Tilburg School of Economics and Management – MSc Finance

An empirical analysis on SRI.

Do sustainable portfolios overperform or underperform non-sustainable ones?

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Academic year:

2019/2020

Abstract

This thesis constructs two distinct sub-samples based on the tails of the Environmental, Social and Governance (ESG) score distribution of securities contained in the MSCI world index used as a benchmark. It aims to evaluate whether high ESG portfolios overperform or underperform low ESG portfolios through the Markovitz mean variance approach and the development of an active strategy for the period 2012-2020. Moreover, with the support of various risk measures it highlights the predominance of non-sustainable portfolios compared to sustainable ones for almost all the analyzed periods. In addition, thanks to the use of the min variance portfolio, it proves the lower risk tolerance of sustainable investors compared to non-sustainable ones.

Contents

Introduction

Investor interest in the Social Responsible Investment (SRI) has drastically increased in recent years. As stated by GSIA's (2019) report, from 2016 to 2018 there has been an increase of 34% in the SRI asset under management (AUM), which corresponds to $30,7 trillion, and this growth is consistent for almost all the 5 main markets presented in their report, with exception of Europe (Europe, United States, Japan, Canada, Australia/New Zealand). IPE (2019) shows that the Top 400 worldwide asset management firms managed approximately $65.7 trillion in 2018, and SRI corresponds to almost half of the assets under management in the market for the said year. Given the continuous growth of the SRI, several theories have been developed over the time. Research findings focusing on the performance of the SRI are discordant. Some of them highlight how sustainable firms overperform non sustainable ones while others present the opposite results. In this contest, Kumar (2016) and Dunn (2017) have shown that high ESG securities are subject to a lower risk.

This thesis attempts to answer the well-known question regarding the potential overperformance or underperformance of a high sustainable portfolio compared to a low one. In addition, through the Markovitz mean-variance approach, it is possible to analyse the minimum variance portfolios for the high and low sustainable sub-samples in order to assess whether the variance associated to the maximum level of risk aversion for both sustainable and non-sustainable investors tends to coincide. To develop this analysis, I have used securities from MSCI world index for the period 2010-2020. In order to create high and low sustainable sub-samples I have used firms with an ESG score higher than the 80^{th} percentile and lower than the 20^{th} percentile. The method I have used to answer to the research question is the Markovitz modern portfolio theory based on a back-test of the previous five years, for both the sub-samples, for the periods 2010-20,2013-20,2016-20 and 2019-20. Firstly, I have analysed their efficient frontier, which highlights a predominance of the sin-stock[1] portfolios for almost all the analysed periods. I have continued the analysis focusing only on the minimum variance portfolios, compared to the MSCI world index, for the given periods which emphasizes a lower risk, with a consequent lower expected return, for the sustainable portfolios. A further analysis, developed in this thesis, corresponds to the construction of two active minimum variance portfolios for the two sub-samples for the period 2012-2020. These active portfolios are useful for this research due to their annual iteration which allowed them to be more accurate for the performance valuation. The results

[1] It corresponds to the stock of a firm that is involved in activities that are considered immoral.

of the active portfolios are in line with the ones highlighted by the static[2] minimum variance portfolios. In order to evaluate the risk and the performances of the two active portfolios I have used several risk ratios and measures, starting from the more common ones such as: standard deviation, Sharpe ratio, Sortino ratio, Treinor ratio, downside and upside risk, ex-ante and ex-post VaR to conclude with more sophisticated ones as the ex-ante Modified VaR using the Cornish-Fisher quantile, modified Sharpe ratio, modified Sortino ratio and the volatility skew. The results of these measures indicate a lower risk for the sustainable portfolio which, however, is less efficient in the aforementioned measures, compared to the low sustainable portfolio and the benchmark.

The thesis is structured as follows; Section I examines the current literature on the definition of SRI and the performance of sustainable vs non-sustainable portfolios. In addition, it also introduces the SRI market variation in the last years and the methodology used by Morgan Stanley Capital International (MSCI) and Bloomberg to assign an ESG score to firms. Section II describes the methodology and the data used to build the efficient frontiers, the minimum variance portfolios and the active portfolios and reviews their results. Section III introduces the theory behind the risk measures used to compare the active portfolios and presents the respective results indicated by these measures for both sustainable and non-sustainable portfolios, as well as the MSCI world index. Lastly, section IV summarizes the conclusion of the analysis and presents a discussion.

I. ESG universe

1.1 Literature review

1.1.1 Socially Responsible Investments definition

SRI has become increasingly relevant in the financial markets (Eurosif, 2018a, Nilsson, 2008). As introduced by Nilsson (2008), this can be explained by two main societal trends: "regular people" are starting to move their savings from bank accounts to mutual funds whilst experiencing a growing and continuous interest in social, environmental and ethical issues. In reference to the SRI investment world, there are several terms that are used to this end such as: sustainable investments, responsible investments and ethical investment (Nilsson, 2008). In this context, it is necessary to provide a definition of the SRI. Doskeland and Pedersen (2016) defined SRI as “an investment that is designed

[2] With the term static I intend portfolios which weights are computed in a given year and they remain fixed for all the period.

to yield the highest possible risk-adjusted financial return while also taking into account social, ethical and/or environmental concerns" while Eurosif (2018a) defines the SRI as "a long-term oriented investment approach, which integrates ESG factors in the research, analysis and selection process of securities within an investment portfolio". An additional definition provided by Doskeland and Pedersen's (2019) recent study defines a responsible investment (RI) as an investment "aiming to maximize risk-adjusted return while taking social, environmental, and moral concerns into account". Given these definitions, it is clear that SRI and IR tend to be exactly the same thing yet expressed in different terms. The Eurosif (2018a) definition incorporates the Environmental, Social and Governance (ESG) concerns as well as the two definitions provided by Doskeland and Pedersen (2016,2019). The ESG parameters include the three main criteria used in the Socially Responsible Investment, which allows investors to categorize and classify firms during an SRI screening. Environmental criteria are necessary to evaluate the behaviour of a firm with regards to nature and the environment, such as the emission of Co2, water consumption, energy use etc. On the other hand, there are potential risks in which a company could incur, concerning environmental risks and the management of such risks, such as land contamination, toxic emissions, waste of essential materials, among others. The Social criteria are used to analyse how a company manages its relationships with customers, suppliers, employees and the community in which it operates. The values which belong to this category are the consideration of the interests of stakeholders and shareholders, labour rights, donations of part of the profits, respect for their employees, etc., while Governance criteria are focused on the firm's leadership such as independent Board of Directors, company audited by an independent committee, accurate and transparent accounting methods, etc.

Because the Responsible Investment is integrated in financial and non-financial objectives, Nilsson (2008) indicates how the environmental, social and ethical criteria are combined with the decision making of an investor. These types of investments have a long-term focus aiming to provide a positive benefit for the environment and society, whilst also providing positive outcomes (Eurosif, 2018a).

1.1.2 SRI performance

In line with the outline of this thesis, part of the literature indicates that ESG investments tend to underperform non-ESG investments. Initial ESG research focused on the performance of funds restricted to SRI investment and conventional investment. Bauer et al. (2005) discovered that both conventional and SRI funds tend to perform the same alpha[3] while they diverge in term of stock picking. Up until the 90's, conventional funds used to perform a higher alpha compared to SRI funds.

[3] It is a term uses in investing to describe a strategy's ability to beat the market

Following this, SRI funds increased their extra-returns and caught up with traditional funds. Barnett and Salomon (2006) highlight how SRI funds are able to overcome their poor diversification through the positive selection and screening of securities. Diltz (1995) analysed funds which used Social and Responsible screening to choose their securities, from January 1989 until 1991, and found a positive impact on their performance. Renneboog et al. (2008) indicated that many European, North American and Asian SRI funds "underperform domestic benchmark portfolios such as the Fama-French-Carhart factors"[4] however, when comparing the alphas of conventional funds with SRI funds, they found statistically non-significant evidence that SRI funds underperform their counterpart in most countries (Renneboog et al. 2008). Statman (2000) analysed the Domini Social index composed by SRI stocks, from 1990 until 1998 and compared it to the S&P 500; results indicated that they almost have the same performance whereas SRI mutual funds underperformed the S&P 500 through the same time frame. Statman (2000), Schroder (2004), Statman (2006) and Schroder (2007) found that SRI indexes performances are comparable with the performances of conventional indexes. A further analysis on SRI indexes and conventional ones is proposed by Belghitar et al. (2014), which highlights the equal amount of expected return and variance between the two different indexes. A research conducted by Brammer et al. (2006) on listed companies in the UK indicates that firms with a high Corporate Social Responsibility (CSR) rating underperform firms with a low CSR ranking value. The results were justified by highlighting a negative correlation of returns with environmental and community indicators. An additional study confirming the underperformance of SRI funds with respect to conventional ones was developed on the Australian market, especially from 2000 until 2005. Van der Laan et al. (2008) used the multifactor CAPM model to show how the Australian's SRI funds had underperformed the market. Salaber (2007), focused exclusively on the European market and indicated that a portfolio made up of sin-stock overperformed a 'sin-free' portfolio by more than 4% annually over the period 1975-2006.

In contrast to the outline of this thesis, the literature indicates higher returns for firms with a high ESG score. One of the first studies to favour the overperformance of SRI companies was by Corten et al. (2005) who indicated how a portfolio composed by high CSR rating firms overperformed a portfolio made up of low CSR rating firms for the period 2000-2004; however, their findings were not significant and their analysis was exclusively focused on firms in the European Union. Further research by Bauer et al. (2005) confirms Corten et al's. findings; the investigation shows that a portfolio composed of large cap firms referred to as "most eco-efficiency" outperform a portfolio of

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[4] Renneboog, L., Horst, J. T., & Zhang, C. (2008). The price of ethics and stakeholder governance: The performance of socially responsible mutual funds. *Journal of Corporate Finance, 14*(3), 302–322.

less eco-efficient firms. The authors created a "best-in-class" and "worst-in-class" portfolios for the US firms for the period 1995-2003, based on the "eco-efficiency score" and they reported how the "best-in-class" portfolio delivers a four-factor alpha of 4.5% per year. The "worst-in-class" portfolio produced a negative alpha of minus 1.8% per year which is not significant.
Osthoff et al. (2007) used the Carhart (1997) four-factor model to compare the performance of two portfolios composed by high and low ESG score firms for the period 1992-2004. Their findings suggest a positive and significant difference in the performance of the high ESG of 8.7% per year compared to the low ESG one. Glushkov et al's., (2009) results are in line with the above-mentioned findings and Nofsinger et al., (2014) proved that SRI funds perform better than conventional ones during financial crisis. Nakai et al., (2015) conducted an analysis on Japanese funds and their results were in line with Nofsinger's findings. This study chose the bankruptcy of the Lehman Brothers as the momentous event and showed, using the Fama-French three-factor model, that the bankruptcy of the Lehamn Brothers had "significantly increased the performance of SRI funds at the 5% level" (Nakai et al. 2015) while the difference in performance between conventional and SRI funds indicated, at 1% significance level, how the crisis had negatively impacted on conventional funds.
Given the aforementioned findings, it is clear that throughout the literature, a uniform point of view is lacking when it comes to emphasizing the potential benefit or downside in investing in sustainable instruments.

1.2 SRI market

The Socially Responsible Investments have increased significantly in the recent years. This can be explained by the growth of the SRI investment universe and by the total asset under management of the ESG portfolio managers. In order to provide an overview of the current SRI market I have used data from Eurosif and Global Sustainable Investment Allianxce (GSIA). Their SRI classification can be used together due to their closely aligned scoring (Eurosif,2018a). Nonetheless, the SRI market data presented below should be considered taking into account a possible overstatement given by a non-clear definition in terms of what constitutes the SRI (Nelson,2018).

