

Financial outcomes of investing into socially responsible companies

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Abstract

Preserving a good environmental situation is one of the most important tasks of modern society. That is why a large body of research studies the impact of socially responsible investment strategies on portfolio performance. However, the conclusions drawn from these studies are contradictory and inconsistent.

The aim of this work is to investigate whether a long-term premium or penalty exists for holding environmentally and socially responsible companies in a portfolio. In contrast to all previous studies that were based on market-capitalization indexes, we perform an analysis based on both market-capitalization and Research Affiliates Fundamental® Indexes. The main conclusion of this study is that the results are heavily dependent on portfolio selection, i.e. the way we define environmentally and socially 'friendly' portfolios. In many cases there is no superior investment strategy, since although some may lead to higher returns with higher risk, others are more suitable for risk-averse investors. One limitation of this study is its short performance history (4.5 years), which makes it impossible to draw any conclusions that are statistically significant.

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Contents

1. Introduction.....	3
2. Overview of previous studies	5
3. Measuring Environmental and Human Rights Performance	9
4. Theoretical overview.....	11
4.1 Market indexes	11
4.1.1 Capitalization-weighted indexes	11
4.1.2 Fundamental indexation	12
4.2 Risk Measures	12
4.3 Bootstrap.....	14
5. Empirical studies.....	17
5.1 Strategy	17
5.2 Indexes comparison.....	19
5.3 Analysis of portfolios based on S&P 500 index	23
5.3.1 Analysis of portfolios constructed using environmental factor and ‘best-in-class’ selection	23
5.3.2 Analysis of portfolios constructed using human rights factor and ‘best-in-class’ selection.....	35
5.3.3 Analysis of the portfolios constructed using environmental factor.....	37
5.3.4 Analysis of the portfolios constructed using human rights factor	40
5.4 Analysis of portfolios based on RAFI US Large.....	44
5.4.1 Analysis of portfolios constructed using environmental factor and ‘best-in-class’ selection	44
5.4.2 Analysis of portfolios constructed using human rights factor and ‘best-in-class’ selection.....	46
5.4.3 Analysis of the portfolios constructed using environmental factor	49
5.4.4 Analysis of the portfolios constructed using human rights factor	51
6. Conclusions.....	54
7. References.....	56
Appendixes.....	58
Appendix 1. Partition of US companies ranked by GES between GICS sectors.....	58
Appendix 2. Number of portfolio constituents	59
Appendix 3. Additional Figures and Statistics	61
1. Portfolios based on S&P 500 index	61
1.1 Portfolios constructed using environmental factor and ‘best-in-class’ selection.....	61
1.2 Portfolios constructed using human rights factor and ‘best-in-class’ selection.....	63
1.3 Portfolios constructed using environmental factor	65

1.4 Portfolios constructed using human rights factor	67
2. Portfolios based on RAFI US Large	70
2.1 Portfolios constructed using environmental factor and 'best-in-class' selection.....	70
2.2 Portfolios constructed using human rights factor and 'best-in-class' selection.....	72
2.3 Portfolios constructed using environmental factor	74
2.4 Portfolios constructed using human rights factor	76

1. Introduction

Socially responsible investing (SRI) has become very popular in recent decades. In Europe alone, total SRI assets have reached €2.665 trillion as of December 31, 2007 and represent as much as 17.5% of the asset management industry. This corresponds to a remarkable growth of 102% since December 31, 2005 according to European Social Investment Forum. In spite of this, there is a debate between practitioners and academics on the relationship between the financial and environmental performance of companies. Many empirical investigations were held in order to determine if adding an ethical dimension to stock selection yields higher investment returns. As stated, the conclusions drawn from different investigations are contradictory and inconsistent: some of them show that investment in 'socially responsible' portfolios is beneficial, others draw completely opposite conclusions.

Opponents of SRI believe that the application of environmental, social and governance factors to the investment process results in lower investment returns since the number of investment opportunities is reduced. They also argue that companies cannot improve their social or environmental performance without decreasing shareholder value as the cost of adhering to ethical standards will cause higher product prices, lower profitability and competitiveness. Therefore, socially responsible investors will suffer from limited diversification and will be forced to report suboptimal returns.

Proponents of SRI argue that improving social or environmental performance will lead to an increase of input-output efficiency and generate new market opportunities. For example, Porter and Van der Linde (1995) stated that an improvement in environmental performance can create a competitive advantage because of more cost-efficient use of resources.

There also exists a third view, which suggests that given a long-term perspective socially responsible and traditional investment strategies produce returns without any meaningful difference.

The purpose of this thesis was to test if the addition of environmental and human rights factors to the stock selection process improves portfolio performance. Previous studies were based on market-capitalization indexes. We have conducted an analysis based on a market-capitalization index as well as on Research Affiliates Fundamental Index® (RAFI®). The construction of the portfolios was done in two ways: without taking into account GICS (Global Industry Classification Standard) sectors; and by using 'best-in-class' selection. We created the hypothetical portfolios of socially responsible companies using the Global Ethical Standard (GES) ranking and compared these portfolios with indexes and 'socially irresponsible' companies. We also carried out a regression analysis for SRI portfolios, but as we are considering a relatively short time span (1 Jul 2004 – 31 Dec 2008), the results were statistically insignificant and we decided not to include them in our report.

The main finding of this study is that there is no clear evidence that portfolios consisting of socially responsible companies systematically outperform or underperform indexes and socially irresponsible companies, but that these portfolios, as a rule, do have smaller standard deviation than their counterparts. It should be noted that these results are heavily dependent on the way we chose SRI portfolios and in many cases different risk measures show the preference of investment into different portfolios. Thus, a final

decision on investments should be made with taking into account whether an investor is risk-averse or risk-seeking, i.e. which risk measure he thinks to be of greater importance. While this research has provided some interesting results, we believe that more empirical testing is needed. In particular, an analysis based on additional data sets would be a useful extension to this study.

This paper is organized in the following way. In the Section 2 we will look at the ways researchers have compared traditional investment strategies and SRI strategies as well as on the conclusions they have drawn. The principles and criteria that GES have used for obtaining Environmental and Human Rights measures and the description of these measures are given in the Section 3. Section 4 deals with the background for market-capitalization and Fundamental Indexes. This section also covers the topics of risk measures and bootstrapping. Section 5 outlines the approach we have used for analysis as well as the analysis itself. Finally, the description of results is provided in Section 6 and additional figures, data and tables that were used in the process of analysis are given in the Appendixes section.

2. Overview of previous studies

The comparison of traditional investment strategy and SRI strategy previously was done in four different ways. These approaches were the following (Phillips, Hager & North):

- Comparing the performance of SRI indexes with traditional indexes
- Comparing the performance of SRI funds with traditional investment funds/indexes
- Creating hypothetical portfolios of companies ranked highly against environmental, social and governance factors and comparing their performance with lower-ranked companies
- Comparing the financial performance of companies that score highly on measures of corporate social performance with those that do not.

Index Comparisons

The first body of literature makes the research of the investment strategies by looking at traditional indexes (S&P 500, S&P/TSX Composite Index, Dow Jones index, etc) and comparable SRI indexes (Domini 400 Social Index (DSI), Citizens Index in the United States, Dow Jones Sustainability World Index, KLD Global Sustainability Index, etc). Studies show that there are no clear indicators that DSI gives lower returns than S&P 500. However, Schroder (2005) got the confirmation of these results, he also pointed out that 20 out of 29 SRI indexes have higher volatility than their benchmarks.

Mutual Fund Comparisons

The second approach deals with comparison of returns of SRI mutual funds and traditional mutual funds and/or traditional market indexes. There are two main difficulties with such type of analysis – SRI mutual funds have very short performance history (less than 10 years) and problem with choosing an appropriate control group of traditional mutual funds. A summary of these studies can be found in Table 1.

Table 1. Summary of SRI Fund Studies¹

Study	Country/Region	Data	Time period	Findings for SRI Funds
Asmundson and Foerster (2001)	Canada	2 SRI funds (over 10-year period) versus TSE 300 Index	January 1990 to December 1999	<ul style="list-style-type: none"> • Evidence of both higher and lower returns • Lower risk
Bauer et al. (2002)	Germany, U.K. & U.S.	103 SRI funds and 4,384 traditional mutual funds	January 1990 to March 2001	<ul style="list-style-type: none"> • Evidence of both higher and lower returns • Differences are not statistically different

¹ As reported in Phillips, Hager & North

Bauer et al. (2007)	Canada	8 ethical, 267 conventional mutual funds	January 1994 to January 2003	<ul style="list-style-type: none"> No significant performance differences between funds
Bello (2005)	United States	42 SRI funds, 84 conventional funds	January 1994 to March 2001	<ul style="list-style-type: none"> Risk adjusted returns of SRI funds indistinguishable from returns of conventional funds Fund characteristics did not differ between the two groups
Derwall & Koedijk (2005)	United States	8 SRI bond funds	1987-2003	<ul style="list-style-type: none"> SRI bond funds provided returns similar to or superior to conventional bond funds Found to perform in-line during an economic expansion, and significantly outperform during an economic contraction
Geczy et al. (2005)	United States	35 no-load SRI funds and 859 no-load traditional mutual funds	July 1963 to December 2001	<ul style="list-style-type: none"> Lower returns Difference is significant under certain conditions
Girard et al. (2007)	United States	117 mutual funds versus style benchmarks	1984 to 2003	<ul style="list-style-type: none"> SRI funds have less diversification SRI fund managers showed poor stock selection and market timing
Gregory et al. (1997)	United Kingdom	18 SRI funds matched with 18 traditional mutual funds	January 1986 to December 1994	<ul style="list-style-type: none"> Lower returns Differences are not statistically different
Hamilton et al. (1993)	United States	32 SRI funds versus 170 traditional mutual funds	January 1981 to December 1990	<ul style="list-style-type: none"> No statistically significant performance differences
Haveman and Webster (1999)	United Kingdom	15 SRI funds versus peer medians	5-year periods ending June 1998	<ul style="list-style-type: none"> Lower returns Lower risk
Kreander et al. (2005)	United Kingdom	29 SRI funds matched with 29 traditional mutual funds	January 1986 to December 2000	<ul style="list-style-type: none"> Higher returns Lower risk Differences considered insignificant
Mallin et al. (1995)	United Kingdom	29 SRI funds matched with 29 traditional mutual funds	January 1986 to December 1993	<ul style="list-style-type: none"> Higher returns Lower risk Differences considered insignificant
Otten and Koedijk (2001)	Netherlands	4 SRI funds matched with 4 traditional mutual funds	January 1994 to December 2000	<ul style="list-style-type: none"> Lower returns Similar returns when style biases corrected
Platinga and Scholtens (2001)	Euronext markets (FR, BE, Germ.)	SRI exposure analysis of 784 mutual funds	1994 - 1999	<ul style="list-style-type: none"> Mutual funds with higher SRI tilt experienced slightly higher returns Differences are not statistically different

Scholtens (2005)	Netherlands	12 SRI fund compared to SRI and non-SRI indexes	November 2001 to April 2003	<ul style="list-style-type: none"> • Slight outperformance of SRI funds vs. the index • Slight underperformance of SRI funds vs non-SRI funds • Neither result was statistically significant
Schroeder (2003)	German, U.S.A., U.K.	30 U.S. funds, 16 German and Swiss funds, and 10 SRI indexes	Minimum of 30 months of data before 2002	<ul style="list-style-type: none"> • No significant performance differences • Some SRI funds exhibited insignificantly higher returns
Statman (2000)	United States	31 SRI mutual funds versus 62 traditional mutual funds	Periods ending September 1998	<ul style="list-style-type: none"> • Higher returns • Differences are not statistically different

Empirical studies of this type suggest that differences between SRI funds and traditional funds are small and statistically insignificant (except for Girard et al. (2007) and Geczy et al. (2005)). Hence more studies should be held in order to determine if SRI funds systematically underperform or outperform traditional funds.

