted return in the range of 6.8% to 11.0% per year.

4.2 Equally-weighted Index

In order to give the same exposure to all constituent firms, Equally-weighted Index of the variant portfolios were formed and we examine the results in comparison to the OMX Nordic 40 Index benchmark. The use of the equally weighted scheme in this thesis is consistent with known green index such as DB NASDAQ OMX Clean Tech Index which weighs equally 119 publicly traded firms. A similar approach is used by PowerShares Cleantech Portfolio which tracks the Cleantech Index[21].

Table 5 presents the annualized return, annualized standard deviation, Sharpe ratio, the Value at Risk and Expected Shortfall for all portfolios. The results look similar to those obtained under the Cap-weighted Index. All the top ES portfolios realized higher annualized returns than the benchmark. They also obtained lower risk measures in comparison to the OMX Nordic 40 Index. As observed in the table, all ES portfolios have Sharpe ratios above 0.45 while that of the benchmark is 0.36.

The Equally-weighted top Dec portfolios also earned higher annualized return than the benchmark. They had lower risks than the benchmark except the top 10 Dec portfolio, which was riskier than the OMX Nordic 40 Index.

The top WG portfolios performed similarly as the top ES portfolios by having higher returns than the benchmark and lower risk measures. The top EC portfolios also performed better than the benchmark in terms of returns but apart from the top 10 EC portfolio which turned out to be riskier than the benchmark, all the remaining top portfolios attained lower risks.

In all, the results of Table 5 show that environmentally friendly portfolios in the Nordic region achieved higher returns with lower risk measures than the benchmark. That is, the applied weighting scheme (market cap or equal weighting) has

[21]Source: Andersson et al, (2014)

no effect on our main conclusions.

ES Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized return (%)	11	12.4	13.7	12.6	9.2
annualized Std (%)	23.7	23.0	22.5	22.3	25.5
Sharpe Ratio	0.46	0.54	0.61	0.57	0.36
$\text{VaR}_{0.95}$	2.30	2.26	2.22	2.19	2.52
$\text{ESh}_{0.95}$	3.46	3.31	3.23	3.25	3.76

Dec Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized return (%)	15.8	11.9	13.3	13.8	9.2
annualized Std (%)	25.9	23.9	22.2	21.7	25.5
Sharpe Ratio	0.61	0.50	0.60	0.64	0.36
$\text{VaR}_{0.95}$	2.53	2.42	2.22	2.19	2.52
$\text{ESh}_{0.95}$	3.82	3.54	3.27	3.21	3.76

WG Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized return (%)	10.7	11.6	13.0	13.6	9.2
annualized Std (%)	23.4	20.7	21.2	21.3	25.5
Sharpe Ratio	0.46	0.56	0.61	0.64	0.36
$\text{VaR}_{0.95}$	2.25	1.95	2.07	2.15	2.52
$\text{ESh}_{0.95}$	3.35	3.03	3.12	3.11	3.76

EC Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized return (%)	15.2	13.9	11.1	12.2	9.2
annualized Std (%)	26.5	23.4	21.6	21.2	25.5
Sharpe Ratio	0.57	0.59	0.51	0.58	0.36
$\text{VaR}_{0.95}$	2.43	2.30	2.1	2.03	2.52
$\text{ESh}_{0.95}$	3.87	3.36	3.17	3.10	3.76

Table 5: returns and risk measures of portfolios under the Equally-weighted Index

4.3 Score-weighted Index

We now examine the constructed portfolios under the Score-weighted scheme. Table 6 reports the return and risk measures for the Score-weighted portfolios. The port-

folios under the Score-weighted scheme follow a similar pattern as those observed under both the Cap-weighted and Equally-weighted indexes with minor differences. The results show higher returns and lower risk measures for the ES portfolios in comparison to the benchmark. However, there is a relative increase in return for the top 40 ES portfolio. It had an annualized return of 14.8% with volatility of 22.9%. The Sharpe ratio for the top 40 ES portfolio was found to be 0.65 which is the highest amongst the various ES portfolios. The OMX Nordic 40 Index on the other hand obtained annualized return of 9.2% and a portfolio volatility of 25.5%. The one day VaR of the top 40 ES portfolio was estimated to be 2.19% and the portfolio Expected Shortfall was 3.35%. The corresponding one day VaR and Expected Shortfall of the benchmark was 2.52% and 3.76% respectively. Comparatively, all the other top ES portfolios recorded higher returns and lower risk measures than the OMX Nordic 40 Index.