Figure 1.1: Growth of SRI Assets by region 2016-2018 (GSIA, 2019)

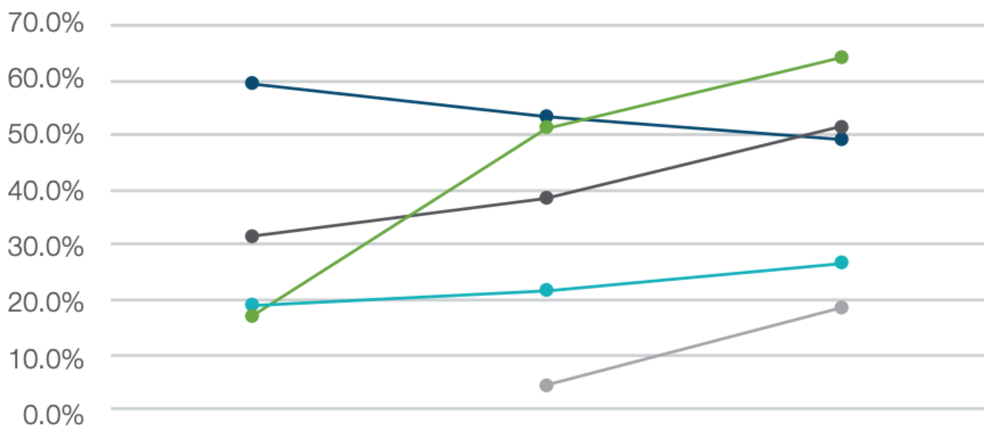
This figure highlights the value of global SRI assets in the five major markets. The asset values are expressed in billions of U.S dollars (GSIA, 2019)

Region	2016	2018
Europe	$ 12,040	$ 14,075
United States	$ 8,723	$ 11,995
Japan	$ 474	$ 2,180
Canada	$ 1,086	$ 1,699
Australia/New Zealand	$ 516	$ 734
TOTAL	**$ 22,890**	**$ 30,683**

As we can see in figure 1.1, at the start of 2018 there were $30.7 trillion of assent under management respecting the SRI values. The increment from the 2016 value represent an increase of 34% of the SRI assets under management (GSIA, 2019). All the market regions in figure 1.1 have exhibited an increase in SRI assets in the analysed period. Europe, United States and Japan present the higher value of SRI assets however Australia, Japan, Canada and New Zealand have had the faster growth with regard to the SRI assets. Figure 1.2 illustrates the share of SRI assets relative to the total of asset under management (AUM).

Figure 1.2: Proportion of sustainable inventing relative to total Managed Assets 2014-2018 (GSIA, 2019)

The figure below, illustrates the share of SRI assets relative to total AUM in each of the five markets. Note that data for Japan was combined with the rest of Asia in 2014 so this information is not available (GSIA, 2019).

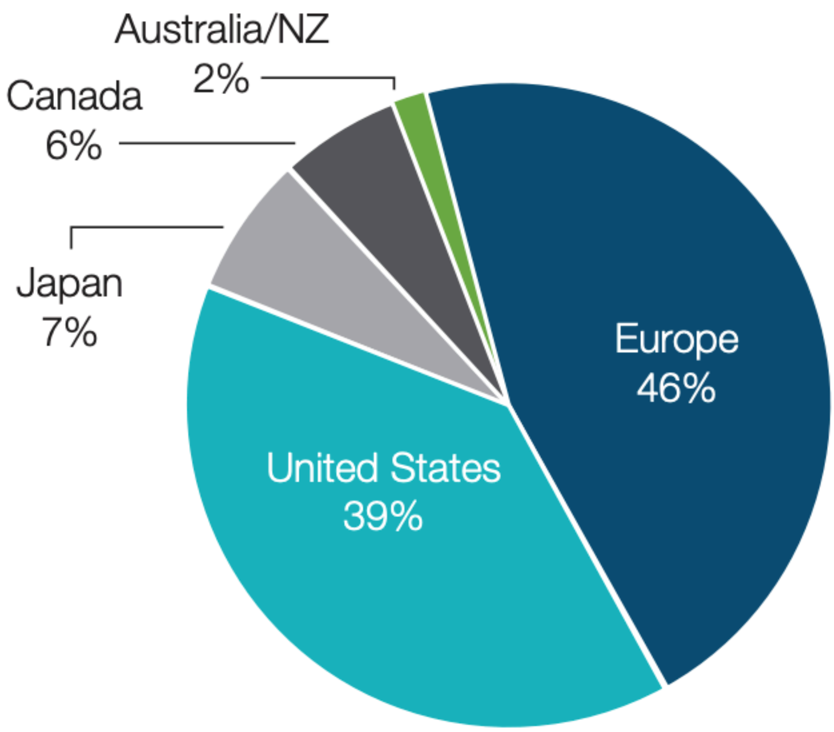


	2014	2016	2018
Europe	58.8%	52.6%	48.8%
United States	17.9%	21.6%	25.7%
Canada	31.3%	37.8%	50.6%
Australia/New Zealand	16.6%	50.6%	63.2%
Japan		3.4%	18.3%

Figure 1.2 shows that the portion of assets under management with SRI standards has a considerable value for all the five markets, which varies from the 18% for Japan to around 63% for Australia and New Zealand. In addition, the SRI share of AUM has increased between the period 2014-2018 for all the analysed markets with the exception of the European market. This exception can be attributed to a shift to more stringent standards and definition for SRI (GSIA, 2019). In addition, as shown by figure 1.3, Europe continues to manage the higher portion of sustainable and responsible investments, which corresponds to almost half of global sustainable investment (GSIA, 2019), followed by United States. Given the amplitude of the growth of SRI investments it is possible to argue that SRI represents an important investment landscape in the global financial markets.

As highlighted by GSIA report, institutional investors have the 75% of the SRI market shares in 2018 while the market shares of retail investors have increased as well, between the period 2016-2018, of the 5%. Another important result highlighted by GSIA (2019) report is that the interest of retail investors in SRI has been steadily growing since 2012. Therefore, it is evident that the appeal to sustainable and responsible investment is growing for both institutional and retail investors.

Figure 1.3: Proportion of global sustainable investing asset by region 2018 (GSIA, 2019)



1.3 Rating methodology

Given the growth of the SRI market there has been a need to provide investors with a rating score on sustainable investments. These ratings are additional to the financial rating provided by Standard & Poor's, Moody's and Fitch. These agencies analyse companies in three areas: Environmental, Social and Governance. These areas cover multiple standards and criteria. Agencies have to analyse these criteria based on policies set out by the firms, the reporting of initiatives taken and the result of these initiatives as well as the implementation of the measures adopted, to provide an overall rating for each company (Novetich research, 2013). In order to provide an ESG score, agencies use information from various sources such as companies, stakeholders and the media (Novetich research, 2013). All rating agencies have developed an almost unique rating system, with a shared aim and different scoring systems due to the assignment of different weights given to the respective analysed criteria.

This thesis does not focus on how an ESG score is achieved but uses this score to build a portfolio strategy. For this reason, only one example is used to show how sustainable rating agencies work, in order to give the reader a more precise idea of these procedures. The analysed rating agency is Morgan Stanley Capital International (MSCI) ESG rating and the methodology is divided into 4-steps:

- Companies are valued on their risk management and risk exposure for each of the three main pillars that correspond to an ESG investment. These pillars are broken down into 10 macro categories which include the 37 ESG key Issues for which a 0-10 scale is provided. Appendix A5 shows how the MSCI agency assigns the score to the company.
- For each of the three pillars, Environmental, Social and Governance, a global score is computed.
- By combining the score for each of the three pillars, a Final Industry Adjusted Score is achieved.
- This Final score is expressed on a decreasing scale from AAA to CCC and it is given by the weighted average of Key issues score normalized by industry.

In this context also Bloomberg, being the most used platform by investors to obtain financial data, has started to provide to investors an ESG score in order to facilitate their access to this value. The Bloomberg ESG metrics is retroactive to 10 years and provides insight for over 9000 companies across 70 countries. "Its product includes as reported data, derived ratio, sector and country specific fields in common to 900+ fields that include ESG disclosure score and span across several sustainability key topics such as:

- Air quality
- Climate change
- Water & energy management
- Materials & waste
- Human capital
- Audit risk & oversight
- Compensation
- Diversity
- Board independence, structure and tenure
- Shareholders' rights etc."[5]

As MSCI ESG rating it is composed by the 3 main criteria E, S and G which are divided into subcategories with their respective weights. Bloomberg gives an equal weight of 33.33% to the E, S and G criteria.

In order to perform this analysis, Bloomberg ESG score was used. All the rating methodologies present some differences however, they share a common goal; to help the investors decide whether a company effectively respects the ESG values and enables them to develop sustainable investment strategies.

II. Methodology

2.1 Data description and variables definition

In order to conduct the following analysis, the MSCI world index was used. The index contains 1601 constituents and it captures large and mid-cap firms across 23 Developed Markets. It covers around 85% of the free float-adjusted market capitalization in each country (MSCI World Index)[6]. The data has been downloaded from Bloomberg; it does not provide the composition of the index but only the

[5] Environmental, Social & Governance (ESG) product [Bloomberg, contest and data solution]

[6] Information obtain from MSCI World Index published at the link: https://www.msci.com/documents/10199/178e6643-6ae6-47b9-82be-e1fc565ededb

one of its relative ETF. Taking the aforementioned into account, an ETF[7] which mimics the index return was used, containing 1227 participants.

There are two main time-series, one contains daily price for each firm in the index and the other one contains yearly ESG scores for each participant in the index for the period 2010-2019. The time frame included is from 2010-01-01 to 2020-07-31. Daily observations as opposed to monthly were used in order to avoid non-invertible matrix issue in the optimization problem develop in this analysis. To develop this study, the price data set has been filtered for the only firms which have no missing ESG score in the ESG time-series observation 2010-2020. The new sub-sample is a time series of 2759 observation and 965 variables corresponding to the securities in the sample.

2.2 The Markowitz Mean-Variance Formulation

With the aim of understanding if a portfolio composes by high sustainability firms overperform or underperform a portfolio composes by low sustainability firms I have used the Markowitz (1952) mean-variance approach to define the efficient frontiers for both the portfolios and to compare them. This model corresponds to the foundation of the modern portfolio theory and it provides benefit in terms of risk-return trade off given by the advantage coming from the diversification of securities in the portfolios. The assumptions underlying the model are the follows:

1. "Investors consider each investment alternative as being represented by a probability distribution of expected returns over some holding period.
2. Investors maximize one-period expected utility, and their utility curves demonstrate diminishing marginal utility of wealth.
3. Investors estimate the risk of the portfolio on the basis of the variability of expected returns.
4. Investors base decisions solely on expected return and risk, so their utility curves are a function of expected return and the expected variance (or standard deviation) of returns only.
5. For a given risk level, investors prefer higher returns to lower returns. Similarly, for a given level of expected return, investors prefer less risk to more risk. "[8].

[7] iShares Core MSCI World UCITS ETF USD (Acc) ISIN IE00B4L5Y983, Ticker SWDA (Bloomberg)

[8] Investments Analysis & Portfolio Management; FRANK K. REILLY, KEITH C. BROWN, 10th edition, chapter 7

By achieving a good percentage of diversification, it is possible to reduce the risk of the portfolio however, a lower expected return has to be expected. The expected return of a portfolio is given by the following equation:

$$E(r) = w'\mu \qquad (1)$$

E(r) represents the expected return for the portfolio, w is the vector of weights for the securities and μ is the vector of expected returns.

Concerning the risk measure, the risk of the portfolio is measure by the variance of its returns.

$$V(R) = \sum_{i=1}^{n} w_i^2\, \sigma_i^2 + \sum_{i=1}^{n} \sum_{j=1}^{n} w_i w_j \sigma_{i,j} \qquad \text{with } i \neq j \qquad (2)$$

V(R) represents the variance of portfolio returns, σ_i^2 is the variance for each security contained in the portfolio and $\sigma_{i,j}$ corresponds to the covariance between securities *j* and *i,* It expresses the measure to which the returns move together. The diversification benefit is provided by the correlation of the securities which is a component of the covariance formula. In the case of only two securities are analysed, we won't have any diversification benefit from it when the correlation is equal to 1 while, if it is equal to -1, we would have a risk-free portfolio which is tangent to the vertical line in a risk-return plot. When $-1 < \rho_{i,j} < 1$ the portfolio gains in terms of risk from diversification. A low value of correlations between securities into the portfolio decrease the variance of the portfolio, while, in particular, negative correlated securities gain a huge risk reduction benefit. The Markowitz mean-variance optimization provides n different portfolios, based on different levels of risk aversion, which are efficient[9] in terms of risk and return. The optimization can be developed in order to find the minimum level of variance for a given expected return, or the maximum expected return for a given level of risk (Stephen, 1979).

The mean-variance approach minimizes "an objective function subject to constraints. The objective function *f* incorporates the concept of trading off risk against return and is given by"[10]:

[9] In Markovitz theory, an efficient portfolio means that it has the maximum expected return for a given level of risk.