Comparing performance of High-Ranked and Low-Ranked Socially Responsible Companies

The third type of analysis deals with creation of hypothetical portfolios of socially responsible companies and comparison of these portfolios with traditional indexes or 'socially irresponsible' companies. Deep analysis of such type of investigations is done by Derwall et al (2005). The authors suggest that a portfolio of high-ranked eco-efficient companies outperforms a portfolio of low-ranked companies and this performance differential cannot be explained by differences in market sensitivity, investment style or industry-specific factors. For ranking companies according eco-efficiency, the authors used Innovest Strategic Value Advisor's corporate eco-efficiency scores.

Corporate Social Performance

A fourth area of SRI research has been focusing on examining of financial performance of companies that have high corporate social responsibility scores versus those that do not. In studies of this type researches tried to determine if there is a linkage between corporate social responsibility and improved financial performance. These studies can be divided into two main parts:

1. Event studies – measuring the influence of corporate social responsibility (CSR) event on the subsequent financial performance of the company. Examples of CSR events are: pollution spill, product recall (negative events) or receiving an award for excellent environmental management (positive event).
2. Cross-sectional regression analysis – study of the relationship between one or more CSR factors and one or more measures of financial performance.

It is worth to mention here that there exists a large body of literature with selective case studies in order to show the benefits to the companies of corporate social responsibility. The most serious methodological difficulties in these studies are:

- The choice of independent variables
- Model specification

- Correlation does not mean causality, i.e. even if there was established a positive dependence between CSR and financial performance, this does not mean that CSR caused it. The situation may be opposite: companies with high profits can allow themselves to be ‘socially responsible’.

In order to overcome these methodological difficulties researchers did a ‘meta-analysis’ and came to the following conclusions (Phillips, Hager&North, 2007):

- 1) There is generally a positive, bidirectional causal association between good CSR and corporate financial performance across all industries;
- 2) Counter-intuitively, corporate environmental performance has a smaller effect on corporate financial performance than other CSR measures (i.e., managerial principles, corporate reputations for minority hiring, etc....);
- 3) Good CSR is more highly reflected in accounting-based financial performance than market-based financial performance, possibly because the market views overemphasis of CSR as a deliberate attempt of the company to manage external impressions.

Thus, the main conclusion from previous studies is that in general SRI does not lead to lower investment returns, or at least, differences between SRI returns and standard investment returns are statistically insignificant.

3. Measuring Environmental and Human Rights Performance

The environmental and social measures were obtained from the Global Ethical Standard (GES) Investment Risk Rating. GES Risk Rating evaluates the companies' preparedness and their performance through a number of criteria and sub-criteria on the basis of international norms on ESG (Environment, Social and Governance) issues in accordance with the United Nations Principles for Responsible Investment (UN PRI). In Table 1 the criteria in GES Risk Rating are presented.

Table 1. GES Risk Rating criteria¹

Environment	Social
<p><i>1) Preparedness</i></p> <ul style="list-style-type: none"> • Organization and routines • Policy and Programs • External Verification • Environmental Reporting • Supplier Evaluation <p><i>2) Performance</i></p> <ul style="list-style-type: none"> • Greenhouse gases • Energy use • Use of water resources • Travel Management • Remediation • Project Development • Hazardous waste • Emissions to air • + 8 more criteria 	<p><i>1) Employees</i></p> <ul style="list-style-type: none"> • Discrimination • Freedom of association • Health & Safety • Working hours & wages • + 5 more criteria <p><i>2) Community</i></p> <ul style="list-style-type: none"> • Use of security forces • Corruption • +2 more criteria <p><i>3) Suppliers</i></p> <ul style="list-style-type: none"> • Code of Conduct • Management system and Program • Performance evaluation

GES systematic screening evaluates companies' present environmental status and readiness for the future. Environmental measures are intended to embody both ex post and ex ante dimensions of corporate risk and opportunity.

For environment and human rights areas companies obtain a rating from Aa to Cc. The capital letters (A-C) indicate the general risk level in the company's industry. The lower case letters (a-c) indicate the risk level in the particular company, based on performance and preparedness. The rating shows the company's ability to deal with the general risks that concern the type of activity and to comply with international norms and procedures.

¹ GES Investment Services

Ratings are based on information obtained from companies in their official documents, including annual and interim reports, and through a direct dialogue in the form of surveys or site visits. Evaluation also uses public information by non-governmental organizations and media.

The empirical analysis in this work uses GES data for the following period: 2004/06/30 – 2008/12/31. In Appendix 1 we present the number of US companies that were analyzed for each period as well as their partition between different sectors according to GICS (Global Industry Classification Standard).

4. Theoretical overview

4.1 Market indexes

4.1.1 Capitalization-weighted indexes

The investment industry has promoted the belief that capitalization-weighted equity market indexes are sufficiently representative of the CAPM market portfolio to be nearly mean-variance efficient. Let us look first at the merits of capitalization-weighted indexes and then we will consider the alternative to these indexes.

Benefits of capitalization-weighted indexes:

1. Investing to a capitalization-weighted index gives lower trading costs and fees than active management since capitalization weighting is a passive strategy that require little trading.

Capitalization weighted portfolios rebalance if

- securities prices fluctuate
 - when new companies become large enough to merit inclusion in an index or when others disappear through merger, failure, or relative changes in capitalization
2. Capitalization weighting tries to assign the greatest weights to the largest companies. As a rule, these companies are among the largest as measured not only by capitalization, but also by sales, book value, cash flow, dividends, and total employment.
 3. Capitalization weighting reduces portfolio transaction costs, since it tends to emphasize the more heavily traded stocks.

These benefits were retained in construction of fundamental indexes.

For our study we have chosen S&P 500 index as a representative of capitalization-weighted indexes. That is why let us look at it in more detail.

The S&P 500 is a capitalization-weighted index. It consists of 500 large capitalization common stocks actively traded in the United States on the New York Stock Exchange (NYSE), American Stock Exchange (AMEX), and the NASDAQ National Market System (NASDAQ). Almost all of the stocks included in the index are among the 500 American stocks with the largest market capitalization (share price times the number of shares outstanding).

Index constituents exhibit the following characteristics:

Market Coverage – approximately 75% of the U.S. equities market

Weighting – market capitalization

Market Capitalization – minimum of US\$ 5 billion

Public Float – at least 50%

Reconstitution – as needed basis, i.e.

- If a company changes its shares outstanding and the new number varies by more than 5% from the Index Shares, S&P will change the Index Shares immediately to reflect the change.
- If a company changes its shares outstanding and the new number varies by less than 5% from the Index Shares, S&P will not change the Index Shares until its next quarterly rebalancing.

Whenever S&P changes the Index Shares of a company, hundreds of money managers have to effect equivalent changes, incurring transaction costs. Therefore, S&P tries to limit the frequency of rebalancing.

4.1.2 Fundamental indexation

In order to construct Fundamental index all companies were divided by the following metrics:

- Book value (Book)
- Trailing five-year average cash flow (Cash Flow)
- Trailing five-year average revenue (Revenue)
- Trailing five-year average gross sales (Sales)
- Trailing five-year average gross dividends (Dividends)
- Total employment (Employment).

Then the 1000 largest companies by each metric were selected. Each of these, 1000 largest companies was included in the index at its relative metric weight to create the Fundamental index for that metric.

For construction of Composite Fundamental index employment and revenues were excluded from metrics list. Employment was excluded because this information is not always available. Revenues were excluded because this metric and sales have very similar concepts and performers. Others four metrics are available in most countries. Hence index can be easily applied globally.

Rebalancing of the portfolio is made once per year, on the last trading day of the year.

In the further study we will use Research Affiliates Fundamental Index (RAFI). Fundamental Index portfolios are constructed by equally weighting the four individual Fundamental Index weights to create the RAFI weight for each company. The top 1000 companies by RAFI weight are included in the RAFI US Large. Companies that do not pay dividends are weighted according to the average of the remaining three metrics and are not punished with a zero weight for dividend component.

Authors of [16] from their studies conclude that Fundamental Index portfolios significantly outperformed the S&P 500 over the 43 year span tested (1962-2004). The performance was robust across time, across bear and bull stock markets, across phases of business cycle and across rising- and falling- interest-rate regimes. Authors also suggest that indexes constructed using Main Street measures of company size are significantly better than capitalization-weighted Wall Street Indexes.

In the Section 5.2 the comparison of RAFI US Large and S&P 500 is done for the period 31 January 1962 – 31 December 2008.

4.2 Risk Measures

Information ratio

Information ratio is the excess return of an active manager over an appropriate benchmark, divided by the standard deviation of excess returns (tracking error).

$$IR = \frac{ER}{TE},$$

where

IR - information ratio

ER - excess return

TE - tracking error.

If we have monthly returns then annualized excess return can be calculated as

$$ER = r_a^{portf} - r_a^{bench},$$
$$r_a^{portf} = \left(\frac{PV^{portf}(12 * d)}{PV(0)} \right)^{1/d} - 1$$
$$r_a^{bench} = \left(\frac{PV^{bench}(12 * d)}{PV(0)} \right)^{1/d} - 1,$$

where

r_a^{portf} - annualized return of portfolio

r_a^{bench} - annualized return of benchmark (we will use S&P 500 or RAFI US Large as a benchmark)

$PV^{portf}(t)$ - portfolio value at time t

$PV^{bench}(t)$ - index value at time t

d - number of years in the data history (in our case $d = 4.5$ years).

In order to compute tracking error, we should first of all calculate returns of the portfolio and benchmark at time points $i = 1, \dots, T$:

$$r_i^{portf} = \frac{PV^{portf}(i) - PV^{portf}(i-1)}{PV^{portf}(i-1)}, \quad i = 1, \dots, T;$$
$$r_i^{bench} = \frac{PV^{bench}(i) - PV^{bench}(i-1)}{PV^{bench}(i-1)}$$

where

r_i^{portf} - return of the portfolio at time i

r_i^{bench} - return of benchmark at time i .

Finally,

$$TE = \sqrt{12} \cdot \sigma(\Delta r_i), \text{ where } \sigma(\Delta r_i) \text{ denotes standard deviation of } \Delta r_i.$$

Note: if computation of IR is based on weekly returns, we should substitute 12 by 52 in the above formulas.

This ratio is called the information ratio because it focuses on the risk and return generated from the manager's ability to use their information to deviate from the benchmark.

A higher information ratio indicates a better performance.

Maximum drawdown

Let us first define the notion of drawdown. Drawdown is a measure of the decline from a historical peak in some variable (typically the cumulative profit of a financial trading strategy), i.e. if $X(t)$ is a random process $\{X(0) = 0, t \geq 0\}$, then the drawdown at time T is defined as

$$D(T) = \max \left[0, \max_{t \in (0, T)} (X(t) - X(T)) \right]$$

The Maximum Drawdown (MDD) up to time T is the maximum of the Drawdown over the history. In more formal way, $MDD(T) = \max_{\tau \in (0, T)} \left[\max_{t \in (0, \tau)} X(t) - X(\tau) \right]$.

Downside risk

Downside risk (semivariance) – a measure of the dispersion of all observations that fall below the mean or target value of a data set. Downside risk (DR) is an average of the squared deviations of values that are less than the mean, i.e.

$$DR = \frac{1}{N} \sum_{r_i < \bar{m}} (\bar{m} - r_i)^2,$$

where

N - the total number of observations below the mean

r_i - the observed value

\bar{m} - the mean or target value of the data set

Thus, the downside risk is similar to the variance; however, it only considers observations below the mean. Downside risk is a useful tool in portfolio or asset analysis, since it only looks at the negative fluctuations of an asset. By neutralizing all values above the mean, or an investor's target return, downside risk estimates the average loss that a portfolio could incur.