There has been risk reduction for some of the portfolios especially all the top 10 subordinate portfolios, although the top 40 portfolios did not record decrease in risks (VaR and Expected Shortfall) compared to the values obtained under the previous weighting schemes. The results are mixed in terms of the top 20 and 30 portfolios. However, all the estimated risk measures for the top subsidiary portfolios are lower than that of the benchmark index. There is a decreasing trend in returns for the different categories of portfolios compared to the Cap-Weighted scheme but these are still higher than the benchmark. Overall, the result conforms to the pattern observed under the Cap-weighted and Equally-weighted schemes.

ES Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	11.9	13.2	13.0	14.8	9.2
annualized standard deviation (%)	20.3	22.9	23.5	22.9	25.5
Sharpe Ratio	0.59	0.58	0.55	0.65	0.36
$\text{VaR}_{0.95}$	1.98	2.15	2.19	2.19	2.52
$\text{ESh}_{0.95}$	2.92	3.33	3.45	3.35	3.76

Dec Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	12.4	12.7	12.9	14.5	9.2
annualized standard deviation (%)	20.1	23.2	23.3	22.7	25.5
Sharpe Ratio	0.61	0.55	0.55	0.64	0.36
$\text{VaR}_{0.95}$	1.95	2.17	2.20	2.19	2.52
$\text{ESh}_{0.95}$	2.92	3.40	3.43	3.33	3.76

WG Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	11.1	14.8	15.3	15.4	9.2
annualized standard deviation (%)	22.1	25.0	24.2	24.0	25.5
Sharpe Ratio	0.50	0.59	0.63	0.64	0.36
$\text{VaR}_{0.95}$	2.12	2.26	2.24	2.25	2.52
$\text{ESh}_{0.95}$	3.17	3.67	3.55	3.50	3.76

EC Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	12.4	13.3	13.9	15.4	9.2
annualized standard deviation (%)	20.8	23.8	24.1	23.5	25.5
Sharpe Ratio	0.59	0.56	0.58	0.66	0.36
$\text{VaR}_{0.95}$	1.98	2.23	2.27	2.22	2.52
$\text{ESh}_{0.95}$	2.99	3.48	3.54	3.45	3.76

Table 6: returns and risk measures of portfolios under Score-weighted Index

We show the Carhart (1997) four-factor model results in Table 7. In all, there is improvement in the nature of fit of the data. Between 77.7% and 92.1% of the monthly risk adjusted returns are explained by the factors. Significant risk adjusted returns are obtained for all the portfolios except the top 10 WG portfolio. This means that a significant risk adjusted return between 5.0% and 8.9% per year is obtained by investing using the Score-weighted strategy. The top 40 WG portfolio

recorded the highest abnormal return of 8.9% per year which is a decrease in relation to the Cap-weighted scheme. It must also be noted that only the top 40 ES portfolio recorded improvement in risk adjusted returns. All other portfolios had reduction in risk adjusted returns.

All the constructed portfolios achieved market beta values lower than 1 and were found to be statistically significant which is similar to the results obtained under the cap-weighted scheme. Once again, the lowest market betas were achieved by the top ES portfolios with the exception of the top 30. The size factor loadings for most of the portfolios were found to be statistically insignificant apart from the top 10 and 30 WG portfolios.

These findings are consistent with most empirical literature which demonstrate that green stocks are significantly different from conventional stocks. Moreover, green stocks exhibit superior performance in relation to reference indexes.

ES Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.42**(0.19)	0.52**(0.20)	0.53***(0.17)	0.68***(0.17)
Market	0.7***(0.04)	0.82***(0.04)	0.85***(0.03)	0.83***(0.03)
SMB	-0.12(0.09)	0.06(0.10)	0.04(0.08)	0.02(0.08)
HML	-0.05(0.09)	0.08(0.09)	0.06(0.08)	0.05(0.08)
MOM	0.05(0.05)	-0.03(0.06)	-0.10(0.05)	-0.08(0.05)
R^2	0.838	0.874	0.918	0.911
Adj. R^2	0.83	0.868	0.914	0.907