[10] Stephen F. Witt, Richard Dobbins "The Markowitz Contribution to Portfolio Theory ", Managerial Finance, Vol. 5 Issue: 1, pp.3-17. 1979

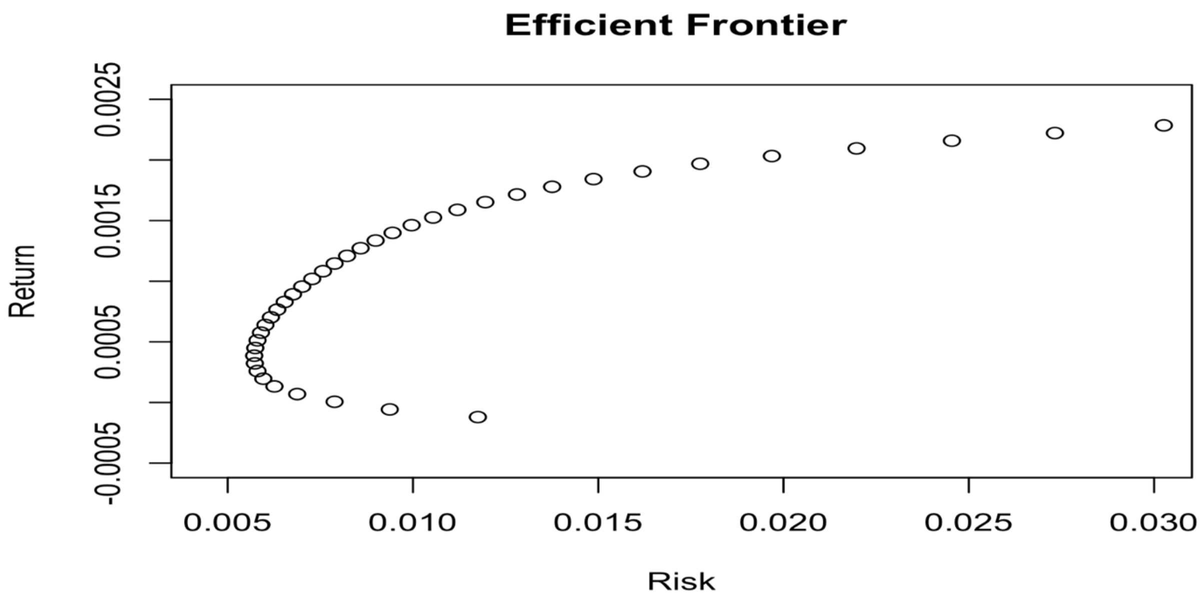
$$\mathcal{M} \ minimize \quad f = [E(R)] - A \frac{1}{2} w' \Sigma w \quad with \ 0 \leq A \leq \infty$$

$$subject \ to \quad \sum_i^n w_{i=1} \quad and \quad w_i \geq 0 \tag{3}$$

A is the risk aversion for the investor. As A approach 0, the investor will be more willing to accept a higher variance in order to obtain a higher expected return. As the risk aversion increase, the investor will select a portfolio with a lower variance. For the maximum level of risk aversion, an investor will pick the minimum variance portfolio. The first constraint means that the portfolio consists of n securities while the second prohibits the short selling as this analysis is aimed only at investors with a high level of risk aversion such as pension funds and governance funds.

In Markowitz theory, the efficient portfolios are any portfolios solving the above quadratic program. Each of these portfolios correspond to a different value of risk aversion for an investor. This concept is express as efficient frontier, shown in figure 2.1. This frontier represents a curve on which lies all the best possible portfolios, in terms of smaller standard deviation, for a given level of excess return.

Figure 2.1. It represents the set of n efficient portfolios, in terms of risk-returns trade-off, for all the possible levels of risk aversion. The y-axis represents the return, while the x-axis represents the risk for the n portfolios.



Given the assumption of risk aversion, all the investors will prefer a portfolio that lies on the frontier with respect to interior portfolios. "An investor will pick a point along the efficient frontier based on his utility function, which reflect his/her attitude toward risk"[11].

As shown in figure 2.1 the slope of the efficient frontier decreases as we move along the risk-axis. This means that once it is reached a certain level of risk on the frontier the increments of excess return as unit of added risk diminish.

2.3 The ESG portfolios

In this section, I have used the above theory in order to analyse the behaviour of portfolios constructed with securities that belong to the 80th and 20th percentiles of the ESG score distribution which are identified as high and low sustainable portfolios. I have adapted the mean-variance optimization integrating the ESG constraint.

$$\mathcal{M}\ \ minimize\quad f = E(R) - A\ \frac{1}{2} w'\Sigma w \quad with\ 0 \leq A \leq \infty. \tag{4}$$

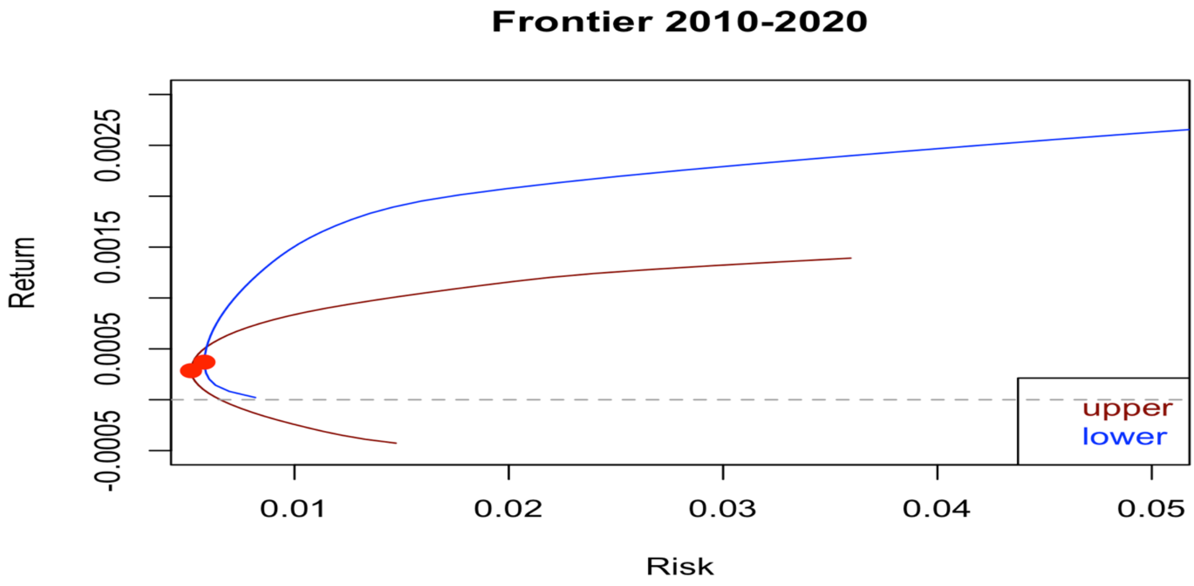
$$subject\ to\ \ ESG_i(<,>)ESG_{quantile}(x),\ \sum_i^n w_{i=1}\ \ and\ \ w_i \geq 0\ \ \ where\ x = (80\%, 20\%)$$

The addition of this constraint to the optimization problem allowed me to sub-set the sample in order to select firms that belong to the lower and upper tail of the ESG score distribution. From now the subsample of firms that have an ESG score bigger than 80th percentile will be referred to as "upper" and the ones which contain firms with an ESG score below the 20th percentile as "lower".

Initially the efficient frontiers were built for both the samples with 50 possible portfolios composing the frontiers. An in-sample valuation for a timeframe of 10 years (2010-2020) using as ESG quantile constraints the 80th and 20th percentiles of the 2010 ESG score distribution was used. Using the 2010 ESG score distribution, in order to set up the constraints means that the lower and upper samples represent all the firm that in 2010 were classify as high and low sustainable firms. This part of the analysis aims to evaluate how two optimize samples, with a fix ESG constraint, would have performed in the next ten years from their setup. The plot below represents the efficient frontiers for the 2010-20 period.

[11] Investments Analysis & Portfolio Management; FRANK K. REILLY, KEITH C. BROWN, 10th edition

Figure 2.2 shows the efficient frontiers for the high and low sustainable firms over the period 2010-2020



As we can see in figure 2.2 the lower dominates the upper. The red dots in both the frontiers represent the minimum variance portfolios for the two samples. The minimum variance portfolio of the lower has a higher return and a higher risk compare to the upper one. The plot shows us how the lower frontier has not any portfolios with negative returns in the lowest part of the curve while the upper has 12 portfolios with negative returns. The premium for a given unit of risk is way higher for the low sustainability sample.

Given this result it is evident that an investor who was disinterested in sustainability issues during the late 2010 would have hugely overperformed an investor who was receptive to the ESG values. To understand whether the predominance of the lower is consistent over the years the frontiers for the 2013-20, 2016-20, 2019-20 are shown in appendix A1.

The appendix A1 illustrates how the two optimized samples behave, in terms of efficient frontier, by changing their starting date. The predominance of the lower frontier is still present but to a lesser extent. The first notable difference, three years from the start of this analysis, is that the negative slope of the lower is increased, and the portion of negative returns portfolios has surpassed the one of the upper in 2019-20. The positive slope of the upper has increase as time approach while the positive slope of the lower has increased to a lesser extent. Last but not least, with regards to the minimum variance portfolios, the premium for the risk of the upper sample has become more powerful compared to the one of the lower. In accordance to this fact, 2019-20 frontier shows how the upper minimum variance portfolio presents, for almost the same amount of return, a lower risk compared to the one of the lower. This overperformance may have been due to the financial crisis caused by the Corona Virus which results would be in line with the ones of Nofsinger (2014) and Nakai (2015). Giving these results it seems that the market has started pricing the Environment, Social and Governance important issues and that the ESG investment universe is becoming considered by investors less risky than its opponent.

The next section aims to further analyse the behaviour of both the minimum variance portfolios evaluated in different periods compared to the behaviour of the MSCI world index.

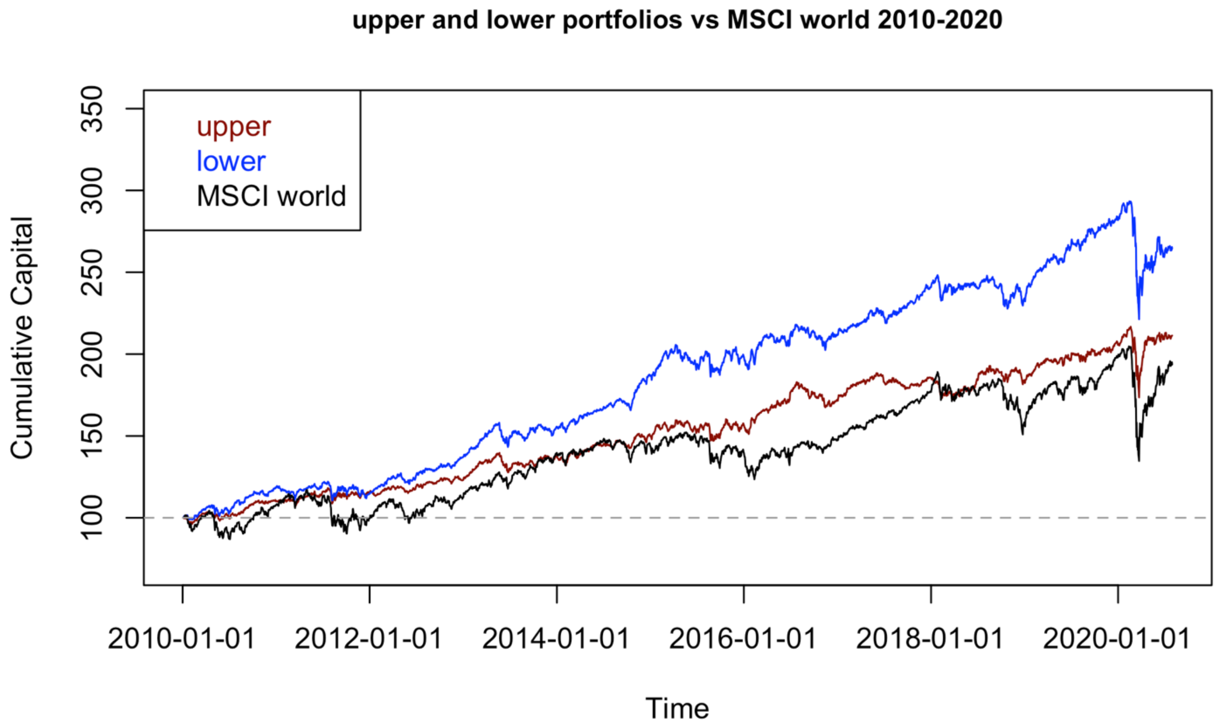
2.4 Min-variance portfolios performance

Selecting the minimum variance portfolio means that this portfolio is suitable for an investor that has the maximum possible risk aversion. For this analysis, I have selected the only minimum variance portfolios, on the efficient frontiers, in order to analyse the behave of the two sub-samples compare to their benchmark and to compare the maximum risk tolerance of an ESG and non-ESG investor for the same level of risk aversion used in the optimization problem.

Figure 2.3 presents the in-sample graphical trends for the lower and upper portfolios which are represented by the colours blue and dark red while the MSCI world index is represented by the black line. These portfolios are evaluated from 2010 to 2020 and they consider the 2018 financial crisis and the whole Corona Virus pandemic. In order to show their trends in a more accurate way the returns to 100 have been normalized.