Skewness and Kurtosis

Skewness measures the lack of symmetry in the return distribution, taking the value 0 for a symmetrical distribution. The formal definition of skewness is:

$$s = \frac{1}{(n-1)} \sum_{i=1}^n \left(\frac{r_i - \mu}{\sigma} \right)^3,$$

where

n - number of observations

r_i - returns

μ - mean value of returns

σ - standard deviations of returns

Kurtosis is a measure of whether the data are peaked or flat relative to a normal distribution. That is, data sets with high kurtosis tend to have a distinct peak near the mean, decline rather rapidly, and have heavy tails. Data sets with low kurtosis tend to have a flat top near the mean rather than a sharp peak. A uniform distribution would be the extreme case. The formal definition of kurtosis is:

$$k = \frac{1}{(n-1)\sigma^4} \sum_{i=1}^n (r_i - \mu)^4.$$

The kurtosis for a standard normal distribution is equal to three.

4.3 Bootstrap

The concept of the bootstrap was first introduced by Efron as an attempt to give some new perspective to an old and established statistical procedure known as jackknifing. Contrary to jackknifing selection, which is mostly concerned with computing

standard errors of statistics of interest, bootstrap was set to achieve more ambitious goal of estimating not only the standard error but also the distribution of a statistic. Efron considered two types of bootstrap: nonparametric and parametric.

In the nonparametric bootstrap one is considering the discrete empirical distribution generated by a random sample of size n from an unknown distribution F . This empirical distribution \hat{F}_n assigns equal probability to each sample item. In the parametric bootstrap setting, one is considering F to be a member of some parametric family and obtain \hat{F}_n by estimating the family parameters from the data. In both cases, i.i.d. random sequence is generated. It is called a resample or pseudo-sequence. From the distribution \hat{F}_n we can arrive at new estimates of various parameters or nonparametric characteristics of the original distribution F .

One of the most important practical applications of the bootstrap is in providing conceptually simple estimates of the standard error and bias for a statistics of interest. Let $\hat{\theta}_n$ be a statistic based on the observed sample, arriving from some unknown distribution function F . Assume that $\hat{\theta}_n$ is to estimate some (real-valued) parameter of interest θ , and let us denote its standard error and bias by $SE_F(\hat{\theta}_n)$ and $BIAS_F(\hat{\theta}_n)$. Since the form of the statistic $\hat{\theta}_n$ may be very complicated the exact formulas for the corresponding bootstrap estimates of standard error (BESE) and bias (BEB) may be quite difficult, if not impossible, to derive. Therefore, one usually approximates both these quantities with the help of the multiple resamples. The approximation to the bootstrap estimate of standard error of $\hat{\theta}_n$ suggested by Efron is given by

$$SE'_N = \left\{ \sum_{i=1}^N (\hat{\theta}_n^*(i) - \hat{\theta}_n^*(\cdot))^2 / (N-1) \right\}^{\frac{1}{2}},$$

where $\hat{\theta}_n^*(i)$ is the original statistic $\hat{\theta}_n$ calculated from the i^{th} resample ($i = 1, \dots, N$),

$\hat{\theta}_n^*(\cdot) = \sum_{i=1}^N \hat{\theta}_n^*(i) / N$, and N is the total number of resamples (each of size n) collected with replacement from the empirical estimate of F (in parametric or non-parametric setting), By the law of large numbers

$$\lim_{N \rightarrow \infty} SE'_N \approx SE(\hat{\theta}_n)$$

Similarly, for BEB one can use its approximation $bias'_N$ based on N resamples

$$bias'_N = \sum_{i=1}^N \hat{\theta}_n^*(i) / N - \hat{\theta}_n$$

Let us note that N , total number of resamples, may be taken as large as we wish, since we are in complete control of the resampling process. For instance, it has been shown that for estimating BESE, N equal to about 250 typically gives already a satisfactory approximation, whereas for BEB this number may have to be significantly increased in order to reach the desired accuracy. We will compute estimates for $N = 1000$ and $N = 10000$.

The extension of the bootstrap method to the case of dependent data was first considered by Kunsch who suggested a moving block bootstrap procedure which takes into account the dependence structure of the data by resampling blocks of adjacent observations rather than individual data points.

Let X_1, X_2, \dots, X_n be a (strictly) stationary time series, $\hat{\theta}_n = \hat{\theta}_n(X_1, \dots, X_n)$ - real-valued statistic estimating some unknown parameter interest θ . Given the observations X_1, X_2, \dots, X_n and an integer l ($1 \leq l \leq n$) we form the l -blocks $B_t = (X_t, \dots, X_{t+l-1})$ for $t = 1, \dots, n-l+1$. In moving blocks procedure of Kunsch the bootstrap data (pseudo-time series) (X_1^*, \dots, X_n^*) is obtained by generating the resample of k blocks ($k = \lfloor n/l \rfloor$) and then considering all individual (inside-block) pseudo-values of the resulting sequence B_1^*, \dots, B_k^* .

The idea behind the block bootstrap is simple: by resampling blocks rather than original observations we preserve the original, short-term dependence structure between the observations although not necessarily the long-term one. In particular, it follows that the formulas for the approximate bootstrap estimates of standard error and bias are still valid with the block bootstrap. It is easy to notice that for $l = 1$ block bootstrap reduce to the Efron's bootstrap procedure for i.i.d. random variables. In our analysis we will use length of block $l = 5$, i.e. we will divide all monthly observations on the blocks consisting of 5 months (weeks) and then perform the block bootstrap.

5. Empirical studies

5.1 Strategy

Data for analysis were obtained from three sources. Environmental and human rights scores were obtained from Global Ethical Standard (GES) Investment Risk Rating. Financial data such as company's total returns, S&P 500 index constituents and their weights were retrieved from Bloomberg. Bloomberg terminal was also used for finding out the company's sector by its SEDOL¹, SEDOL of the company by its Ticker², etc. Financial data for RAFI US Large index were obtained from Research Affiliates.

Analysis of portfolio performance was carried out for the period: 1 July 2004 – 31 December 2008. The reason for analyzing such a relatively short time span (4.5 years) is unavailability of GES scores before 2004. Historical data for indexes comparison were retrieved for the period: 31 January 1962 – 31 December 2008.

Let us consider the question of portfolio construction. Since GES ratings are based on information obtained from companies in their official documents, we sometimes arrive to the situation when potentially more dangerous for environment companies (for example mining companies) have higher environmental scores than less dangerous companies (software development companies). That is why we decided to perform two types of analysis:

- analysis of SRI portfolios that are constructed without taking into account GICS (Global Industry Classification Standard) sectors
- analysis of SRI portfolios that are constructed using 'best-in-class' selection.

The algorithm of SRI portfolio construction for the first type of analysis is the following:

Algorithm 1

1. Select US companies from the GES list of companies.
2. Rank the companies semiannually on their most recent environmental or human rights scores.
3. Divide ranked companies into three mutually exclusive stock portfolios:
 - High-ranked portfolio consists of 33% companies that have the highest GES ranks
 - Low-ranked portfolio consists of 34% companies that have the lowest GES ranks
 - Middle-ranked portfolio consists of all other companies that were not included into high- or low- ranked portfolios.
4. Match all companies in portfolios obtained in step 3 with the benchmark weights, i.e. assign the corresponding weight to each company either from RAFI US Large index or from S&P 500 index.

¹ SEDOL – (Stock Exchange Daily Official List), a list of security identifiers. SEDOLs are seven characters in length, consisting of two parts: a six-place alphanumeric code and a trailing check digit.

² Ticker – is a mnemonic used to identify uniquely publicly-traded shares of a corporation on a particular stock market.

5. Make portfolios weights obtained in step 4 sum up to one, i.e. if portfolio has weights (w_1, w_2, \dots, w_n) then resulting portfolio will have weights

$$\left(\frac{w_1}{sum}, \frac{w_2}{sum}, \dots, \frac{w_n}{sum} \right), \text{ where } sum = \sum_{i=1}^n w_i .$$

Thus, by following steps 1-5, we will obtain $12 = 2 * 2 * 3$ portfolios, since we can rank companies according two GES characteristics (environment and human rights), the weights can be assigned from two indexes (RAFI US Large and S&P 500) and in each case we get three portfolios (high-ranked, middle-ranked and low-ranked).

The idea of SRI portfolio construction for the second type of analysis is the following:

Algorithm 2

1. Select US companies from the GES list of companies.
2. Divide all companies into 10 groups in correspondence with its GICS sector. The sectors are the following: 'Energy', 'Materials', 'Industrials', 'Consumer Discretionary', 'Consumer Staples', 'Health Care', 'Financials', 'Information Technology', 'Telecommunication Services', 'Utilities'.
3. Within each group rank the companies semiannually on their most recent environmental or human rights scores.
4. In each group divide ranked companies into three mutually exclusive subportfolios (high-ranked, middle-ranked and low-ranked).
5. All companies from high-ranked subportfolios will constitute high-ranked portfolio. All companies from middle-ranked subportfolios will constitute middle-ranked portfolio and all companies from low-ranked subportfolios - low-ranked portfolio.
6. Match all companies in portfolios obtained in step 5 with the benchmark weights, i.e. assign the corresponding weight to each company either from RAFI US Large index or from S&P 500 index.
7. Make weights for portfolios obtained in step 6 sum up to one.

If we follow steps 1-7 above then we will get the same number of portfolios as in case one, i.e. 12.

Steps 3-6 can be described in more formal way as:

After dividing all companies in correspondence with GICS sectors we got 10 groups. Let us suppose that we have m_i , $i=1, \dots, 10$ companies in each group:

$company_1, \dots, company_{m_i}$. Then steps 3-5 look as:

3. Rank companies in each group according to GES scores. For i^{th} group, we will get $company'_1, \dots, company'_{m_i}$.

4. In each group divide ranked companies into three mutually exclusive subportfolios:

- High-ranked subportfolio: $subportf_i^1 = (company'_1, \dots, company'_j)$
- Middle-ranked subportfolio: $subportf_i^2 = (company'_{j+1}, \dots, company'_i)$
- Low-ranked subportfolio: $subportf_i^3 = (company'_{i+1}, \dots, company'_{m_i})$,
 $i = 1, \dots, 10$

5. Construct three mutually exclusive portfolios:

- High-ranked portfolio: $(subportf_1^1, subportf_2^1, \dots, subportf_{10}^1)$
- Middle-ranked portfolio: $(subportf_1^2, subportf_2^2, \dots, subportf_{10}^2)$
- Low-ranked portfolio: $(subportf_1^3, subportf_2^3, \dots, subportf_{10}^3)$

Once portfolios are constructed, the time series of portfolio values can be computed using the following formula:

$$V(t) = \sum_{i=1}^N V(t-1) * w_i(t) * (1 + r_i(t)), \text{ where} \quad (1)$$

$V(t)$ - portfolio value at time t

N - number of portfolio constituents

$w_i(t)$ - weight of the company i in the portfolio

$r_i(t)$ - return of the company i in the period t .

The portfolio returns can be calculated as:

$$r(t) = \frac{V(t) - V(t-1)}{V(t-1)}, \text{ where} \quad (2)$$

$r(t)$ - portfolio return at time t

$V(t)$ - portfolio value at time t .

When two time series (portfolio value and returns) for each portfolio are obtained the analysis of the portfolios can be made. Each portfolio will be compared with corresponding benchmark (S&P 500 or RAFI US Large).

5.2 Indexes comparison

Comparison

In this section comparison of RAFI US Large and SP 500 indexes for the period 31 January 1962 – 31 December 2008 will be done. Let us assume that in the beginning of the period we have invested 1\$ in each index. In the Figures 1-2 the value of both indexes and their returns are plotted. According to Figure 1 RAFI US Large outperformed S&P 500 index by substantial amount during the time period measured. But let us look at other measures before this assertion can be made with any validity.