Dec Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.44**(0.18)	0.48**(0.19)	0.51***(0.19)	0.66***(0.18)
Market	0.7***(0.03)	0.83***(0.04)	0.86***(0.04)	0.84***(0.03)
SMB	-0.12(0.09)	0.07(0.09)	0.03(0.09)	0.02(0.09)
HML	-0.01(0.08)	0.13(0.09)	0.08(0.08)	0.09(0.08)
MOM	0.09*(0.05)	-0.02(0.05)	-0.08(0.05)	-0.05(0.05)
R^2	0.847	0.89	0.91	0.904
Adj. R^2	0.84	0.885	0.906	0.90

WG Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.41(0.25)	0.71***(0.21)	0.74***(0.18)	0.74***(0.17)
Market	0.73***(0.05)	0.84***(0.04)	0.84***(0.03)	0.83***(0.03)
SMB	-0.31**(0.12)	0.03(0.1)	-0.00**(0.09)	0.004(0.09)
HML	-0.14(0.12)	0.03(0.09)	-0.04(0.08)	0.002(0.08)
MOM	-0.06(0.07)	-0.17***(0.06)	-0.17***(0.05)	-0.13***(0.05)
R^2	0.777	0.89	0.91	0.913
Adj. R^2	0.768	0.885	0.906	0.909

EC Portfolios	Top 10	Top 20	Top 30	Top 40
Alpha	0.44**(0.21)	0.55**(0.21)	0.62***(0.18)	0.73***(0.19)
Market	0.73***(0.04)	0.86***(0.04)	0.87***(0.03)	0.86***(0.03)
SMB	-0.13(0.10)	0.07(0.10)	0.07(0.09)	0.06(0.09)
HML	-0.03(0.09)	0.11(0.10)	0.08(0.08)	0.06(0.09)
MOM	0.06(0.06)	-0.07(0.06)	-0.13***(0.05)	-0.10*(0.05)
R^2	0.829	0.883	0.915	0.907
Adj. R^2	0.822	0.877	0.912	0.903

Table 7: Results of the Carhart four-factor model of portfolios under the Score-weighted Index

4.4 Environmentally Friendly Mutual Funds

We now analyse the risk and performance measures of environmentally friendly mutual funds. The idea of assessing the performance of the screened mutual funds is to provide more insight into the nature of environmental friendliness of equities in the Nordic region and to find out if investment in environmentally friendly equities come at a cost. We first look at the return nature of the funds and proceed to examine their respective Carhart (1997) four-factor model.

Funds	Fund 1	Fund 2	Fund 3	Fund 4	Nordic 40
annualized returns (%)	7.3	15.0	11.5	11.9	9.2
annualized standard deviation (%)	19.7	23.6	22.4	22.5	25.5
Sharpe Ratio	0.37	0.63	0.51	0.53	0.36
$\text{VaR}_{0.95}$	2.04	2.21	2.22	2.21	2.52
$\text{ESh}_{0.95}$	2.91	3.58	3.32	3.33	3.76

Table 8: returns and risk measures of environmentally friendly funds

Table 8 presents the funds' annualized return, annualized standard deviation, Sharpe ratio, the Value at Risk and Expected Shortfall. All the funds with the exception of fund 1 recorded higher returns than the benchmark index with lower risk measures. The recorded Sharpe ratios were all higher than the OMX index.

The observed pattern is in accordance with our constructed portfolios under the different weighting schemes. The pattern is expected since the screened funds invest in the same geographical region as our portfolios and are therefore bound to hold the same equities but with different weightings.

In Table 9, we have the results of the Carhart (1997) four-factor model. Positive risk adjusted returns were recorded for all funds out of which two of them were statistically significant at 10% and 5% levels. All the funds had lower and significant

systematic risk in relation to the market.

The results of Tables 8 and 9 give credence to the ones obtained with our portfolios that, investing in environmentally friendly firms in the Nordic region do not result in lower performance in comparison to the benchmark index.