As highlighted by the efficient frontier in figure 2.2, figure 2.3 shows how the lower portfolio overperforms the upper one while both of them overperform the benchmark. By analysing only the last two years of the trend we can see how the upper portfolio is less sensitive, in terms of returns, to the advent of a financial crisis. The loss of value in both the last two financial crises has been smaller for the upper portfolio compared to the lower one; this was clearly highlighted during the Corona virus pandemic where the lower portfolio has lost almost 100 cumulated point while the upper one has only lost 45 cumulated points.

Figure 2.3: portfolios and index performances over the period 2010-2020.
the dotted line represents the limit within the portfolio's performance are positive.



In appendix A2 the graphic trends for the min-variance portfolios that lies on the frontiers displayed in appendix A1 are shown. In appendix A2 the first two plots 2013-20 and 2016-20, indicate that the lower portfolio overperform the upper one whereas, in the third plot, the opposite occurs. In appendix A3 annual returns and the annual standard deviation for the previous mentioned portfolios are reported.

In appendix A3, the lower riskiness of the two optimize portfolios compared to the index is noticeable. For all samples evaluated, the trade-off between risk and returns is more favourable for the lower and upper portfolios. Overall, the lower portfolio has a higher risk return trade-off for all samples with exception of the 2019-20. As the selected portfolios are those with the minimum variance, they are constructed with the same value of risk aversion. How highlighted by the above findings, for the same level of risk aversion, non-sustainable investors are willing to accept a higher risk compare to sustainable ones in order to obtain a higher return. This different risk tolerance might be explained by the fact that generation Y, investing more in accordance to their personal values with respect to older investors, represents the biggest section of SRIs universe (MSCI, 2020). Compared to generation X and baby boomers, generation Y tends to have less invested capital which makes them more risk averse as well as being more careful about sustainable issues.

These results confirm the previous hypothesis emphasizing how, in the last two years, the market has started considering the high sustainable investment universe a better option for a long-term investment due to its higher return for a lower risk portion.

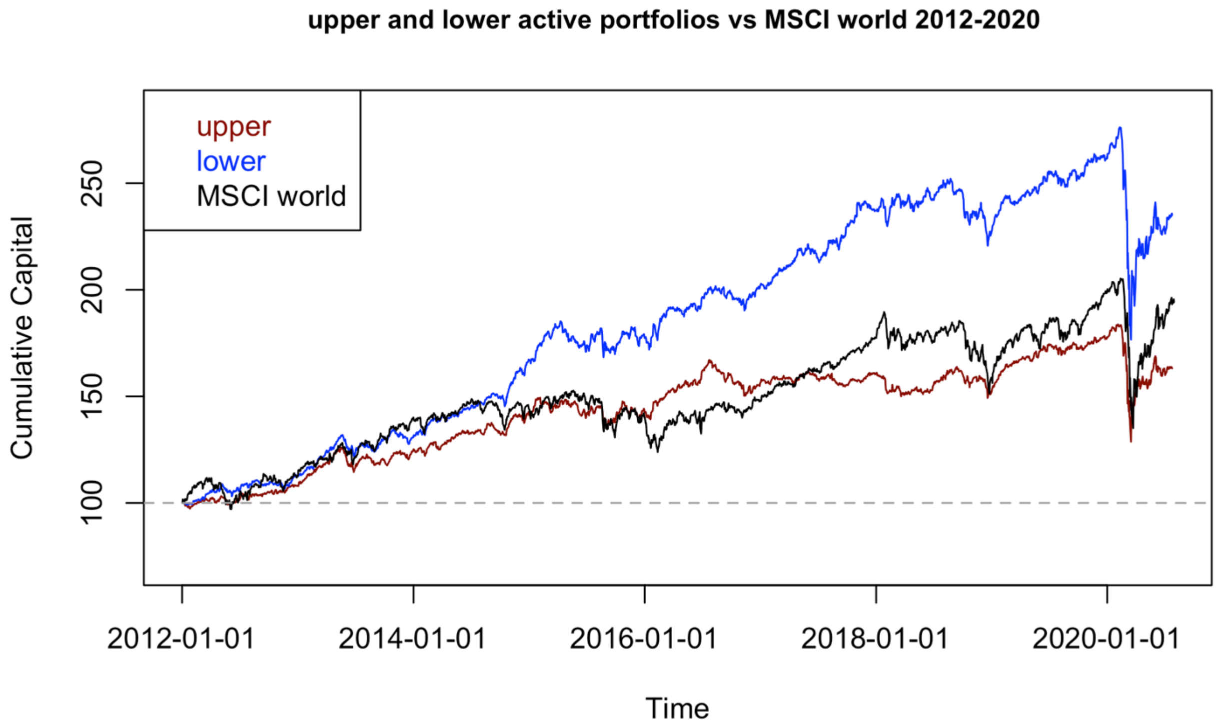
2.5 The active portfolio

Given the results so far, a good question to ask is how an active portfolio with ESG constraints would have behaved in the analyse period. In order to answer at this question, the mean-variance optimization problem was adapted to allow it to iterate year by year over the ESG, the ESG quantiles and the return data frames. As a result of this optimization problem, a data frame composed in each row by the total daily return of the only stocks that participate to the minimum variance portfolio for the *i*-th year is returned. This active portfolio is long-only and the portfolios' components update is yearly. The back-test sample for this optimization problem (for each of the *i* years) was given by the previous five years daily return observations for the whole index. The portfolio computation starts on January 1st each year and uses the value obtained on December 31st of the previous year as an ESG constraint. Throughout the construction of these active portfolios the bid and ask transaction were not taken into account.

These active portfolios being yearly update and their relative risk measures, used to analyse their performance, presented in table 1 in the next section are a useful instrument to bettered evaluate the results highlighted by the previous findings.

The active ESG portfolios are assessed over the period 2012-2020. The first two year have been excluded from the evaluation due to the low interest of market participants in the ESG investment universe which could have given a starting bias to the lower portfolio.

Figure 2.4 represents the comparison between the upper, the lower active portfolios and the MSCI world index for the period 2012-2020



As we can see in figure 2.4 the lower active portfolio dominates both the upper active one and the MSCI world index. The lower portfolio has a drastically grown after 2015; before the Corona virus pandemic it used to have 100 cumulated points more than the high sustainable active portfolio and almost 80 more than the referencing benchmark. Analysing only the 2018 and 2020, which represent the 2018 financial crisis and the Coronavirus pandemic, we can see how the upper portfolio performs better than the lower one during the two crises. This result is in line with Nofsinger (2014) and Nakai (2015) ones.

Given the performance of these two active portfolios, it seems clear how an active manager could have gained a positive alpha in the low sustainable scenario. As these portfolios are annually iterated, it could be interesting to compare how the portfolios behave across the years and throughout all periods of their life.

As a result, the yearly cumulative growth for the single year weighted portfolios have been reported in appendix A4 and compared to the MSCI world index for the relative year. As predicted by the active portfolios in figure 2.4 the lower portfolio in appendix A4 (represented by the blue curve) has a higher performance compared to the benchmark; this is true for almost all the samples, with the exception of 2019 and 2020 where the latter is dominated by the benchmark and the upper portfolio. The upper portfolio in appendix A4 (represented by the dark red line), has always been dominated by the lower one, except for the last two periods; additionally, it has been dominated by the benchmark in some periods, while in others it was dominating the index.

The results highlighted by the active portfolios confirm the outcome achieved in the previous section. An active strategy developed on the MSCI world index which is long on the firms that have a high ESG score seems to underperform an active strategy which, on the other hand, is long exclusively towards the firms that have a low ESG score. The findings are only based on the returns factor which are represented by the trend of the portfolios' cumulated returns on the plot. However, these are not enough to properly assess the dominance of a portfolio over another nor over the benchmark; to do so, we need statistical measures which can ascertain the relative risks of the aforementioned portfolios. These measures are displayed in the next section and focus exclusively on the risk measures.

III. Risk measures and results

This section aims to introduce the main theory behind risk measures which have been used to assess risk in the two active portfolios and compare them with those belonging to the MSCI world index.

3.1 Tracking error volatility

The main measure used to evaluate the risk of a portfolio's absolute risk is the standard deviation, which measures the volatility of its returns. The tracking error is a common risk measure used to compare a portfolio with its relative benchmark and it's closely associated with the excess return. Tracking error is a useful ratio to gauge in which measures a portfolio overperform or underperform its benchmark. For a high value of the tracking error, the portfolios will have a drastic deviation from its benchmark. The lower the tracking error, the more the portfolio performance will mimic those of the benchmark.

This gauge is used to value the active decision by the portfolio manager to defer from the benchmark position weights. It only measures the volatility of excess returns, but it does not affect the positive and negative direction of the excess returns.

There are two measures of tracking error volatility; the ex-post or the ex-ante. The tracking error volatility is the standard deviation of the active returns in terms of difference from the benchmark, and is given by the following equation:

$$TE = \sqrt{Var(r_p - r_b)} = \sqrt{E\left[(r_p - r_b)^2\right] - \left[E(r_p - r_b)^2\right]} = \sqrt{(w_p - w_b)^T \Sigma\, (w_p - w_b)} \qquad (5)$$

The ex-ante tracking error evaluation is based, given the assumption of normality of the excess return's distribution, on a forecasting model. It is given by the product between equation 5 and the quantile of a normal distribution, expressed by z in the following equation, for a certain confidence interval.

$$TE_{ex-ante} = \left(\sqrt{(w_p - w_b)^T \Sigma\, (w_p - w_b)}\right) * z \qquad (6)$$

The ex-post tracking error, for a given confidence interval, is equal to the x percentile of the historical returns' distribution.

A high value of tracking error, for both ex-ante and ex-post measures, is a good result for an active portfolio manager as it allows the portfolio to vary from the benchmark performance, that is exactly the aim of an active manager. With regard to a passive portfolio manager (whose aim is to mimic the performance of the benchmark as much as possible with the lowest possible transaction costs) a good result in terms of tracking error is considered to be a low value.

3.2 Upside and downside volatility

The volatility of a portfolio is computed as the standard deviation of its returns. It is clear that this measure captures the variation from its mean for both positive and negative returns. The downside risk was firstly modelled by Roi (1952) who described the semi-standard deviation and assessed for the downside risk, as a 'safety first' rule. The downside volatility is evaluated as the standard deviation of only the negative returns of the portfolio; as such, it expresses the negative variation of the portfolio performance. From an investor's point of view, the lower the downside volatility the better the investment will be. Semi-standard deviation is used by Post-Modern-Portfolio theory due to it recognizes that investors prefer upside risk rather than downside risk. Among the positive aspects of this risk measure, is that it considers the investor's preference for the upside potential with respect to the downside risk.

The upside volatility is the ‘risk’ premium that it is researched by the investors. It represents the range of variation of the positive returns from their mean and the higher it is, more will be the potential returns for the investors.

These two measures are evaluated with the following equations.

$$SD_m = \sqrt{E[r_m^2] - E[r_m]^2} \quad \text{where m = (+, -).} \tag{7}$$

Where m specifies the sing used in equation 7 and SD_m represents the upside and downside volatility.

A practical market measure uses in this thesis to value the portfolios performance is the so-called volatility skewness.

$$Volatility\ Skew = \frac{Downside\ Risk}{Upside\ Risk} \tag{8}$$

This ratio gives to an investor a measure of the asymmetry of the volatility distribution. For a value greater than one, the portfolio volatility has a bigger inclination in the negative side of the volatility distribution which translate in higher risk for the investor. As opposite, a value lower than one is positive for an investor, meaning that the positive variation of the portfolio returns has a greater amplitude with respect to the negative one.

3.3 Sharpe Ratio

The Sharpe ratio was introduced by William F. Sharpe in 1966. The ratio is used by investors in order to analyse the performance of a portfolio compared to the risk-free asset after adjusting for the risk of the portfolio. It gives information on how much excess return an investor gains adding a single unit of risk. The higher this value, the more excess return will be added per unit of risk for the investor.

$$SR = \frac{(R_p - R_f)}{\sigma_p} \tag{9}$$

3.4 Value at risk

Value at risk is a downside risk measure based on a certain position and it summarizes risk in a single number. “VaR is the worst loss over a target horizon such that there is a low prespecified probability that the actual loss will be larger"[12]. VaR requires the definition of two factors, the horizon and the confidence level. The VaR correspond to the smallest loss, such that

$$P(L > VaR) \leq 1 - c \tag{10}$$

Where c represent the confidence level and L is the loss. The general method for computing the VaR is the nonparametric one and it does not make any assumption on the distribution of returns. W_0 is defined as the initial investment and R as its rate of return, that is random. At the end of the target horizon the portfolio value is equivalent to W=$W_0(1-R)$ assuming that the position is fixed. The expected returns and the volatility of the investment are defined as μ and σ. W*=$W_0(1-R^*)$ corresponds to the lowest portfolios value for a given confidence level c. The value obtained by the VaR model is always a positive number representing the worst loss at some confidence interval. VaR can be defined as the dollar loss relative to the mean on the horizon as

$$VaR = E(W) - W^* = -W_0(R^* - \mu) \tag{11}$$

The most common way to evaluate the VaR is deriving it from the probability distribution of the future value *f(w)* (Jorion, 2001). The aim of this model is to identify the worst possible realization W*, for a given confidence interval c, for which the probability of surpass this value is c:

$$c = \int_{W^*}^{\infty} f(w)dw \tag{12}$$

Or, conversely, the probability for a value to be lower than W*, p= P (w$\leq$ W*), is equal to 1-c that correspond to:

$$1 - c = \int_{-\infty}^{W^*} f(w)dw = P(w \leq W^*) = p \tag{13}$$

W*, for which a fixed probability exists, is the quantile of the distribution and it represent the threshold value of being exceeded. The nonparametric VaR does not use the standard deviation to compute the model.