From Table 1 follows that RAFI US Large has smaller standard deviation and maximum drawdown in comparison with S&P 500. It also has larger mean, maximum and minimum monthly return. Figures 3-5 show that in general RAFI US Large outperformed S&P 500 Index.

Therefore, we may conclude that RAFI US Large has better performance than S&P 500.

Table 1. Descriptive statistics for S&P 500 and RAFI US Large Indexes (31 Jan 1962 -31 Dec 2008)

Index	Mean	Std. Dev. of monthly returns	Maximum monthly return	Minimum monthly return	IR	MDD (%)
S&P 500	0.0081	0.0432	0.1681	-0.2154		44.7240
RAFI US Large	0.0096	0.0425	0.1872	-0.2116	0.5039	41.5831

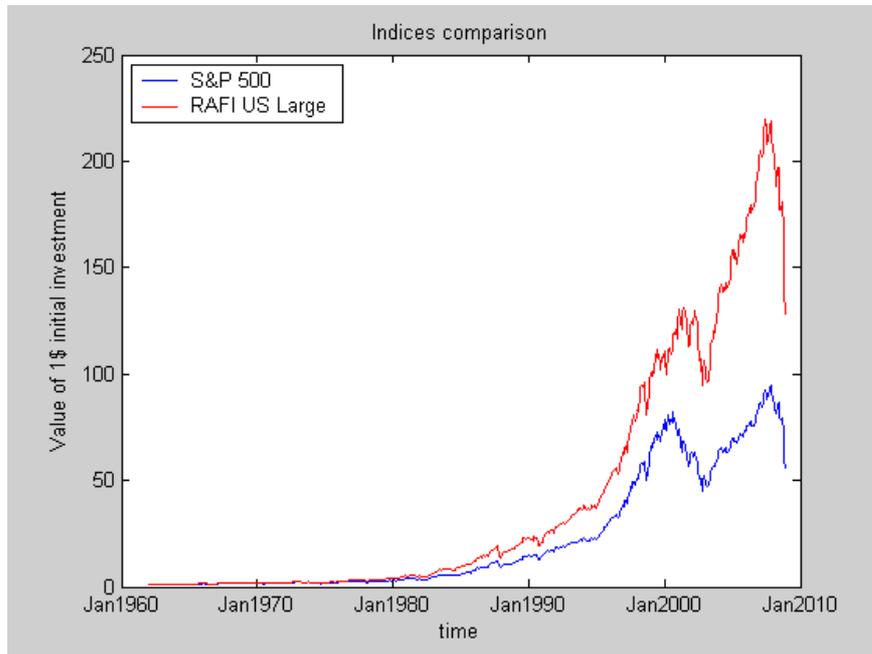


Figure 1.
Value of 1\$ initial investment into S&P 500 and RAFI US Large

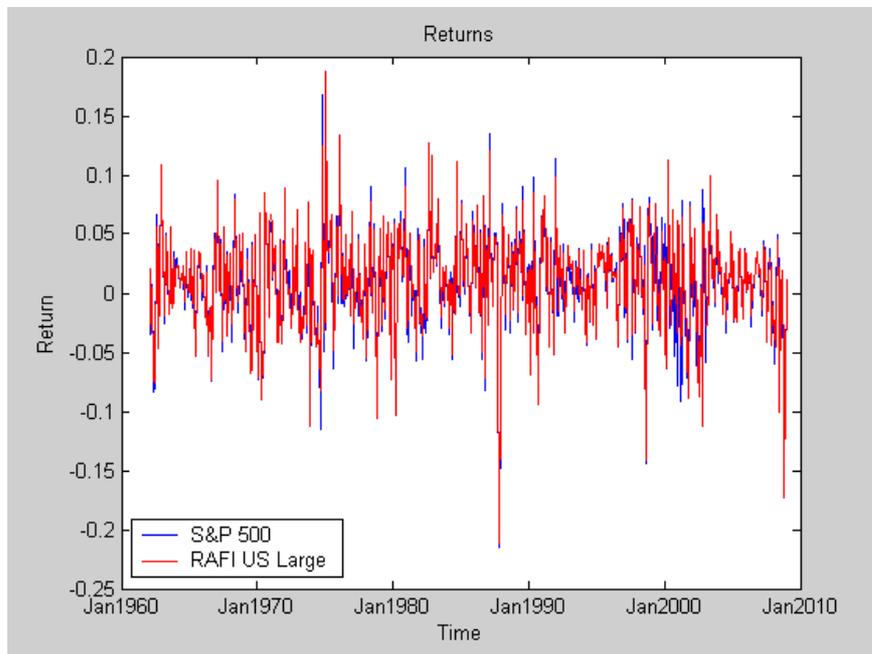


Figure 2.
Returns of S&P 500 and RAFI US Large

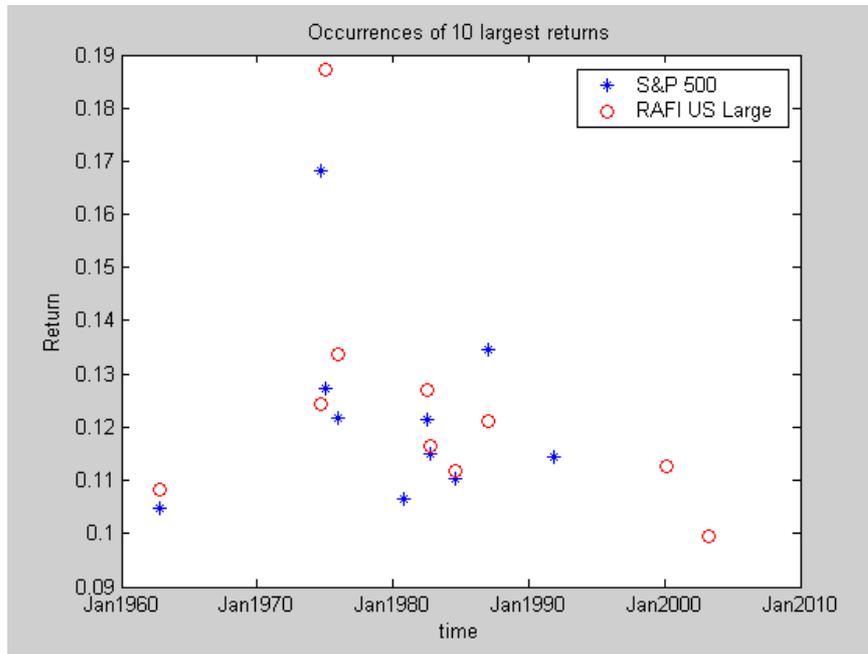


Figure 3.
Occurrences of 10 largest returns

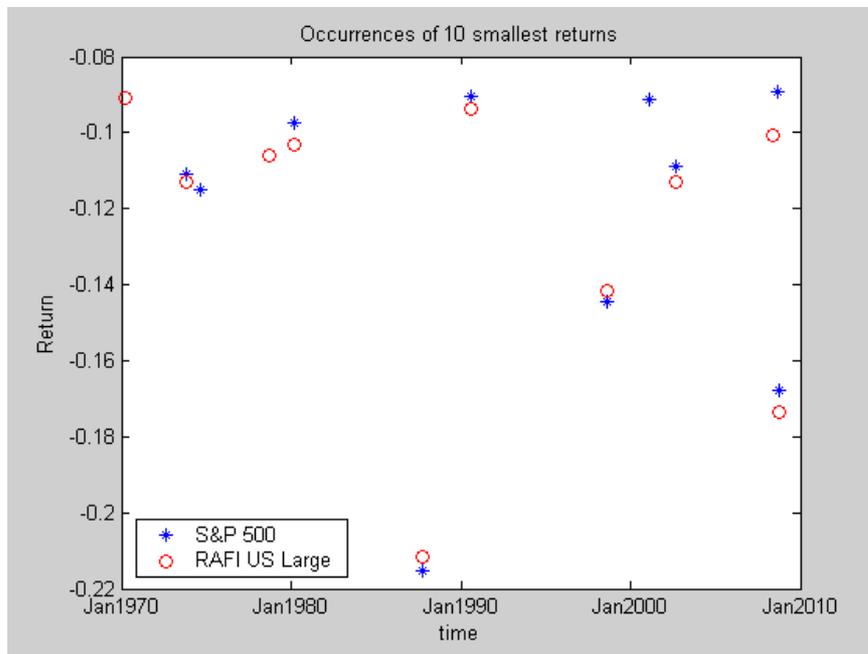


Figure 4.
Occurrences of 10 smallest returns

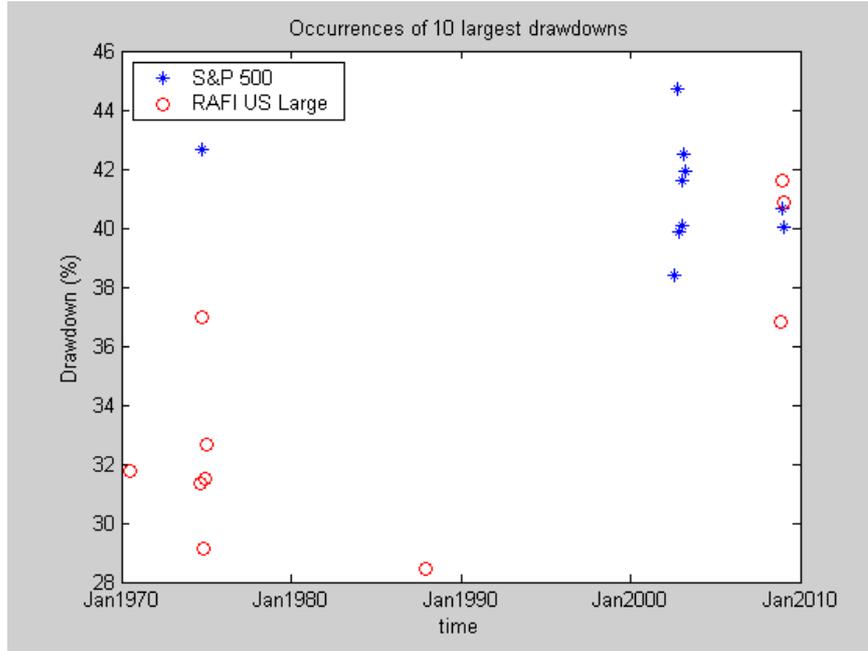


Figure 5.
Occurrences of 10 largest drawdowns

Computation error

Analysis for eco-efficient portfolios will be made for the period 1 Jul 2004-31 December 2008. We will calculate portfolio value at time t as

$$V(t) = \sum_{i=1}^N V(t-1) * w_i(t) * (1 + r_i(t)), \quad (3)$$

where

$V(t)$ - portfolio value at time t

N - number of portfolio constituents

$w_i(t)$ - weight of the company i in the portfolio

$r_i(t)$ - return of the company i in the period t .

In order to find out if formula (3) results in a good approximation of portfolio value, given information we have, we will compute the value of 100\$ initial investment into S&P 500 index using (3) and using S&P 500 returns obtained from Research Affiliates.

In the Figure 6 plotted the value of 100\$ initial investment into S&P 500 and RAFI US Large indexes as well as approximation of value curve for S&P 500 index. From the graphs it is clearly seen that we got quite good approximation of value curve for S&P 500 index. As a digital measure of this difference we will consider root mean square deviation (RMSD).