Funds	Fund 1	Fund 2	Fund 3	Fund 4
Alpha	0.01(0.22)	0.49(0.34)	0.40*(0.22)	0.44**(0.22)
Market	0.79***(0.04)	0.88***(0.06)	0.8***(0.04)	0.84***(0.04)
SMB	0.09(0.1)	0.27*(0.16)	0.14(0.10)	0.14(0.10)
HML	0.02(0.06)	0.18*(0.09)	-0.05*(0.06)	-0.05* (0.06)
MOM	0.06(0.05)	-0.02(0.05)	-0.06(0.06)	-0.04 (0.05)
R^2	0.841	0.733	0.86	0.858
Adj. R^2	0.834	0.721	0.853	0.852

Table 9: Results of the Carhart four-factor model of funds

4.5 Environmentally Friendly Companies

In order to show which featured firms are the most environmentally friendly Nordic companies, we present Table 12 in the **Appendices**, the largest 40 companies in terms of market capitalization for the 2014 Calendar year with the number of times each firm appears in the top 40 ES, Dec, WG and EC portfolios. The highest number to achieve for the ranking is 8, representing the number of years for which rankings were conducted. For the top 40 ES portfolio, we find about 7 firms which appeared in the top 40 every year, 6 firms appearing each year for the top 40 Dec portfolio, 11 firms for each of the top 40 WG and EC portfolios. Table 13 in the **Appendices** shows the average weight over the years for the largest companies in the top 40 under the Score-weighted Index. In an equally-weighted scheme, each company would have a weight of 2.5%. Therefore, all companies which obtain weights above 2.5% under the Score-weighted Index are over-weighted due to their environmental scores. The reverse holds for companies achieving weights less than 2.5%.

4.6 Excluding Norwegian firms

A careful observation of both Tables 12 and 13 also show that, the average number of large cap firms from Norway and Finland are 6 and 7 respectively for the various metric rankings. Whilst Denmark and Sweden contribute the largest numbers of 8 and 19 respectively. It can therefore be explained that the performance of the strategy is not drastically influenced by firms coming from Norway and that their absence in the benchmark index is not the the source of the difference in higher returns since those firms from Norway contribute a small proportion in the top 40 portfolios. For the top 40 ES and Dec portfolios, three out of six ranked firms from Norway obtained weights less the threshold of 2.5% under the Score-weighted scheme whereas four out of seven firms in the WG portfolio obtained weights less the threshold. In the case of the EC portfolio, four out of six firms obtained weights above 2.5%. With larger proportion of the Norwegian companies receiving lesser weightings as it is in the case of the top 40 WG portfolio, the return for the ensuing portfolio estimated in Table 11 increased. However, when the number of firms which obtained above-threshold weightings increased as we see in the top 40 EC portfolio, the corresponding return was lower in Table 6 compared to the estimated returns for that portfolio under the same scheme in Table 11.

In general, all the top 40 portfolios for the various categories achieved higher returns when the Norwegians companies were excluded under the Score-weighted scheme. This fact buttresses the point that performance of the strategy is purely based on the environmental scores of firms and not their countries of origin. To back up this point, we have recalculated the portfolios under the Cap and Score-weighted indexes excluding all the Norwegian companies to see if the return difference could be attributed to those firms, but the results confirm the above claim. The results can be found in Tables 10 and 11 in the **Appendices**.

5 Conclusion

As an alternative investment strategy to green bonds which is one of the ways of improving the environment without sacrificing return, this study has shown that investors who care about the environment can equally invest in environmentally friendly firms in the Nordic stock market.

The research sampled some qualitative and quantitative environmental metrics to rank equity firms in the Nordic region. All firms were screened against the selected metrics using the positive screening approach and thereafter, portfolios of the top ranked firms formed. The return and risk measures of the top 10 to 40 portfolios were analysed. Our results showed that, risk averse investors in the region could put their investments in firms which are environmentally friendly since the risk is significantly lower compared to the OMX Nordic 40 Index.

Using the Score-weighted strategy, the top 40 ES portfolio resulted in a highly significant positive risk adjusted return of 8.2% per year and a raw return 0f 14.8% over the entire sample period. The findings are consistent with existing literature such as the papers by Cohen (1995), White (1996) and Cai et al (2014, & 2015) on the performance of environmentally friendly indexes and their benchmarks. A decarbonized portfolio of the top 40 firms produced lesser risk than the benchmark and a higher positive risk adjusted return of 7.9% per year, which was found to be statistically significant.

In order to ascertain the veracity of the results and the nature of environmental friendliness in the region, checks were done by selecting environmentally friendly equity mutual funds with geographical focus on the Nordic region. Analyzing the return characteristics and performance gave similar results as in the case of our constructed stock portfolios.

Further research could be carried out by using both the negative and best in class screening approaches to find out if they would result in lower risks and significant risk adjusted returns as suggested in the definition of decarbonization by CDP (Carbon Disclosure Project).