The parametric VaR assumes returns to be normally distributed and given this assumption the computation can be simplified. This approach, instead of evaluating the quantile of the empirical distribution, involves the estimation of its standard deviation. If the assumption of normality is

[12] Jorion, P. (2001). Value at risk: the new benchmark for managing financial risk. New York: McGraw-Hill.

respected, it ensures a more accurate measure of VaR. In this model the general distribution *f(w)* becomes the normal distribution function $\Phi(\varepsilon)$ where ε has a standard deviation of a unit and zero mean. W* is associated with the cut-off returns R* and becomes $W^* = W_0(1 - R^*)$. R* can be associated with a standard normal deviate $\alpha > 0$ by setting: (Jorion, 2001)

$$-\alpha = \frac{-|R^*| - \mu}{\sigma} \tag{14}$$

That is equivalent to set:

$$1 - c = \int_{\infty}^{W^*} f(w)dw = \int_{-\infty}^{-|R^*|} f(w)dw = \int_{-\infty}^{-\alpha} \Phi(\varepsilon)d\varepsilon \tag{15}$$

Thanks to the normality assumption, finding the parametric VaR consists only in finding the deviate α such that 1 - c corresponds to the left area of it. For a given probability, α can be easily found on the cumulative standard normal distributions function table as

$$\rho = N(x) = \int_{-\infty}^{x} \Phi(\varepsilon)d\varepsilon \tag{16}$$

Form equation 14 we can extract the R* value as:

$$R^* = -\alpha\sigma + \mu \tag{17}$$

Given these results and a time interval Δt, it is possible to express the parametric VaR to the mean as:

$$VaR = -W_0 R^* = W_0\, \alpha\, \sigma\sqrt{\Delta t} \tag{18}$$

"The VaR represents a multiple of the standard deviation of the distribution times an adjustment factor that is related directly to the confidence level and horizon"[13].

It is possible to implement this model with different parametric distribution such as t-student for which it would vary the relative α. In this analysis the parametric VaR corresponds to the ex-ante VaR and the non-parametric one corresponds to the ex-post VaR.

[13] Jorion, P. (2001). Value at risk: the new benchmark for managing financial risk. New York: McGraw-Hill.

3.5 Sortino and modified Sortino ratios

This ratio is a modified version of the Sharpe ratio for which it penalizes only the returns falling below a target return. The Sharpe ratio does not make any distinction between the upside and downside volatility while the Sortino ratio measures the premium in term of returns for a given unit of downside deviation. As the Sharpe ratio this measure is used to compare the risk-adjusted performance of portfolios with different risk and returns profiles.

$$Sortino\ ratio = \frac{R-T}{DR} \tag{19}$$

T in equation 19 represents the target return under which the portfolio should not go. In this discussion T is assumed to be null. DR represent the downside deviation of the portfolio returns which is equal to the standard deviation of the only negative returns.

$$DR = \sqrt{E[r_-^2] - E[r_-]^2} \tag{20}$$

In this thesis I have built the modified Sortino ratio which takes the excess return correct for the downside and relates it to the excess return correct for the upside deviation. This ratio corresponds to the premium for the negative returns over the premium for the positive return. For the behavioural finance an investor who is not risk averse is optimistic so, with regards to this ratio, the downside risk should not be a factor for consideration. This investor will be willing to look for a fund that has an upside premium for the risk that is wider compared to the downside premium for the risk. Given this ratio a non-risk averse investor will expect a value smaller than 1, meaning that this measure goes in the direction of the upside premium. A risk averse investor would prefer to invest in funds with a premium for the risk on the downside part that is bigger than the premium for the upside; this is due to the need to self-protection from a possible loss or what can be derived from a potential loss. The investor would prefer to invest in funds with a modified Sortino ratio bigger than 1. This ratio tries to incorporate a concept of the behavioural finance into the choice of the investment and is given by the following formula.

$$Modified\ Sortino = \frac{\frac{(R_p - r_f)}{DR}}{\frac{(R_p - r_f)}{UR}} \tag{21}$$

3.6 Modified Value at Risk and modified Sharpe ratio

As proven by several authors Y. Mandelbrot (1967), E. Fama and J. MacBeth (1973), G. Szego (1975), R. Roll(1977), Peter Chung (2004), the returns are not normally distributed but they are distributed by a distribution which potentially has values of skewness and kurtosis which diverge form the mesokurtic one. Given this fact, the ex-ante VaR presented in the previous section appears to be non-reasonable given the assumption of normality distribution of returns. In this context it is possible to introduce the Cornish-Fisher (1937) Approximation. The authors prove, with an asymptotic approach, that it is possible to obtain a formulation of a modified quantile which is able to incorporate the effects of the asymmetry and kurtosis inside the distribution. This expansion allows to transform a standard Gaussian random variable into a non-Gaussian random variable (MAILLARD, 2012). The main point behind their findings is that if the distribution is Gaussian, the quantile corresponds to one of a normal distribution because the asymmetry and the kurtosis will remain unaltered. In case of non-normal distribution there are two possible approaches; the first approach, uses a process which can model the asymmetry and the kurtosis, such as the Gamma variance process. In contrast to the Winer stochastic process (which uses the normal distribution), the Gamma variance process models the distribution by taking in consideration the skewness and the kurtosis. This process is commonly used when modelling the historical series of the Euro-Dollar in the evaluation of the option prices, due to the presence of the volatility smile[14]. It follows that it is possible to model the VaR with a parametric approach using distributions such as Gamma or Laplace; similarly, it is possible to start from a Gaussian distribution and to move the relative quantile left and right whilst taking into consideration both the asymmetry and the kurtosis. Given the second approach, Cornish and Fisher have asymptotically proven the validity of this modified quantile. The modified quantile of Cornish Fisher tends to be preferred with respect to the first aforementioned approach due to computational reasons. Another reason for which the modified quantile is preferred to a modelled distribution such as the Laplace distribution is that the four moments request from the model to implement a Monte Carlo simulation are evaluated on the historical returns. As the normal distribution is the starting point for both the model, the Cornish Fisher approach reaches the same result with smaller computation and requiring a smaller robustness.

The following equation corresponds to the modified VaR.

[14] The volatility smile represents the shape that comes from the plotting of the strike price and the implied volatility of a bunch of options having the same expiration date and underlying asset

$$modified\ VaR^{p} = W_0 * CF_p^{-1}\ \sigma\sqrt{\Delta t}$$

$$CF_p^{-1} = \Phi_p^{-1} + \frac{\zeta_1}{6}\left[\left(\Phi_p^{-1}\right)^2 - 1\right] + \frac{\zeta_2}{24}\left[\left(\Phi_p^{-1}\right)^3 - 3\Phi_p^{-1}\right] - \frac{\zeta_1^2}{36}\left[2\left(\Phi_p^{-1}\right)^3 - 5\Phi_p^{-1}\right] \quad (22)$$

In equation 22 $\frac{\zeta_1}{6}$ represents the sample skewness, $\frac{\zeta_2}{24}$ represents the sample excess kurtosis and Φ_p^{-1} represents the portfolio returns distribution. The Cornish-Fisher quantile, CF_p^{-1} can be seen as a Taylor expansion around the normal distribution. If the portfolio returns distribution has neither skewness nor excess kurtosis $\zeta_1 = \zeta_2 = 0$ the Cornish-Fisher quantile corresponds to the normal distribution quantile, $CF_p^{-1} = \Phi_p^{-1}$.

In this section, the modified Sharpe ratio is introduced where the modified value at risk appears to the denominator as a risk measure instead of the standard deviation. This ratio, which is calculated taking into account the asymmetry and the kurtosis, can be seen as a precautionary measure expressing the excess returns after adjusting for the maximum possible loss for a given confidence interval.

$$modified\ Sharpe\ ratio = \left(\frac{R_p - r_f}{modified\ VaR}\right) \quad (23)$$

3.7 Risk analysis of active portfolios

Once the main theory behind the risk measures adopted has been introduced in this thesis, it is possible to provide a deeper analysis of the performance of the two active portfolios compared to MSCI world index. In table 1 all the key results necessary to value the risk of the active ESG portfolios are reported. For this analysis it is assumed that the risk free is zero and the confidence interval used to build the VaR, the ex-ante and ex-post tracking error is 95%.

In terms of mean-standard deviation, the lower portfolio dominates both the benchmark and the upper portfolio while the latter is dominated by the benchmark as well. The downside risk of both the active portfolios is smaller with respect to the downside deviation of the MSCI world index and the same goes for the upside risk. The volatility skew, which relates the downside over to the upside risk, is bigger for the two active portfolios compared to the benchmark and the upper portfolio has the higher absolute value for this ratio. Given these results it is possible to affirm that the negative volatility of the portfolios is more than proportional to the upside with respect to the benchmark. According to this ratio, the two active portfolios tend to be inefficient compared to the benchmark and in addition, the upper portfolio is inefficient compared to the lower one. Observing the Sortino ratio, the premium for the risk given the downside risk of the lower portfolios is much higher than the MSCI index and the upper portfolio. This portfolio rewards the increased risk very well for the downside part of it, meaning that it would be a good investment for a risk averse investor which requires a higher premium for the downside risk with respect to the upside one. Conversely, the Sortino of the upper portfolios confirms its inefficiency with respect to both the lower portfolio and the MSCI world index presented by the volatility skewness. A more sophisticated measure useful to judge the efficiency of these portfolios is the modified Sortino ratio. This ratio is built as the premium for the negative risk over the premium for the positive risk and shows that both the portfolios as well as the benchmark have a premium for the negative risk which is smaller than the premium for the positive risk. Given these results, the portfolios are inefficient for a rational investor which is risk averse while it would be a good investment opportunity for a non-risk averse investor which is not worried about potential losses but is only focused on the positive increment. Concerning the lower portfolios, the modified Sortino shows us how the simple ratio gives a non-accurate measure of the premium for the negative risk which could guide investors toward an investment that is not suitable for their risk aversion. This result shows the importance of the use of more sophisticated measures to assess an investment. Concerning the probability of losing the maximum amount of money invested for a given confidence interval the value at risk is presented. In order to value this potential loss, three different risk measures are introduced. The ex-ante VaR, the ex-post VaR and the modified VaR which is a modification of the ex-ante VaR for which the normality assumption is relaxed, and the referencing quantile is evaluated with Cornish-Fisher approach. The ex-ante VaR represents the ex-ante forecast, based on the assumption of normality distribution of returns, for the 95% confidence interval. As it is a forecasting model, it is based on the historical returns to predict the maximum potential lose for a given horizontal time and confidence interval. The most efficient way to explain this risk measure is through an example; let us assume the amount invested is equal to 100$, with a parametric approach the maximum potential loss for the lower portfolio corresponds to 7.55$ while for the upper one it is 9.94$ and for the benchmark the loss corresponds to 14.14$. Given this parametric approach the lowest portfolio is the one with the smaller loss. In the case of the ex-post VaR, which is a retroactive measure, the valuation is based on the only historical returns and the upper portfolio is the one with the smallest loss compared to the other two. As mentioned in the VaR section, the returns tend to have a non-normal distribution with a skewness and kurtosis values that diverge from the one of a mesokurtic distribution. Taking this into account, it is easy to understand the usefulness of the ex-ante modified VaR. This value is greater than its relative parametric approach for the three analysed portfolios, due to the negative value of the skewness of the funds which goes to ratify downwards the parametric VaR; taking into consideration this negative asymmetry for which it is more likely that there will be negative returns around the mean compared to the positive returns in purely probabilistic terms. Analysing the Sharpe ratio, it is possible to see how the premium for the absolute risk is higher for the lower portfolio followed by the benchmark, which has a risk premium that is 33% lower than the low ESG portfolio's premium and lastly, there is the upper portfolio. Given this result the lower portfolio is more efficient than the benchmark, but their Sharpe ratios are still lower than one which means that the risk is not more than compensated by the excess return. To be identify as a good investment according to the Sharpe ratio, a portfolio should have at least a value greater than one. By evaluating the modified Sharpe ratio, (in which the denominator does not include the standard deviation but the modified VaR) it is possible to see how this more sophisticated ratio confirms the findings of the simple one, for which the lower portfolios dominate the others. In addition, if we take the maximum loss (whilst taking in consideration the asymmetry and kurtosis of the fund) the 'real' risk is more than compensated by the excess returns of the portfolio for which the modified Sharpe ratio has a value of 1.4022; therefore, the excess returns are more than proportional to the risk assumed. This result is a guarantee of the efficiency of the portfolio, not only with respect to itself being greater than 100%, but also with respect to the benchmark and the other active portfolio. The modified Sharpe ratio confirms the inefficiency of the upper portfolio compared the lower one.