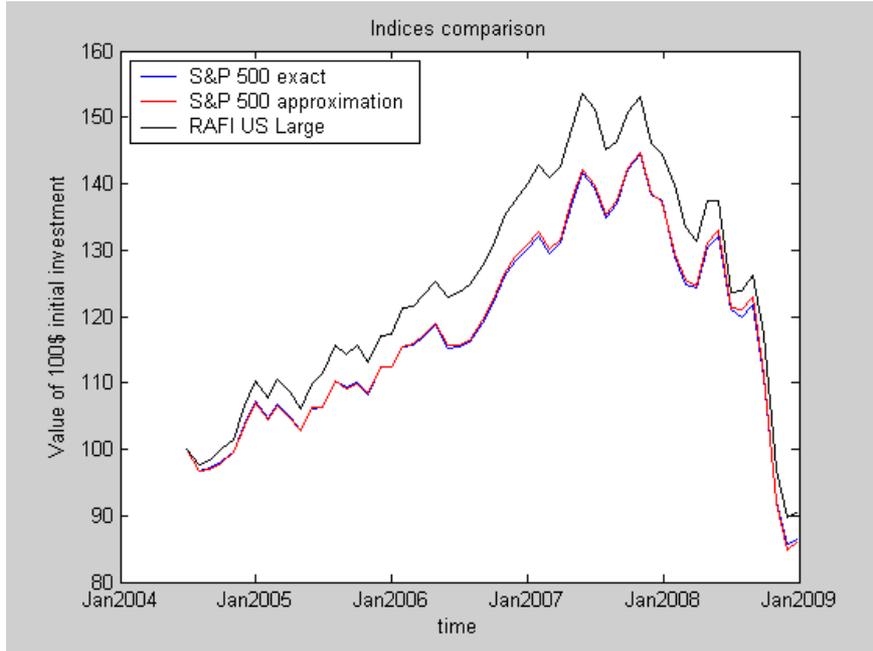


Figure 6.
Value of 100\$ initial investment into indexes

Let us assume that real S&P index values are $\theta = (\theta_1, \theta_2, \dots, \theta_T)$ and the approximation values are $\hat{\theta} = (\hat{\theta}_1, \hat{\theta}_2, \dots, \hat{\theta}_T)$. Then RMSD can be computed as:

$$\text{RMSD}(\theta, \hat{\theta}) = \sqrt{E((\hat{\theta} - \theta)^2)} = \sqrt{\frac{\sum_{i=1}^T (\hat{\theta}_i - \theta_i)^2}{T}}.$$

In our case, $\text{RMSD}(\theta, \hat{\theta}) = 3.1686$.

This error can be explained by two reasons:

- rebalancing of S&P 500 index we do only twice a year
- since we don't have returns for some index constituents, we calculated S&P 500 based on given information, i.e. on returns for 495-500 companies in different time periods.

Thus, we will consider that formula (3) gives good approximation of real portfolio value and will use it in our analysis.

5.3 Analysis of portfolios based on S&P 500 index

5.3.1 Analysis of portfolios constructed using environmental factor and 'best-in-class' selection

In this section we will perform the analysis of portfolios that were constructed using 'best-in-class' selection, GES environmental scores and weights from S&P 500 index. In other words, companies' allocation between portfolios was made according to *Algorithm 2* from Section 5.1, where in step 3 US companies were ranked according to Environmental scores and weights in step 6 were taken from S&P 500 index.

First of all, let us carry out the analysis on monthly basis. Assume that we invested 100\$ in each portfolio. In the Figures 1 and 2 corresponding portfolio values and portfolio returns are plotted.

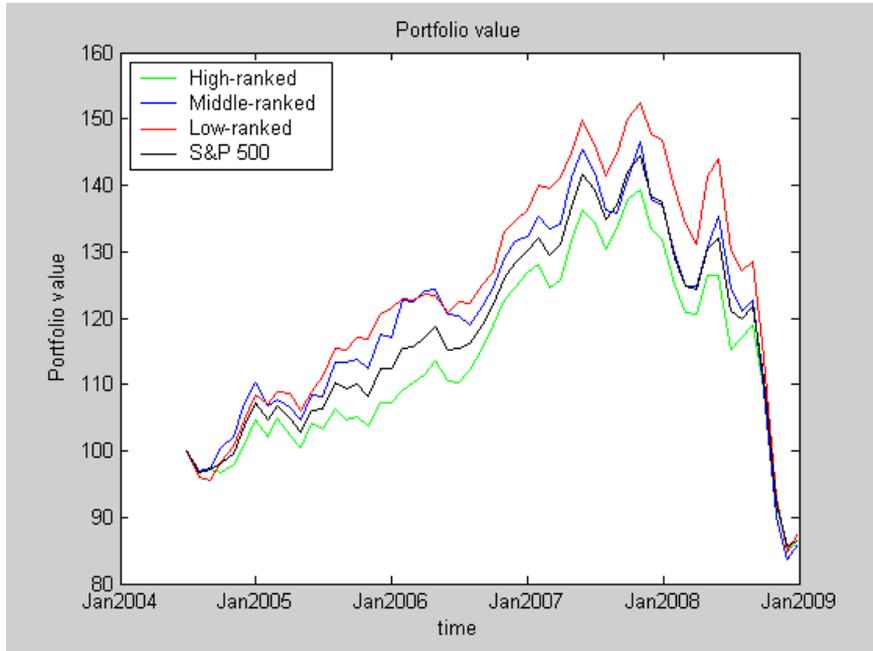


Figure 1.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and S&P 500 index

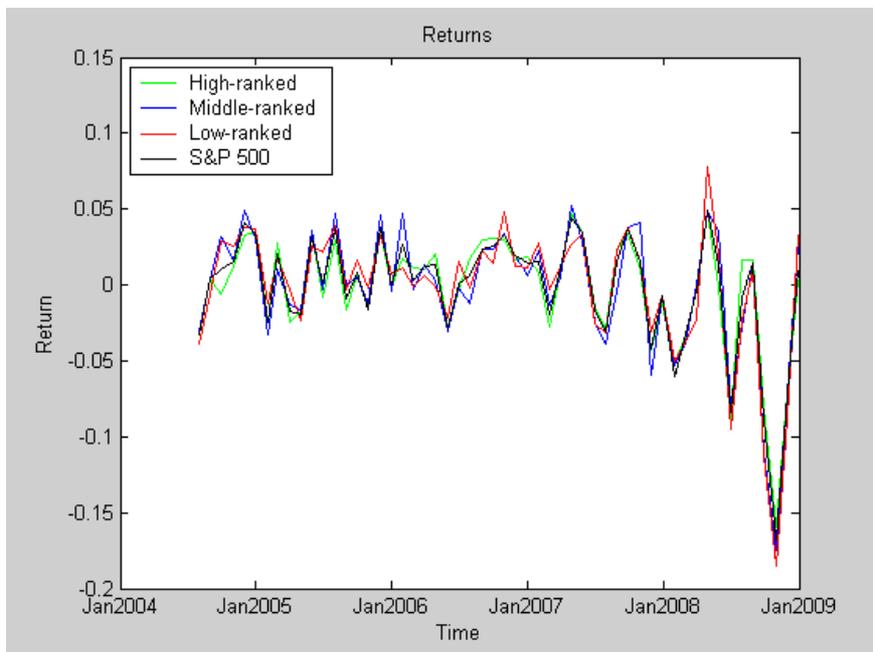


Figure 2.

Returns of high-ranked, middle-ranked, low-ranked portfolios and S&P 500 index

From Figure 1 it is seen that middle- and low-ranked portfolios outperform S&P 500 index in portfolio value during the whole period with few exceptions. Portfolio that consists of high-ranked companies underperforms the benchmark. From Figure 2 the following conclusions can be made:

- Curve that represents returns was fluctuating with almost the same amplitude before the crisis that began in 2008. Amplitude of oscillations increased during the crisis.

As a rule, returns of low- and middle-ranked portfolios have larger amplitude of oscillations than returns of high-ranked portfolios. This can be the evidence of more risky investment in these companies.

In order to make final conclusion about expediency of investment, let us look at different financial measures. In Tables 1, 2 the descriptive statistics are presented. In the Figures 3-5 occurrences of 10 largest returns, 10 smallest returns and 10 largest drawdowns are plotted. In Tables 1 and 2 as well as in the rest of the work, the following notations were used:

Std. Dev. – standard deviation

MDD – maximum drawdown

IR_1 - information ratio calculated for the period 1 Jul 2004-31 Dec 2008

TE_1 - tracking error calculated for the period 1 Jul 2004 – 31 Dec 2008

IR_2 - information ratio calculated for the period 1 Jul 2007 – 31 Dec 2008

TE_2 - tracking error calculated for the period 1 Jul 2007 – 31 Dec 2008

IR_3 - information ratio calculated for the period 1 Jul 2004 – 1 Jul 2007

TE_3 - tracking error calculated for the period 1 Jul 2004 – 1 Jul 2007

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk ($\cdot 10^{-4}$)	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0021	0.0377	2.2125	0.0477	-0.1597	38.6851
Middle-ranked companies	-0.0019	0.0426	2.0240	0.0522	-0.1748	42.9655
Low-ranked companies	-0.0015	0.0432	3.4211	0.0777	-0.1851	44.3677
S&P 500	-0.0019	0.0388	2.4400	0.0487	-0.1679	40.6817

Low-ranked portfolio has the largest mean return and maximum monthly return (according to Table 1), but from Figure 3 follows that this largest maximum monthly return appeared only once during the whole period. At the same time, middle-ranked portfolio was outperforming other portfolios and benchmark by this statistics during the whole period. High-ranked portfolio has the smallest standard deviation, but middle-ranked companies have the smallest downside risk, which is more important. From

Figure 5 and Table 1 follows that high-ranked companies and S&P 500 index have the smallest drawdown. Middle-ranked portfolio has maximum drawdown on $\approx 4.28\%$ larger than high-ranked.

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	-0.0765	0.0236	0.4678	0.0289	-0.6452	0.0206
Middle-ranked companies	-0.0455	0.0352	-0.2632	0.0466	0.2360	0.0285
Low-ranked companies	0.0675	0.0407	-0.3335	0.0497	0.4970	0.0357

As for information ratio (see Table 2), low-ranked companies outperform middle-ranked, but at the same time they have larger tracking error. Hence, it's hard to draw strong conclusion that one portfolio outperforms another on the basis of such a short history.