Appendices

ES Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	13.1	13.4	15.5	15.1	9.2
annualized standard deviation (%)	23.0	21.6	21.3	21.4	25.5
Sharpe Ratio	0.57	0.62	0.73	0.70	0.36
$VaR_{0.95}$	2.25	2.08	2.08	2.1	2.52
$ESh_{0.95}$	3.28	3.09	3.05	3.05	3.76

Dec Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	13.1	13.3	16.9	16.0	9.2
annualized standard deviation (%)	27.4	24.7	22.7	21.1	25.5
Sharpe Ratio	0.48	0.54	0.74	0.76	0.36
$VaR_{0.95}$	2.63	2.42	2.21	2.05	2.52
$ESh_{0.95}$	3.99	3.58	3.26	3.04	3.76

WG Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	9.2	13.5	15.3	15.5	9.2
annualized standard deviation (%)	28.4	21.8	22.0	22.0	25.5
Sharpe Ratio	0.32	0.62	0.70	0.70	0.36
$VaR_{0.95}$	2.74	2.09	2.11	2.14	2.52
$ESh_{0.95}$	4.16	3.12	3.16	3.17	3.76

EC Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	11.8	16.9	15.6	16.2	9.2
annualized standard deviation (%)	28.7	24.4	21.6	21.7	25.5
Sharpe Ratio	0.41	0.69	0.72	0.75	0.36
$VaR_{0.95}$	2.77	2.35	2.10	2.09	2.52
$ESh_{0.95}$	4.16	3.48	3.10	3.11	3.76

Table 10: returns and risk measures for Cap weighted Portfolios when Norwegian firms are excluded

ES Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	11.2	13.2	14.7	15.3	9.2
annualized standard deviation (%)	21.2	24.1	23.3	23.0	25.5
Sharpe Ratio	0.53	0.55	0.63	0.66	0.36
$\text{VaR}_{0.95}$	2.08	2.32	2.26	2.23	2.52
$\text{ESh}_{0.95}$	3.02	3.51	3.40	3.33	3.76

Dec Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	11.4	14.6	14.5	15.4	9.2
annualized standard deviation (%)	20.9	24.1	23.2	22.7	25.5
Sharpe Ratio	0.55	0.61	0.63	0.68	0.36
$\text{VaR}_{0.95}$	2.08	2.29	2.23	2.20	2.52
$\text{ESh}_{0.95}$	2.97	3.49	3.37	3.28	3.76

WG Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	12.4	13.6	15.4	17.3	9.2
annualized standard deviation (%)	24.0	24.6	24.1	23.8	25.5
Sharpe Ratio	0.52	0.56	0.64	0.73	0.36
$\text{VaR}_{0.95}$	2.22	2.30	2.29	2.31	2.52
$\text{ESh}_{0.95}$	3.45	3.59	3.51	3.44	3.76

EC Portfolios	Top 10	Top 20	Top 30	Top 40	Nordic 40
annualized returns (%)	11.5	14.8	15.4	15.6	9.2
annualized standard deviation (%)	21.5	24.6	24.1	23.9	25.5
Sharpe Ratio	0.53	0.60	0.64	0.65	0.36
$\text{VaR}_{0.95}$	2.08	2.34	2.26	2.23	2.52
$\text{ESh}_{0.95}$	3.06	3.55	3.51	3.46	3.76

Table 11: returns and risk measures for score weighted Portfolios when Norwegian firms are excluded.