The results highlighted by these risk measures, for the active portfolios, show how a high ESG portfolio has a lower risk compared to a non ESG one as shown by the annual volatility and the ex-post VaR in table 1. However, it is less efficient in terms of annualized mean return, premium for the risk expressed by the Sharpe ratio, Sortino ratio and their modified versions, the two ex-ante VaR and the volatility skew with respect to the lower one.

Table 1: Risk measures for sustainable and non-sustainable active portfolios and MSCI world index for the period 2012-2020.

Portfolios comparison	Lower portfolio	Upper portfolio	MSCI world index
TE	18.05%	17.38%	-
Ex Ante TE	29.68%	28.59%	-
Ex Post TE	20.69%	12.61%	-
Annualized Mean Return	10.83%	6.20%	8.96%
Annualized Vol	11.18%	9.81%	14.04%
Downside Risk	7.73%	6.85%	9.47%
Upside Risk	6.67%	5.62%	8.29%
Volatility Skew	1.16	1.22	1.14
Sharpe ratio	96.91%	63.15%	63.79%
Sortino ratio	140.22%	90.48%	94.54%
Ex Ante VaR	-7.55%	-9.94%	-14.14%
Ex Post VaR	-12.01%	-11.04%	-20.44%
Skew	-0.51	-0.50	-0.17
Kurtosis	1.69	1.99	1.91
Ex Ante Modified VaR	-8.74%	-10.91%	-14.28%
Modified Sharpe Ratio	123.90%	56.80%	62.74%
Modified Sortino ratio	86.31%	82.04%	87.54%

IV. Conclusion

In recent years, investors' interest for SRI issues has significantly grown as has the discordant literature about the overperformance of high sustainable portfolios. In this contest, I shall attempt to answer the question of whether a high ESG portfolio can overperform or underperform a low one in addition to analysing the risk tolerance, for the maximum level of risk aversion in the optimization problem, for sustainable and non-sustainable investors. This thesis uses MSCI world index stocks to build and analyse efficient frontiers and static and active min-variance portfolios, over several periods, constructed with securities that lie on the tail of the ESG score distribution. The results of this thesis highlight an underperformance of ESG portfolios compared to non-ESG ones for almost all samples analysed with exception of the 2019-20 where the financial crisis, caused by the Corona virus pandemic, might be a reason of this overperformance. The analysed period covers both the 2018 and the Corona virus financial crises and, for almost all the periods, high ESG portfolios tend to perform better in a bear markets than its opponents. These results are in line with the ones of Nofsinger (2014) and Nakai (2015). The efficient frontiers and the static min-variance portfolios show that, for the same level of risk aversion, non-sustainable investors have a higher risk tolerance than sustainable ones but, at the same time, they are rewarded with a higher expected return. Active portfolios, through risk measure analysed in section III, provide a more profound analysis regarding the performance of the two ESG extreme portfolios and their risk-returns trade-off. Section III confirms the lower riskiness of the upper sample but at the same time emphasises the inefficiency of the upper portfolio compared to the lower one. In conclusion to this analysis, it would not be optimal for a manager to develop an ESG strategy in order to achieve a higher shareholder return over the last 10 years but adopting this strategy could be a good investment opportunity for high risk averse investors given the lower risk involved.

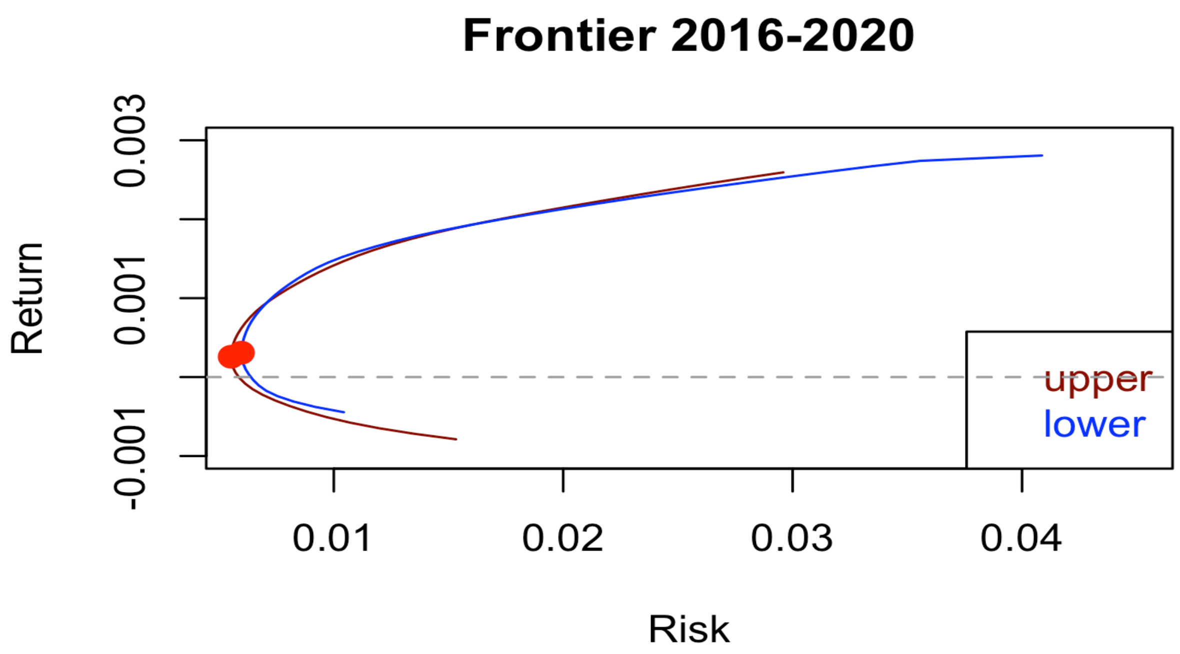
4.1 Discussion

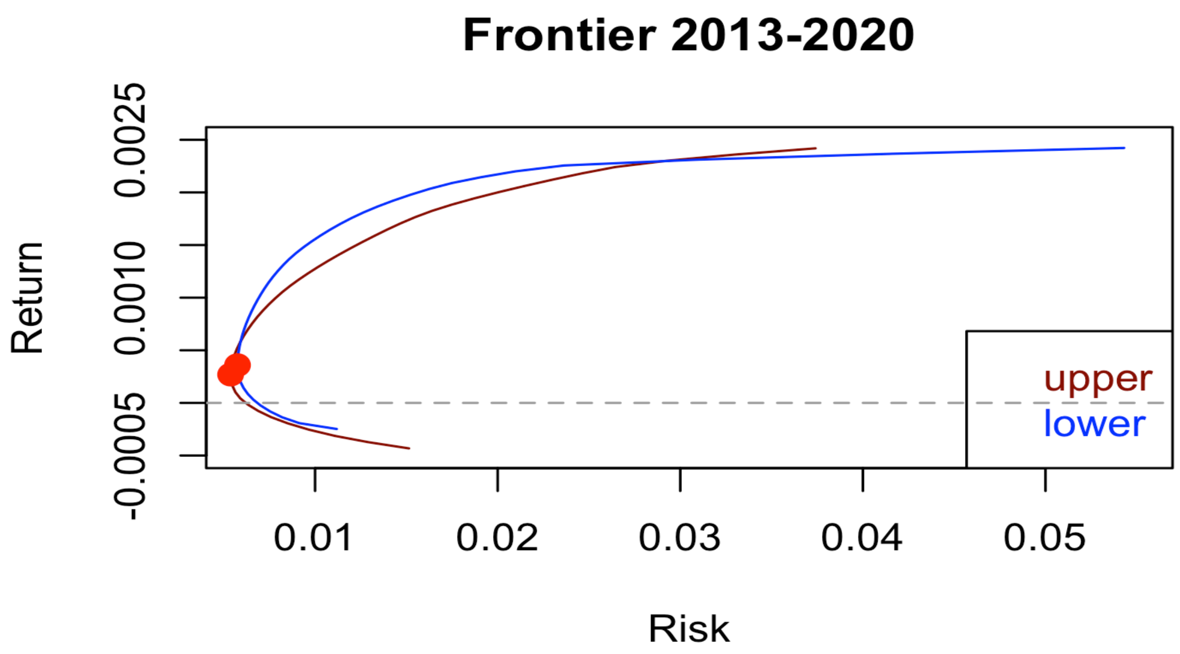
A significant amount of research has highlighted the fact that a key value driven in the ESG framework is the Governance dimension. Hermes (2013), analysing the MSCI world index, showed that corporate governance is a key figure for shareholders return while environmental and social dimensions are not significant. A study in accordance with Hermes's result, developed on almost 900 European securities, was published by Auer (2014). He used a negative filter for governance rating and excluded the worst ranking-companies from the portfolio. A Harvard research by Serafeim et al. (2015) has shown that a portfolio composed of low immaterial and high material ESG securities overperform. Given the following results, in order to define a possible reason for the overperformance of the lower portfolio I have individually analysed the Environmental, Social and Governance scores dimension for the portfolio's components. The average G score for the lower portfolio corresponds to almost 70 while for the E is 6.5 and for the S is 20. The upper portfolio, being composed of the only securities with an ESG score bigger than the 80th percentile, has the average individual E, S and G scores high. The predominance of the G in the lower portfolio might be one of the reasons for this overperformance and it would be in line with the above literatures. In this contest, it would be interesting to submit to institutional and non-institutional investors a questionnaire in order to understand if they consider the three ESG dimensions equally important, as Bloomberg does, or if they overweigh the only G dimension as being the most material one.

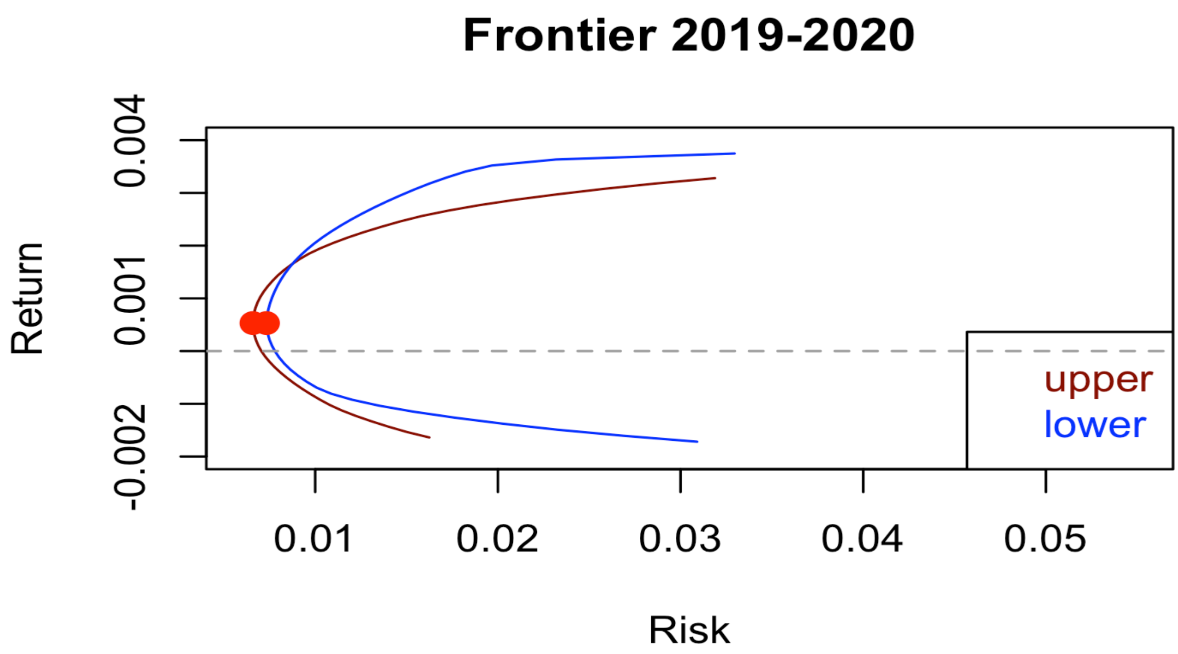
Appendix

A 1. 2013-20,2016-20,2019-20 efficient frontiers.