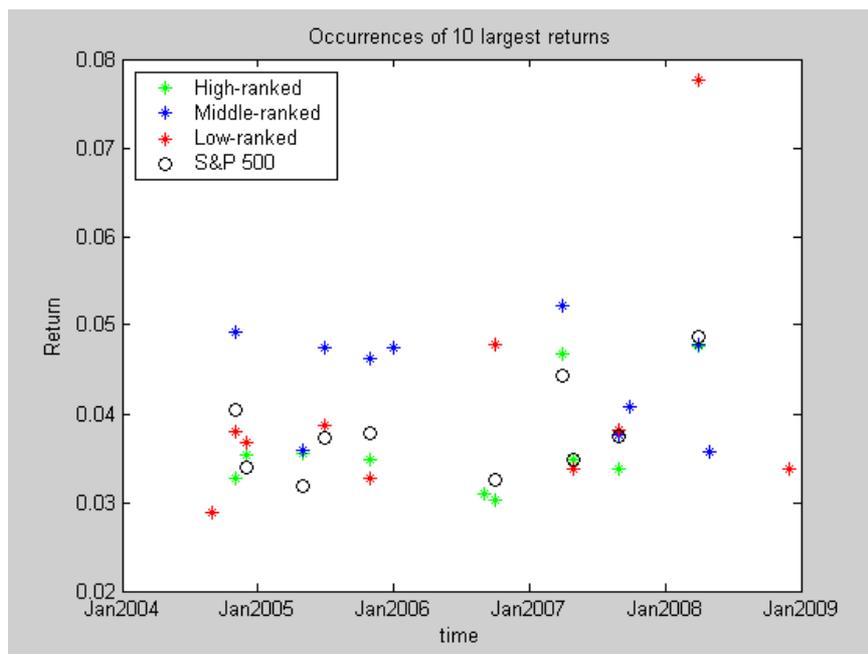


Figure 3.
Occurrences of 10 largest returns

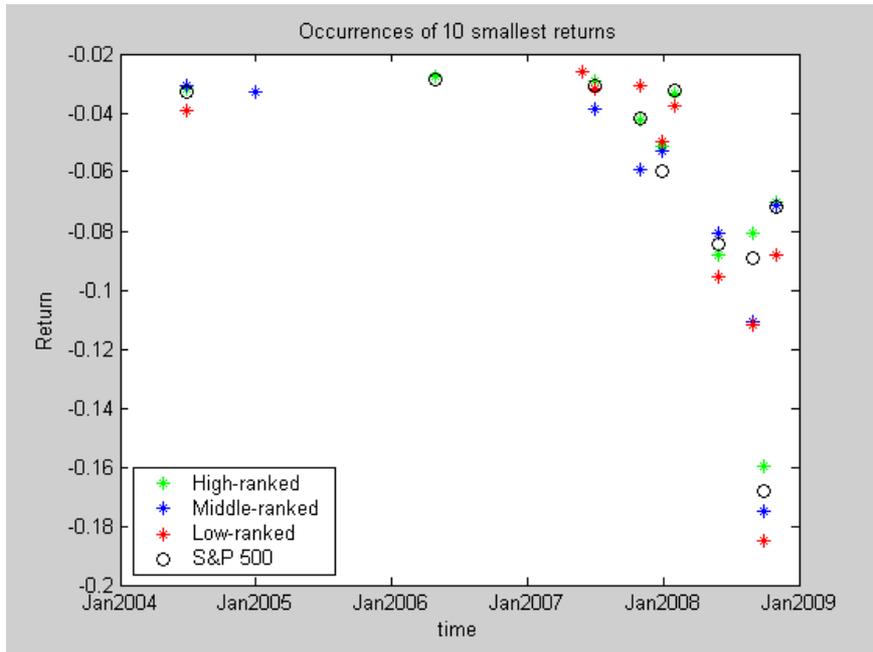


Figure 4.
Occurrences of 10 smallest returns

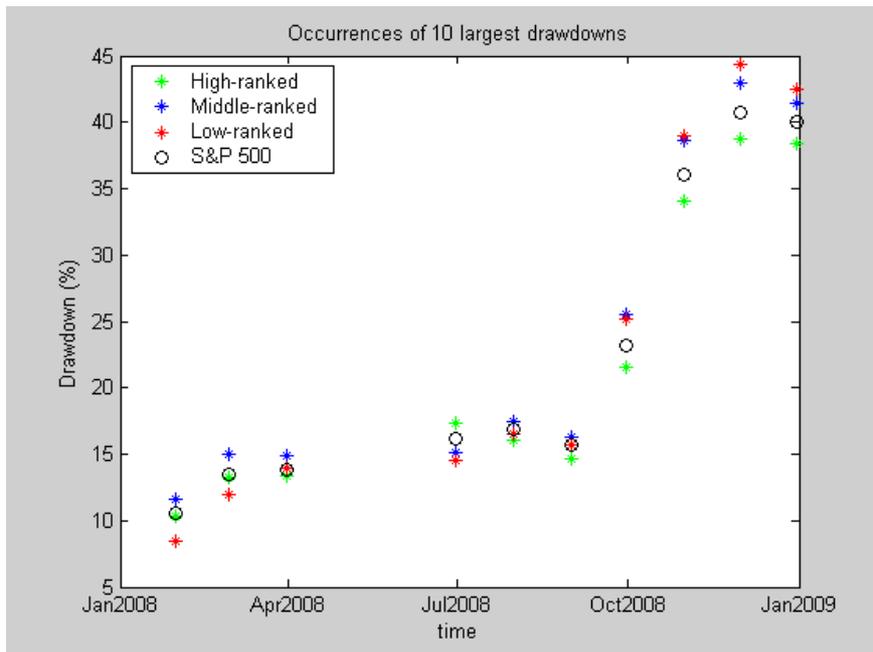


Figure 5.
Occurrences of 10 largest drawdowns

Therefore, different measures show the preference of investment into different portfolios and each investor should decide by himself, which measure is more important for him. In the Table 3 the ranking of portfolios (from best till worst) according to different statistics is presented.

Table 3. Summary¹

Rank	Mean	Std. Dev. of monthly returns	Downside risk	Maximum monthly return	Minimum monthly return	MDD (%)	IR	TE
1	L	H	M	L	H	H	L	H
2	M/I	I	H	M	I	I	M	M
3	M/I	M	I	I	M	M	H	L
4	H	L	L	H	L	L		

Let us now again look at the portfolios constructed using environmental factor and ‘best-in-class’ selection, but this time data will be retrieved on weekly basis. In the Figure 6 value of 100\$ initial investment is plotted for weekly and monthly data. It’s not surprisingly that portfolio values based on monthly returns reflects portfolio values based on weekly returns, but monthly returns sometimes do not catch all peaks of value curve.

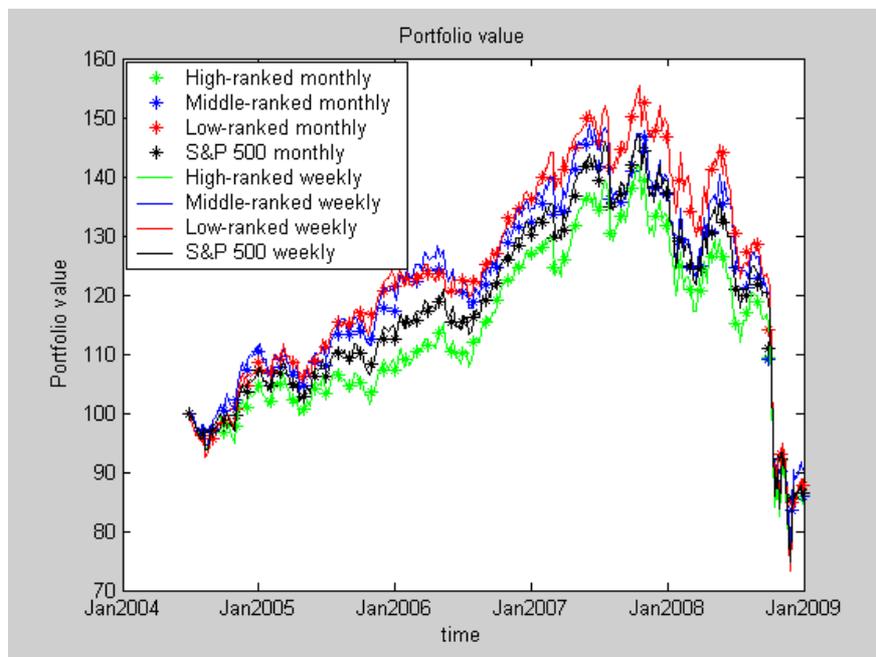


Figure 6.
Portfolio values based on weekly and monthly basis

The ranking of portfolios (from best till worse) that was made on the basis of Figures 7,8 and Tables 4,5 are given in Table 6.

¹ H – High-ranked companies
M – Middle-ranked companies
L – Low-ranked companies
I – Index (S&P 500)

Table 4. Descriptive statistics on weekly basis (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean ($\cdot 10^{-4}$)	Std. Dev. Of weekly returns	Downside risk ($\cdot 10^{-6}$)	Maximum weekly return	Minimum weekly return	MDD (%)
High-ranked companies	-3.4135	0.0275	2.2434	0.1637	-0.1893	47.4235
Middle-ranked companies	-0.35286	0.0286	3.3442	0.1681	-0.1773	47.9669
Low-ranked companies	-1.4801	0.0301	5.9640	0.1892	-0.1913	52.7902
S&P 500	-2.4468	0.0280	3.4350	0.1696	-0.1874	48.9648

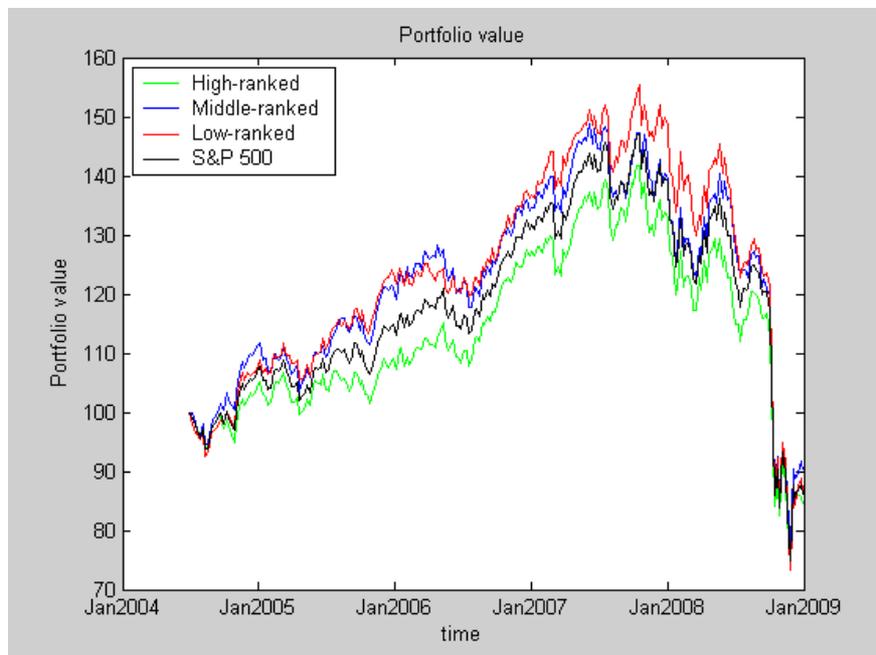


Figure 7.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and S&P 500 index (weekly basis)

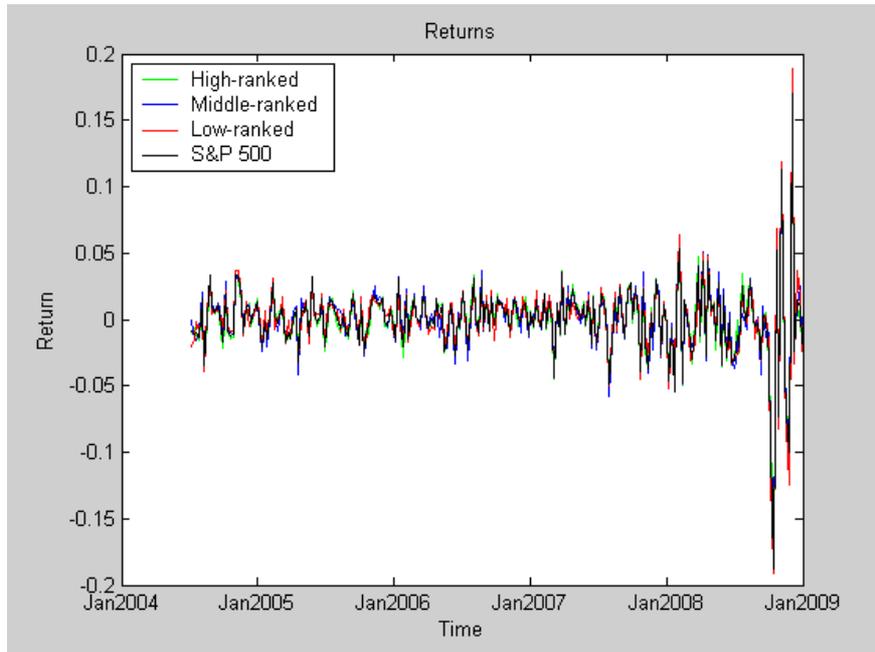


Figure 8.
Returns of high-ranked, middle-ranked, low-ranked portfolios and S&P 500 index (weekly basis)

Table 5. Information Ratios and Tracking Errors (on weekly basis)

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	-0.1713	0.0237	0.1793	0.0484	-0.6160	0.0205
Middle-ranked companies	0.2691	0.0369	0.2293	0.0667	0.1821	0.0335
Low-ranked companies	0.0422	0.0439	-0.1064	0.0938	0.2699	0.0371

Table 6. Summary¹

Rank	Mean	Std. Dev. of weekly returns	Downside risk	Maximum weekly return	Minimum weekly return	MDD (%)	IR	TE
1	M	H	H	L	M	H	M	H
2	L	I	M	I	I	M	L	M
3	I	M	I	M	H	I	H	L
4	H	L	L	H	L	L		

¹ H – High-ranked companies, M – Middle-ranked companies, L – Low-ranked companies, I – Index (S&P 500)

Let us now find out which distribution our data fit. From the histogram of weekly returns with fitted normal distribution (Figure 9) it is clearly seen that our data do not fit Normal distribution. Skewness and kurtosis from Table 7 also support this conclusion.