Firm Ticker	ES Ranking	Dec Ranking	WG Ranking	EC Ranking
NOVOB DC	7	8	5	8
AZN SS	7	5	8	7
HMB SS	0	6	NA	2
STL NO*	2	1	4	0
ABB SS	8	1	6	4
NDA SS	4	6	7	8
MAERSKB DC	0	0	1	0
ERICB SS	7	7	8	8
ATCOA SS	8	8	8	8
TEL NO*	8	1	7	2
SHBA SS	0	2	NA	3
NOKIA FH	8	7	8	8
TELIA/TLSN SS	6	5	6	5
SEBA SS	3	7	8	8
INVEB SS	0	NA	NA	NA
SWEDA SS	0	7	3	7
DANSKE DC	5	8	8	8
SAMAS FH	0	5	4	1
DNB NO*	6	6	7	7
KNEBV FH*	7	7	7	7
VOLVB SS	2	8	NA	8
ASSAB SS	8	3	8	3
FUM1V FH	0	0	0	0
COLOB DC	8	1	8	7
SCAB SS	3	0	1	0
NZYMB DC	5	0	5	0
YAR NO*	0	0	8	0
SAND SS	8	1	2	2
CARLB DC	6	1	0	1
NHY NO*	0	0	0	0
HEXAB SS	0	NA	NA	NA
PNDORA DC	0	1	3	2
SKFB SS	2	1	NA	1
ALIV SS	0	0	NA	3
KINVB SS	0	NA	NA	NA
WRT1V FH	7	3	4	8
SKAB SS	0	2	NA	0
UPM1V FH	1	0	1	0
ELUXB SS	6	1	2	7
GJF NO*	0	6	0	6
VWS DC	NA	8	2	8
ALFA SS	NA	8	8	8
ICA SS *	NA	0	0	0
STERV FH	NA	NA	2	NA
ORK NO*	NA	NA	0	NA
GR4SEC DC*	NA	NA	2	NA
TDC DC	NA	NA	5	NA
NESTE FH	NA	NA	8	NA
SWMA SS	NA	NA	1	NA

Table 12: Number of times largest companies appear in the top 40 ES, Dec, WG and EC rankings.

* in Table 12 above indicates the company is not listed on the OMX Nordic 40 Index.

Firm Ticker	ES (%)	Dec (%)	WG(%)	EC(%)
NOVOB DC	3.12	3.13	1.74	3.25
AZN SS	3.36	3.13	3.30	2.91
HMB SS	2.55	3.14	NA	1.09
STL NO	2.96	2.98	1.74	3.10
ABB SS	3.50	3.11	3.30	3.24
NDA SS	2.68	2.43	2.68	3.27
MAERSKB DC	2.68	2.27	2.15	2.59
ERICB SS	3.22	2.63	3.30	3.26
ATCOA SS	3.35	3.14	3.30	3.26
TEL NO	3.13	3.10	2.68	3.23
SHBA SS	0.74	3.06	NA	1.06
NOKIA FH	3.53	3.15	3.30	3.26
TLSN /TELIA SS	3.23	3.14	2.34	3.25
SEBA SS	2.84	2.63	3.30	3.27
INVEB SS	0.02	NA	NA	NA
SWEDA SS	2.68	3.01	1.01	3.14
DANSKE DC	3.30	3.15	3.30	3.27
SAMAS FH	1.24	1.84	1.40	0.35
DNB NO	2.51	2.23	2.68	2.75
KNEBV FH	3.04	2.62	2.68	2.74
VOLVB SS	2.82	3.15	NA	3.26
ASSAB SS	3.30	3.12	3.30	3.25
FUM1V FH	0.94	0.21	2.14	0.00
COLOB DC	3.30	2.92	3.18	2.99
SCAB SS	3.05	2.84	3.28	2.81
NZYMB DC	3.15	2.87	3.30	3.11
YAR NO	2.33	1.92	3.30	2.06
SAND SS	3.27	3.11	3.30	3.23
CARLB DC	3.06	2.68	2.15	3.19
NHY NO	2.15	2.23	1.03	2.39
HEXAB SS	0.17	NA	NA	NA
PNDORA DC	1.47	0.00	2.01	1.85
SKFB SS	2.91	3.09	NA	2.81
ALIV SS	2.27	2.86	NA	2.80
KINVB SS	0.05	NA	NA	NA
WRT1V FH	3.13	2.89	3.18	2.93
SKAB SS	1.97	2.62	NA	0.00
UPM1V FH	2.08	1.32	1.99	2.44
ELUXB SS	2.81	2.30	3.30	3.26
GJF NO	2.18	2.91	0.00	2.94
VWS DC	NA	3.28	3.56	3.34
ALFA SS	NA	2.98	3.30	3.13
ICA SS	NA	2.93	1.77	2.76
STERV FH	NA	NA	3.30	NA
ORK NO	NA	NA	2.15	NA
GR4SEC DC	NA	NA	0.39	NA
TDC DC	NA	NA	1.67	NA
NESTE FH	NA	NA	3.62	NA
SWMA SS	NA	NA	2.67	NA

Table 13: Composition and average weights of the Score-weighted top 40 portfolios

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