It shows the efficient frontiers for the periods: 2013-2020, 2016-2020, 2019-2020

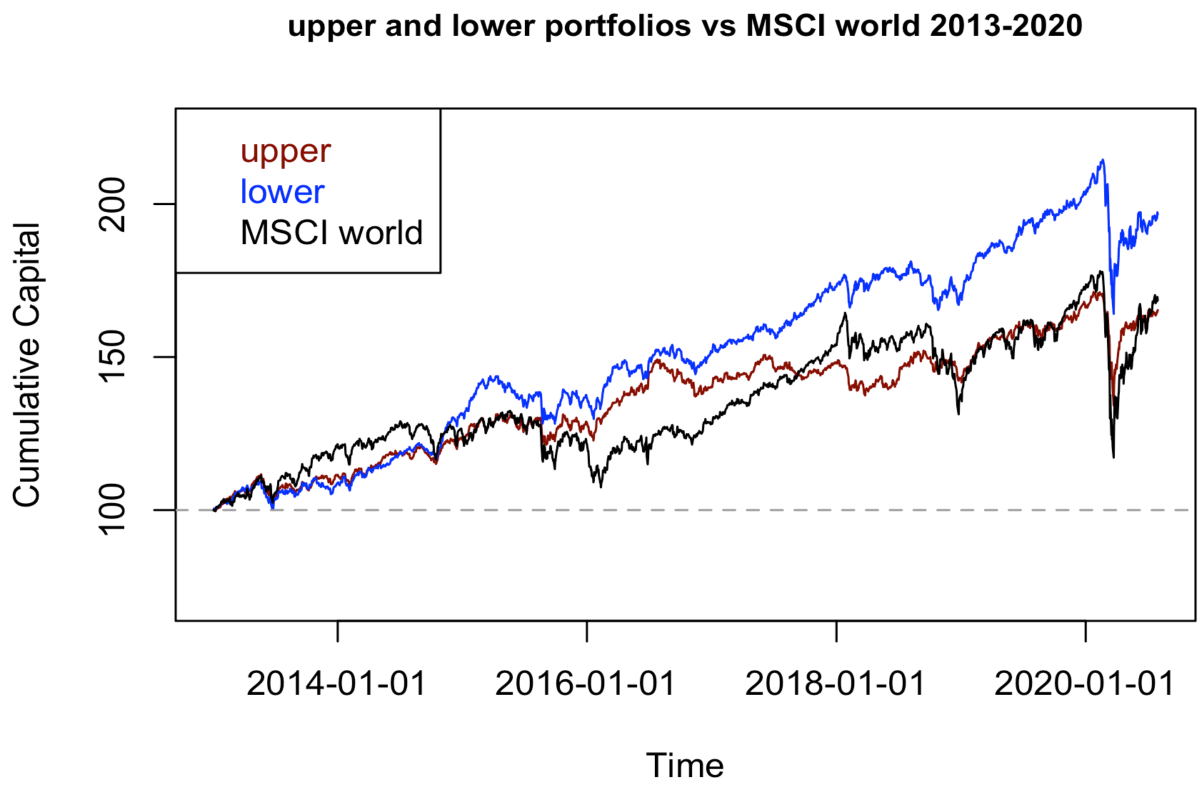




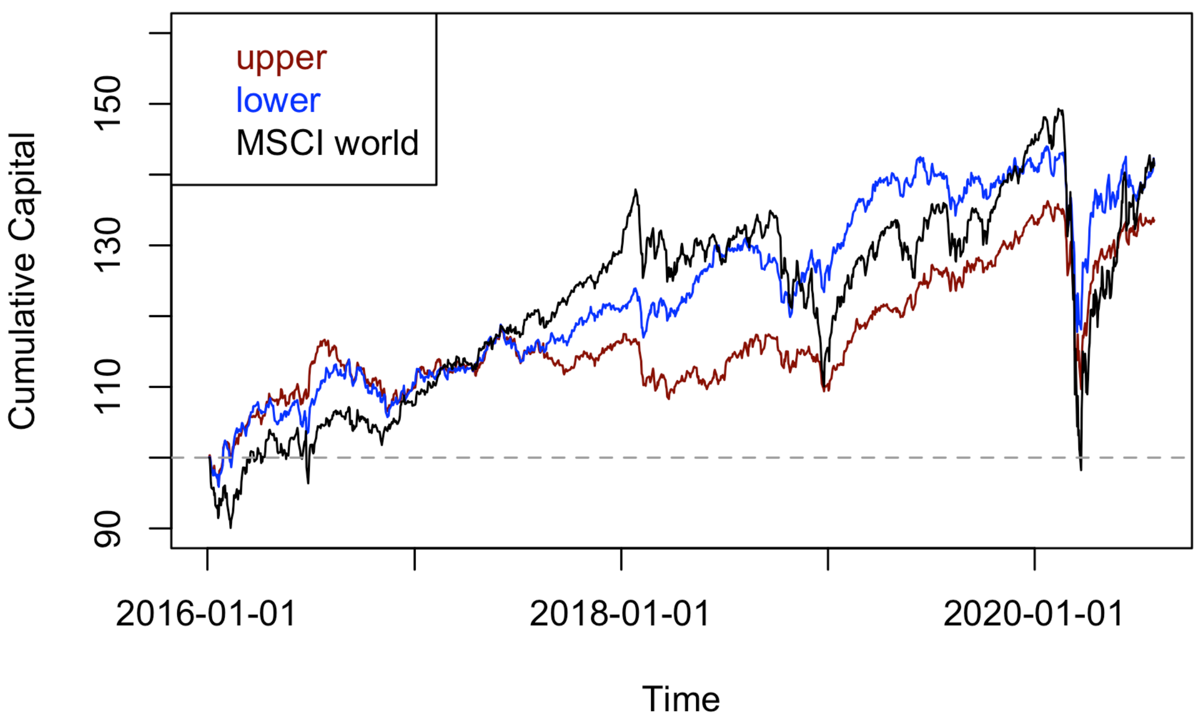


A 2. 2013-20,2016-20,2019-20 min-variance portfolios

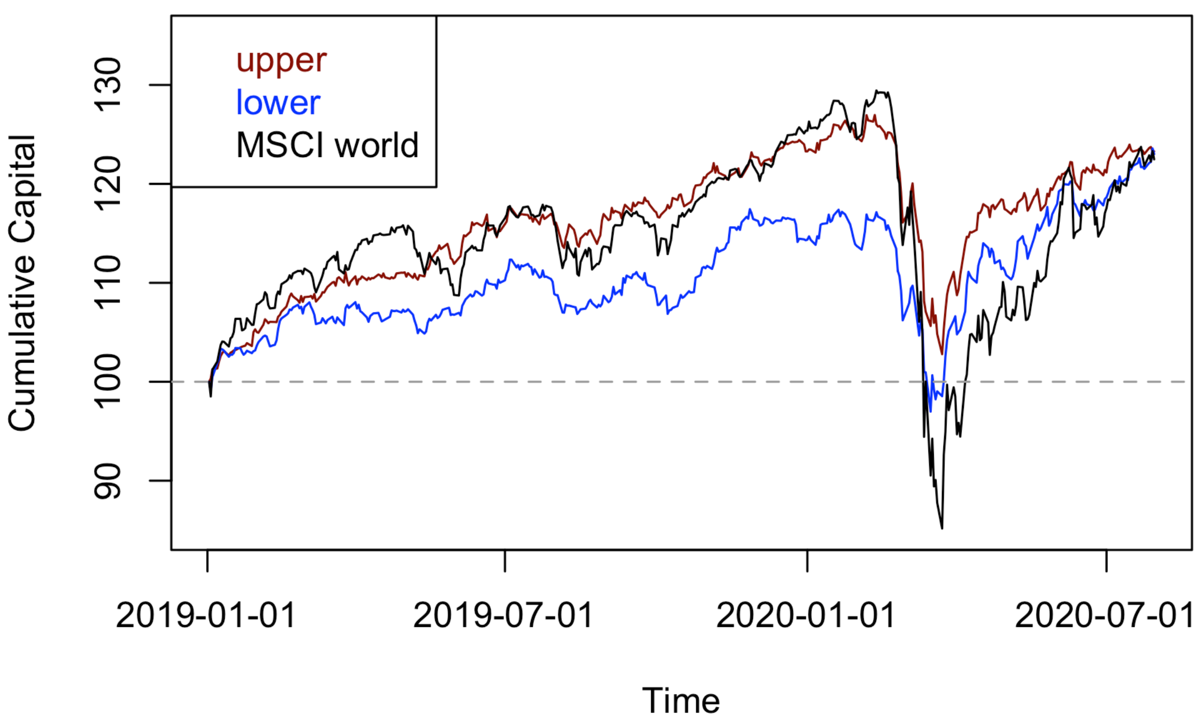
It shows the min-variance portfolios for the aforementioned periods.



upper and lower portfolios vs MSCI world 2016-2020



upper and lower portfolios vs MSCI world 2019-2020



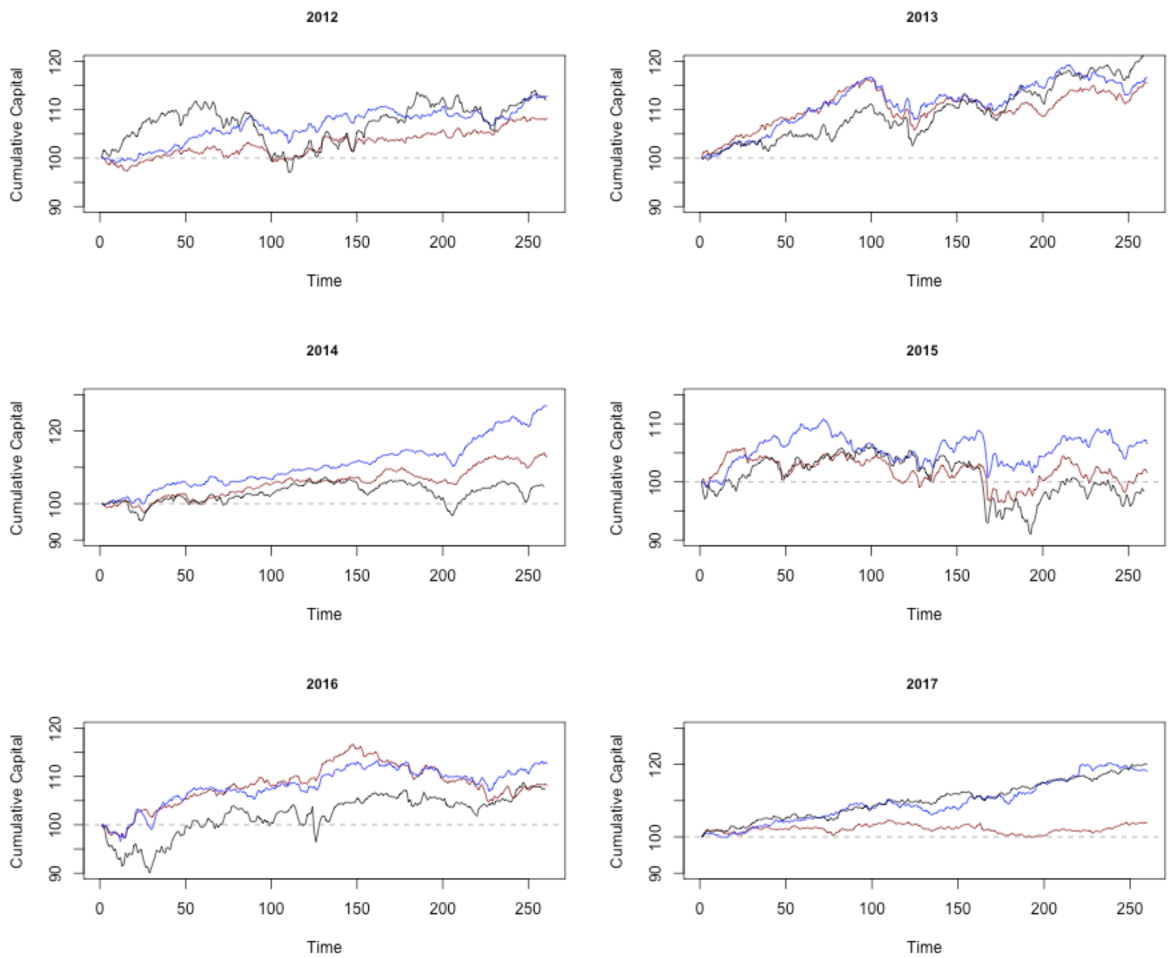
A 3. risk-returns table for 2013-20, 2016-20, 2019-20 samples