In order to determine to which distribution our data fit, we will use qq plots. In the Figures 10-13 quantiles of returns against quantiles of Student distribution with different degrees of freedom are plotted. It is known that if the qq plot looks like a line then data have good fit with this distribution. From Figures 10-13 follows that Student distribution with 2 degrees of freedom is suitable for all portfolio's returns. That is why we could use this distribution for parametric bootstrap. Since all returns have the same distribution, we can not bootstrap from it. This is because the result will depend on sample and we will not be able to draw any conclusion. One more reason not to use parametric bootstrap in our case is limited size of sample. In the Figures 10-13 qq-plots were based on weekly data, but when we consider monthly data, it's hard to determine the distribution on the basis of 54 points. That is why we will use non-parametric block bootstrap.

Table 7.

Portfolio	Skewness	Kurtosis
High-ranked companies	-0.6027	17.9400
Middle-ranked companies	-0.4513	15.1412
Low-ranked companies	-0.4657	18.1797
S&P 500	-0.5625	17.6882

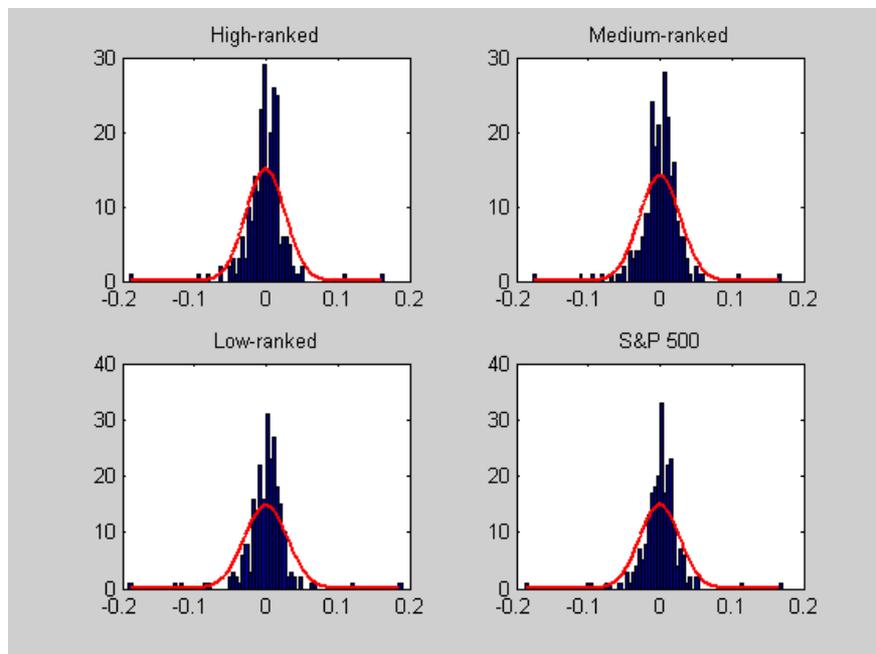


Figure 9.
Histogram of returns with fitted normal distribution

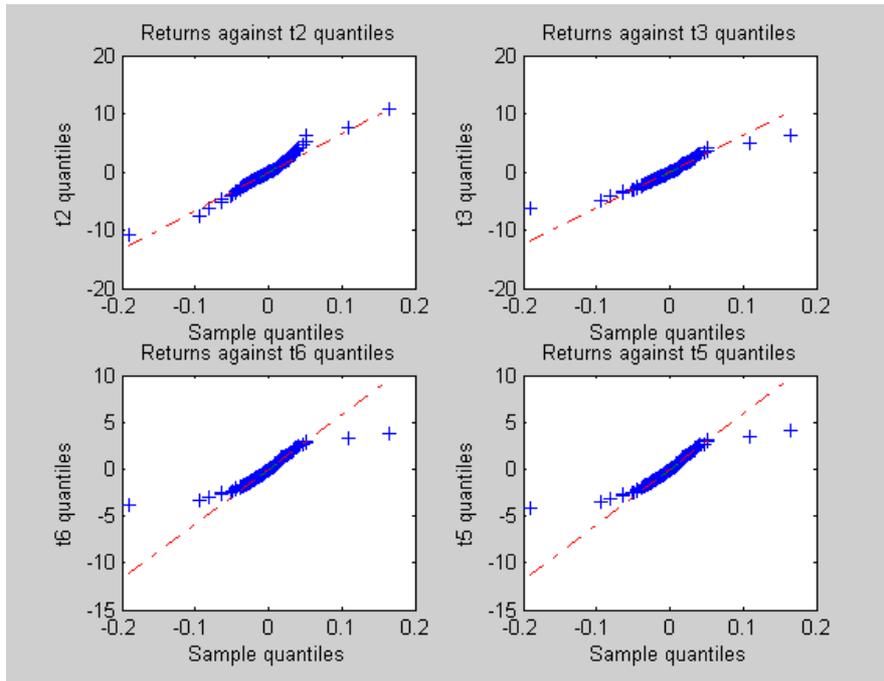


Figure 10.
 QQ plot for portfolio consisting of high-ranked companies

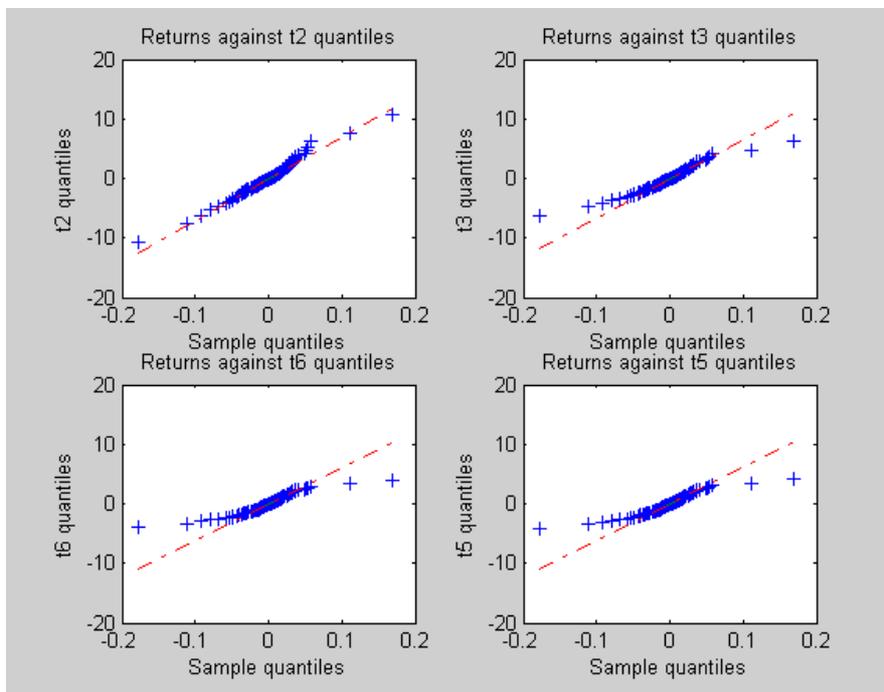


Figure 11.
 QQ plot for portfolio consisting of middle-ranked companies

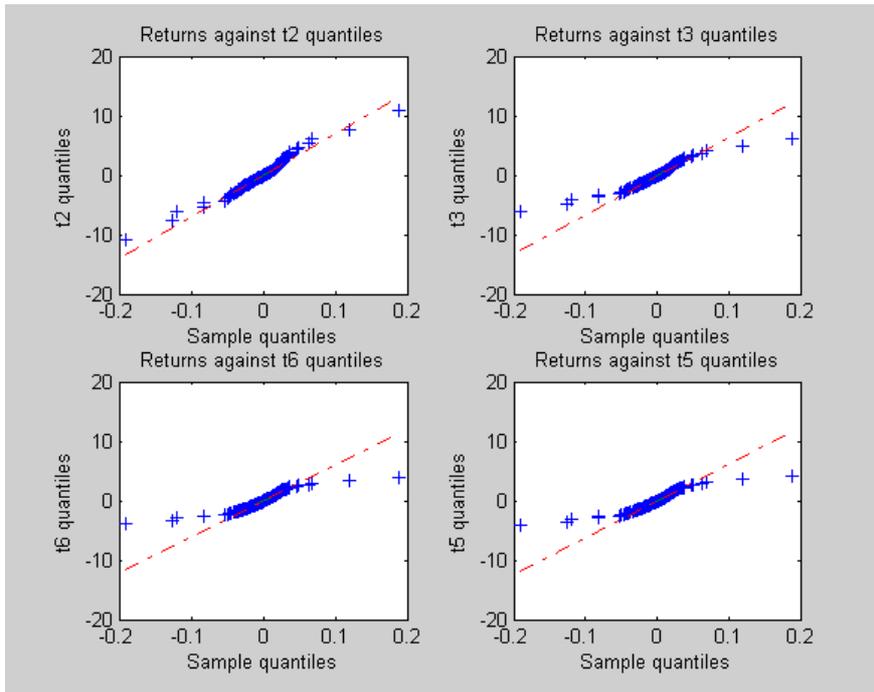


Figure 12.
 QQ plot for portfolio consisting of low-ranked companies

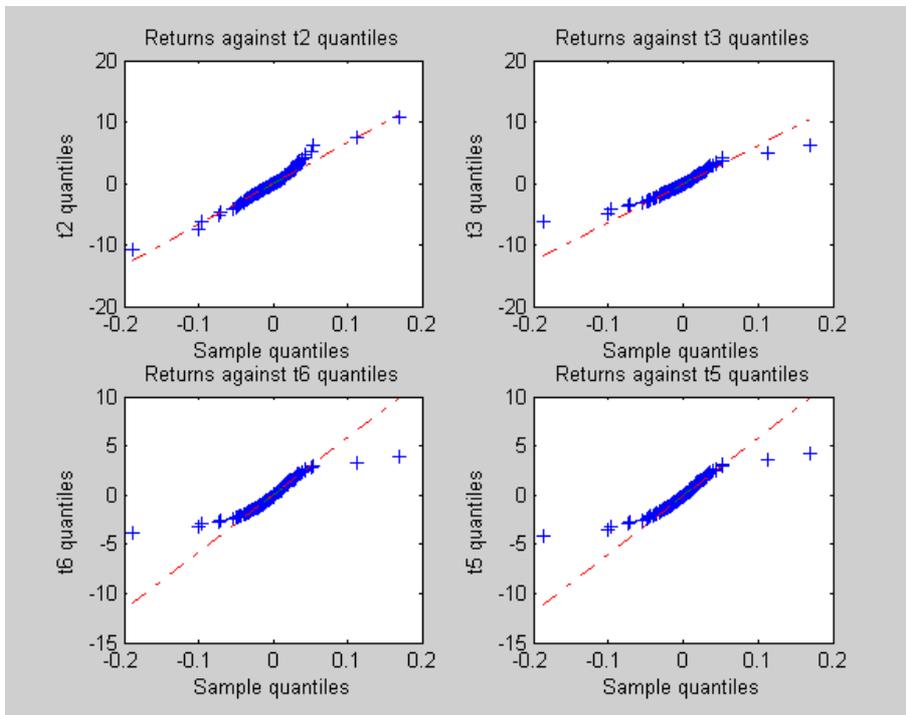


Figure 13.
 QQ plot for S&P 500 index

From Tables 8,9 the following conclusion can be drawn: middle-ranked portfolio outperform its counterparts according to majority of statistics (IR, mean, downside risk, minimum weekly return).