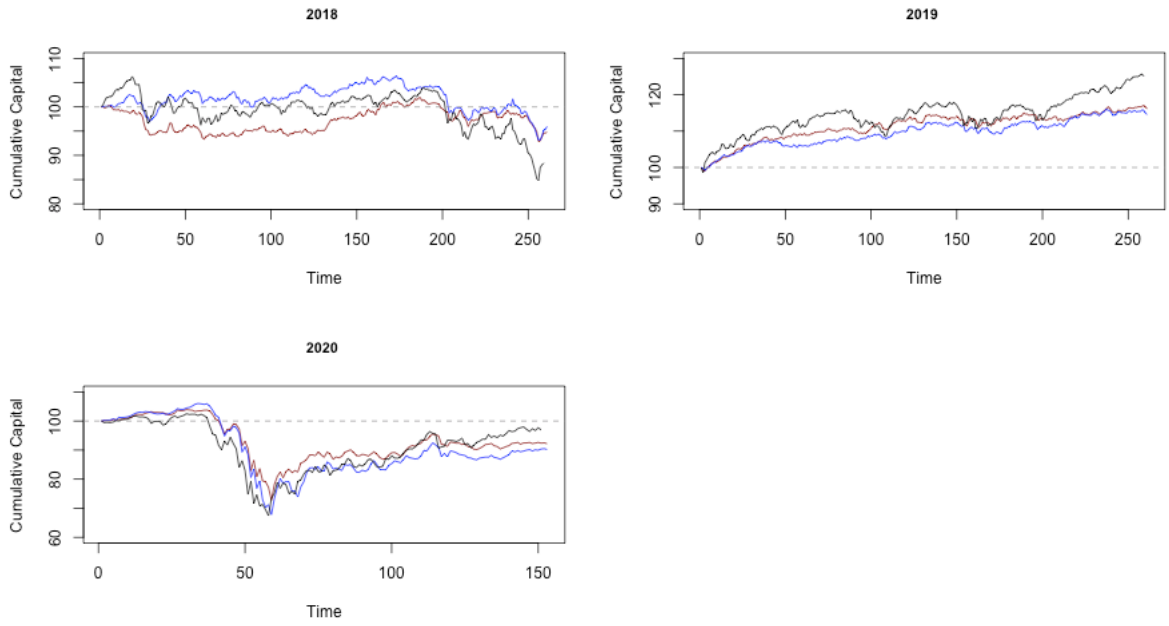
Mean	2010-20	2013-20	2016-20	2019-20
Upper	7.44%	7.01%	6.71%	14.32%
Lower	9.76%	9.46%	8.10%	14.31%
MSCI world	7.45%	7.97%	8.98%	16.31%

Volatility	2010-20	2013-20	2016-20	2019-20
Upper	8.21%	8.53%	8.77%	10.46%
Lower	9.20%	9.13%	9.49%	11.64%
MSCI world	15.08%	14.20%	16.09%	23.02%

This table shows the annual mean return and the annual standard deviation for the analysed portfolios.

A 4. yearly growth for each iteration of the active portfolios.





A 5. Pillars, themes and ESG Key Issues

3 Pillars	10 Themes	37 ESG Key Issues	
Environment	**Climate Change**	Carbon Emissions Product Carbon Footprint	Financing Environmental Impact Climate Change Vulnerability
	Natural Resources	Water Stress Biodiversity & Land Use	Raw Material Sourcing
	Pollution & Waste	Toxic Emissions & Waste Packaging Material & Waste	Electronic Waste
	Environmental Opportunities	Opportunities in Clean Tech Opportunities in Green Building	Opp's in Renewable Energy
Social	**Human Capital**	Labor Management Health & Safety	Human Capital Development Supply Chain Labor Standards
	Product Liability	Product Safety & Quality Chemical Safety Financial Product Safety	Privacy & Data Security Responsible Investment Health & Demographic Risk
	Stakeholder Opposition	Controversial Sourcing	
	Social Opportunities	Access to Communications Access to Finance	Access to Health Care Opp's in Nutrition & Health
Governance	**Corporate Governance***	Board* Pay*	Ownership* Accounting*
	Corporate Behavior	Business Ethics Anti-Competitive Practices Tax Transparency	Corruption & Instability Financial System Instability

(MSCI ESG ratings methodology, 2018, p. 4)

References

Auer, B. (2014). Do Socially Responsible Investment Policies Add or Destroy European Stock Portfolio Value? Journal of Business Ethics, 135(2), 381-397.

Barnett, M. & Salomon, R. (2006). Beyond Dichotomy: The Curvilinear Relationship between Social Responsibility and Financial Performance. Strategic Management Journal, 27 (11), 1101-1122.

Bauer, R., Derwall, J., Guenster, N. & Koedijk, K. (2005). The Eco-Efficiency Premium Puzzle. Financial Analysts Journal, 61(2), 51-63.

Belghitar, Y., Clark, E. & Deshmukh N. (2014). Does it pay to be ethical? Evidence from the FTSE4Good. Journal of Banking and Finance, 47 (c), 54-62.

Bloomberg (2019). The Terminal.

Brammer, S., Brooks, C. & Pavelin, S. (2006). Corporate Social Performance and Stock Returns: UK Evidence from Disaggregate Measures. Financial Management, 35 (3), 97–116.

Chung, P, Johnson, H. & Schill, M. J. (2004). Asset Pricing When Returns are Nonnormal: Fama-French Factors vs. Higher-Order Systematic Co-Moments. Forthcoming in the Journal of Business, 79 (2), 923-940.

Corten, F., Van de Velde, E. & Vermeir, W. (2005). Corporate social responsibility and financial performance. Corporate Governance 5 (3), 129–138.

Diltz, J. (1995). The private cost of socially responsible investing. Applied Financial Economics, 5 (2), 69-77.

Døskeland, T. & Pedersen, L. J. T. (2016). Investing with brain or hear? A filed experiment on responsible investment. Management Science, 62 (6), 1632–1644.

Dunn J., Fitzgibbons S. & Pomorski L. (2017). Assessing Risk Through Environmental, Social and Governance Exposures: Avalibale at: https://www.aqr.com/Insights/Research/Journal-Article/Assessing-Risk-through-Environmental-Social-and-Governance-Exposures

Eurosif (2018a). European SRI Study 2018. Available at: http://www.eurosif.org/wp-content/uploads/2018/11/European-SRI-2018-Study.pdf

Eurosif (2018b). SDGs for SRI Investors. Available at: http://www.eurosif.org/wp-content/uploads/2018/01/Eurosif-SDGs-brochure.pdf

Fama, E. & MacBeth, J. (1973). Risk, Return, and Equilibrium: Empirical Tests. The Journal of Political Economy, 81 (3), 607-636.

Frank, K. R., Keith, C. G. Investments Analysis & Portfolio Management, 10th edition

Giudici, G. La relazione fra rating ESG e performance di mercato: uno studio sui titoli dell'indice Stoxx Europe 600– Dipartimento di Ingegneria Gestionale del Politecnico di Milano Matteo Bonaventura – Banor SIM

Goldman Sachs Sustainability Report (2019). SUSTAINABLE FINANCE THE IMPERATIVE AND THE OPPORTUNITY, Available at: https://www.goldmansachs.com/what-we-do/sustainable-finance/documents/reports/2019-sustainability-report.pdf

GSIA (2017). 2016 Global Sustainable Investment Review. Available at: http://www.gsi-alliance.org/wp-content/uploads/2017/03/GSIR_Review2016.F.pdf

GSIA (2019). 2018 Global Sustainable Investment Review. Available at: http://www.gsi-alliance.org/wp-content/uploads/2019/03/GSIR_Review2018.3.28.pdf

Guenster, N., Bauer, R., Derwall, J. & Koedijk, K. (2011). The Economic Value of Corporate Eco-Efficiency. European Financial Management, 17 (4), 679-704.

Hamilton, S., Jo, H., & Statman, M. (1993). Doing well while doing good? The investment performance of socially responsible mutual funds. Financial Analysts Journal, 49 (6), 62-66.

Hermes Fund Managers (2013). ESG investing – Does it just make you feel good, or is it actually good for your portfolio?

Holton, G. Value-At-Risk: Theory and Practice, Second Edition

Investment & Pensions Europe (2019). Total Global AUM Table 2018. IPE. Available at: https://www.ipe.com/total-global-aum-2019/10031648.article

Jones, S., Van der Laan, S., Frost, G., & Loftus, J. (2008). The investment performance of socially responsible investment funds in Australia. Journal of Business Ethics, 80 (2), 181-203.

Jorion, P. (2001). Value at risk: the new benchmark for managing financial risk. New York: McGraw-Hill.

Kempf, A. & Osthoff, P. (2007). The Effect of Socially Responsible Investing on Financial Performance. European Financial Management 13 (5), 908–922.

Khan, M., Serafeim, G. & Yoon, A. (2015). Corporate Sustainability: First Evidence on Materiality. The Accounting Review. 96 (6), 1697-1724.

Kumar, A., Smith, C., Badis, L., Wang, N., Ambrosy, P. & Tavares, R. (2016). ESG factors and risk-adjusted performance: a new quantitative model. Journal of Sustainable Finance & Investment, 6 (4), 292-300.

Maillard, D. (2012). A user's guide to the Cornish–Fisher expansion. SSRN Electronic Journal Papers Series.

Mandelbrot, B. (1967). The Variation of Some Other Speculative Prices. The Journal of Business, University of Chicago Press, 40(4), 393-393.

MSCI (2018). MSCI SRI INDEXES METHODOLOGY. Available at: https://www.msci.com/eqb/methodology/meth_docs/MSCI_May18_SRI_Methodology.pdf

MSCI ESG Research LLC (2020). Swipe to invest: the story behind millennials and ESG investing. Available at: https://www.msci.com/documents/10199/07e7a7d3-59c3-4d0b-b0b5-029e8fd3974b

MSCI, (2019). MSCI ESG RATINGS METHODOLOGY, Executive Summary, ESG Research.

Nakai, M., Yamaguchi, K., & Takeuchi, K. (2016). Can SRI funds better resist global financial crisis? Evidence from Japan. International Review of Financial Analysis, 48 (c), 12-20.

Nelson, E. (2018). Sustainable investing risks becoming a victim of its own success. Available at: https://qz.com/1490365/esg-investing-risks-becoming-a-victim-of-its-own-success/

Nilsson, J. (2008). Investment with Conscience: Examining the Impact of Pro-Social Attitudes and Perceived Financial Performance on Socially Responsible Investment Behaviour. Journal of Business Ethics, 83 (2), 307–325.

Nofsinger, J., & Varma, A. (2014). Socially responsible funds and market crises. Journal of Banking & Finance, 48 (c), 180-193.

Novetich, Research (2013). Overview of ESG Rating Agencies. Available at: https://www.novethic.com/fileadmin/user_upload/tx_ausynovethicetudes/pdf_complets/2013_overview_ESG_rating_agencies.pdf

Renneboog, L., Ter Horst, J. & Zhang, C. (2008). The price of ethics and stakeholder governance: The performance of socially responsible mutual funds. Journal of Corporate Finance, Elsevier, 14 (3), 302-322.

Roll, R. (1997). A critique of the asset pricing theory's tests. Journal of Financial Economics 4 (2), 129–176.

Salaber, J. (2007). The Determinants of Sin Stock Returns. Evidence on the European Market.Working Paper, University of Paris Daufine.

Sauer, D. (1997). The impact of social-responsibility screens on investment performance: Evidence from the Domini 400 social index and Domini Equity Mutual Fund. Review of Financial Economics, 6 (2), 137-149.

Schröder, M. (2004). The performance of socially responsible investments: Investment funds and indices. Financial Markets and Portfolio Management, 18 (2), 122–142.

Schröder, M. (2007). Is there a difference? The performance characteristics of SRI equity indices. Journal of Business Finance and Accounting, 34 (1), 331–348.

Sharpe, W. (1964). The Sharpe Ratio. The Journal of Portfolio Management, 21 (1), 49-58.

Statman, M. (2000). Socially Responsible mutual fund. Financial Analysts Journal, 56 (3), 30-39.

Statman, M. (2006). Socially responsible indexes. Journal of Portfolio Management. 32 (3), 100.

Statman, M. & Glushkov, D. (2008). The wages of social responsibility. Financial Analysts Journal, 65 (4), 33-46.

Szeg¨o, G.P. (1975). Nuovi risultati analitici nella teoria della selezione del portafoglio, (C.N.R., Comitato Scienze Economiche, Sociologiche e Statistiche).

Townsend, B. (2017). The Origins of Socially Responsible and Sustainable Investing. Bailard Wealth Management

Witt, S. & Dobbins, R. (1979). The Markowitz Contribution to Portfolio Theory. Managerial Finance, 5 (1), 3-17.