Table 8. Descriptive statistics for bootstrapped data based on 1000 samples (weekly)

Portfolio	Mean ($\cdot 10^{-4}$)	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-3.1317	0.0269	1.2894	0.1363	-0.1466	38.4166	-0.1794
Middle-ranked companies	-0.49557	0.0280	1.2378	0.1404	-0.1398	38.8789	0.2444
Low-ranked companies	-1.3939	0.0294	1.5617	0.1568	-0.1563	41.3017	0.0605
S&P 500	-2.2930	0.0274	1.3286	0.1411	-0.1476	39.0522	

Table 9. Descriptive statistics for bootstrapped data based on 1000 samples (weekly)

Portfolio	Mean ($\cdot 10^{-4}$)	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-3.2675	0.0270	1.1908	0.1357	-0.1484	38.8311	-0.2053
Middle-ranked companies	-0.22948	0.0281	1.1222	0.1399	-0.1414	38.9680	0.2797
Low-ranked companies	-1.3800	0.0295	1.4629	0.1561	-0.1571	41.5017	0.0652
S&P 500	-2.3072	0.0275	1.2196	0.1404	-0.1491	39.3213	

For further analysis of portfolios' performance we will use monthly data. The main reason for this is the following: RAFI US Large consists of 1000 companies, but for some companies total returns are unavailable in Bloomberg. Therefore, we arrive to the situation when we are forced to compute RAFI return from 850-1000 companies. This leads us to large computational error. That is why we decided to use RAFI US Large returns obtained from Research Affiliates, which are available on monthly basis.

5.3.2 Analysis of portfolios constructed using human rights factor and 'best-in-class' selection

In this case, portfolios are constructed in the same way as in Section 5.3.1, but with one exception: in Step 3 of *Algorithm 2* US companies were ranked according to human rights GES scores.

From the Figure 1 it is clearly seen that, in general, middle- and low- ranked companies outperform S&P 500 index in portfolio value. Similarly to Section 5.3.1, Figure 2 shows that middle- and low- ranked portfolios have larger amplitude of oscillations which has increased during the world economic crisis.

From Table 1 follows that low- ranked companies have the smallest standard deviation, downside risk and maximum drawdown. At the same time low-ranked companies have largest information ratio and tracking error during the whole period (see Table 2). In its own turn, high-ranked portfolio has the best performance according to information ratio during the crisis period.

Thus, investment in low- and middle- ranked companies will result in higher returns, but it is much more risky, especially during the crisis.

Note that additional figures and statistics can be found in the Section 1.2 of Appendix 3.

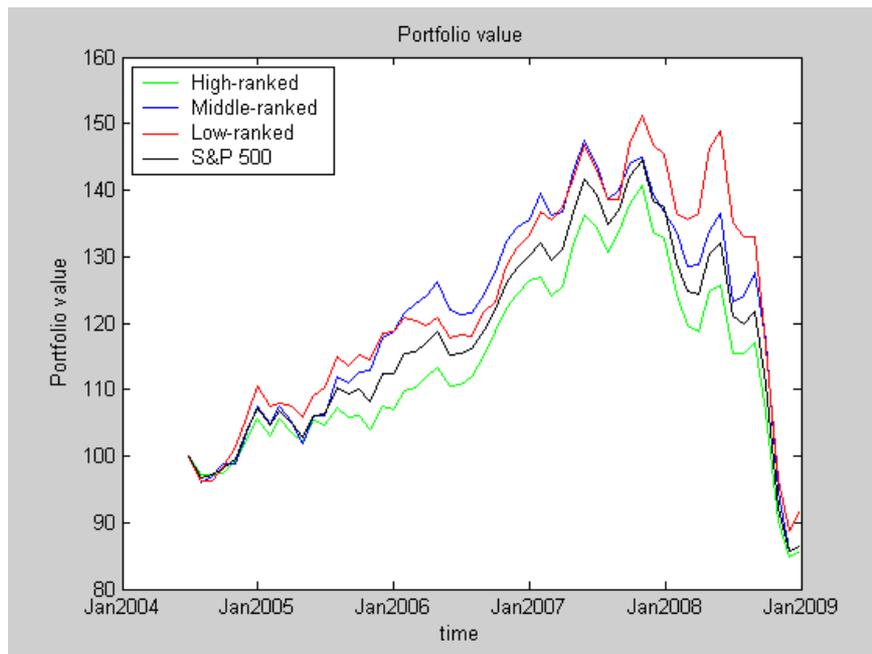


Figure 1.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and S&P 500 index

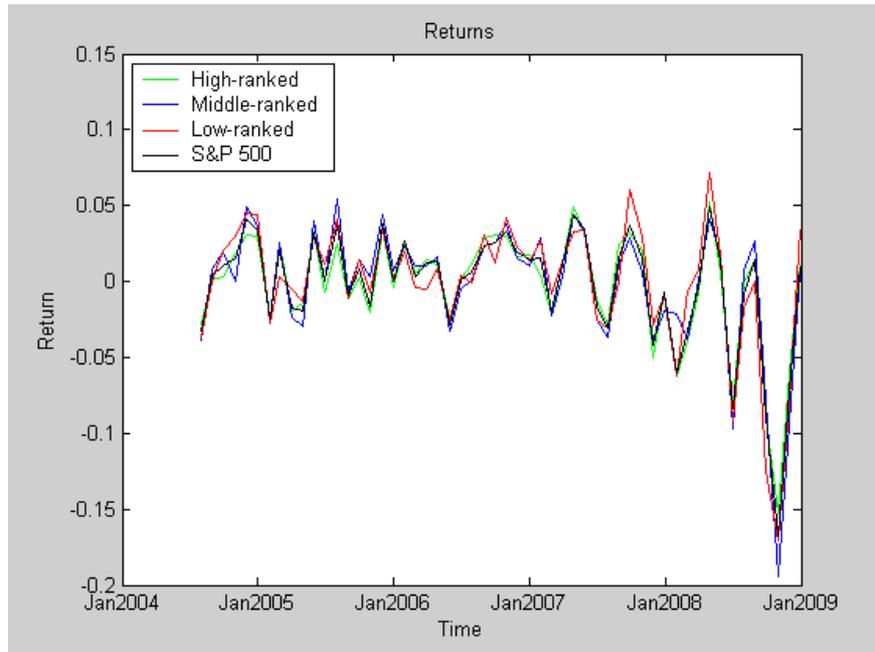


Figure 2.

Returns of high-ranked, middle-ranked, low-ranked portfolios and S&P 500 index

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk ($\cdot 10^{-4}$)	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0021	0.0371	1.6262	0.0520	-0.1524	39.7433
Middle-ranked companies	-0.0017	0.0426	4.7079	0.0546	-0.1943	41.8854
Low-ranked companies	-6.1572e-004	0.0428	2.9671	0.0719	-0.1705	41.2933
S&P 500	-0.0019	0.0388	2.4400	0.0487	-0.1679	40.6817

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	-0.0957	0.0194	0.5628	0.0230	-0.7657	0.0170
Middle-ranked companies	-0.0091	0.0365	-0.3108	0.0519	0.4611	0.0260
Low-ranked companies	0.3223	0.0403	0.2876	0.0573	0.3390	0.0291

Descriptive statistics that were obtained from the bootstrapped data are presented in Table 2 of Section 1.2 (Appendix 3) and Table 3 of current section.

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0023	0.0358	4.4299	0.0495	-0.1252	33.9543	-0.1337
Middle-ranked companies	-0.0019	0.0409	11.707	0.0521	-0.1551	35.9381	0.0063
Low-ranked companies	$-7.6478 \cdot 10^{-4}$	0.0411	4.5036	0.0661	-0.1400	34.8549	0.3583
S&P 500	-0.0020	0.0373	4.4621	0.0467	-0.1362	34.6348	

According to the analysis that was made on the basis of bootstrapped data, we again get that investment into low-ranked companies is more profitable, but in the same time more risky.

In Table 4 ranking of portfolios (from best till worse) according to different measures is presented.

Table 4. Summary¹

Rank	Mean	Std. Dev. of monthly returns	Downside risk	Maximum monthly return	Minimum monthly return	MDD (%)	IR	TE
1	L	H	H	L	H	H	L	H
2	M	I	I	M	I	I	M	M
3	I	M	L	H	L	L	H	L
4	H	L	M	I	M	M		

5.3.3 Analysis of the portfolios constructed using environmental factor

Let us carry out the analysis of portfolios that were constructed using GES environmental scores and weights from S&P 500 index. This time we will not take into account GICS sectors. In other words, companies' allocation between portfolios was made according to *Algorithm 1* from section 5.1, where in step 2 US companies were ranked according to Environmental score and weights in step 4 were taken from S&P 500 index.

¹ H – High-ranked companies, M – Middle-ranked companies, L – Low-ranked companies, I – Index (S&P 500)

From the Figure 1 it is seen that high-scored companies have better performance than S&P 500 index and other companies. Low ranked companies had good performance before the crisis, but during it the value of low-ranked portfolio had greatly decreased. Besides, low-ranked portfolio has larger amplitude of returns oscillations in comparison with other portfolios (see Figure 2). In order to make final conclusion about superior performance, let us look at other characteristics (Tables 1-2 of current section and Figures 1-3 of Section 1.3 of Appendix 3).

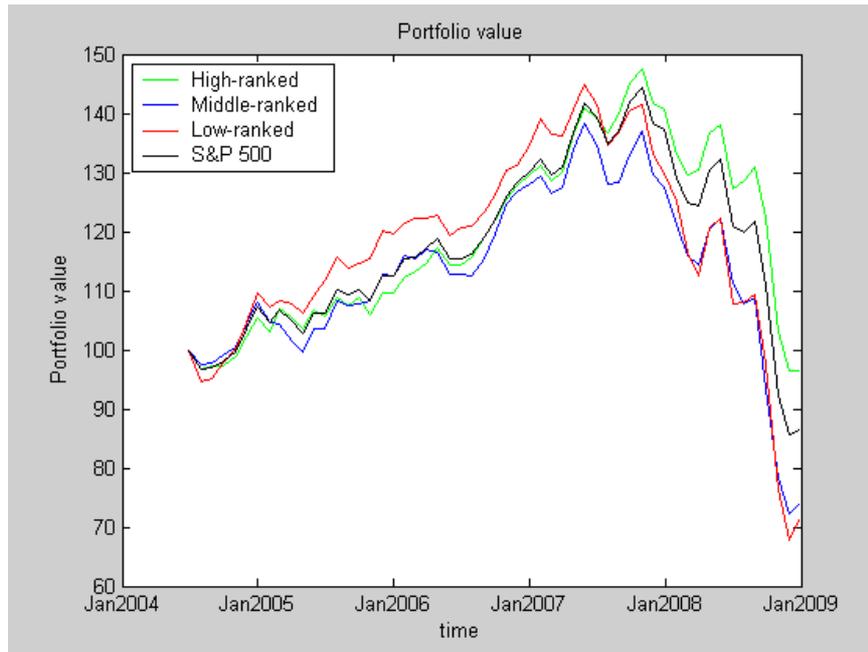


Figure 1.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and S&P 500 index

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	$1.0494 \cdot 10^{-5}$	0.0361	$7.2887 \cdot 10^{-9}$	0.0470	-0.1576	34.5228
Middle-ranked companies	-0.0046	0.0433	$2.6539 \cdot 10^{-4}$	0.0536	-0.1612	47.7806
Low-ranked companies	-0.0049	0.0492	$7.0051 \cdot 10^{-4}$	0.0716	-0.2161	53.2255
S&P 500	-0.0019	0.0388	$2.4400 \cdot 10^{-4}$	0.0487	-0.1679	40.6817

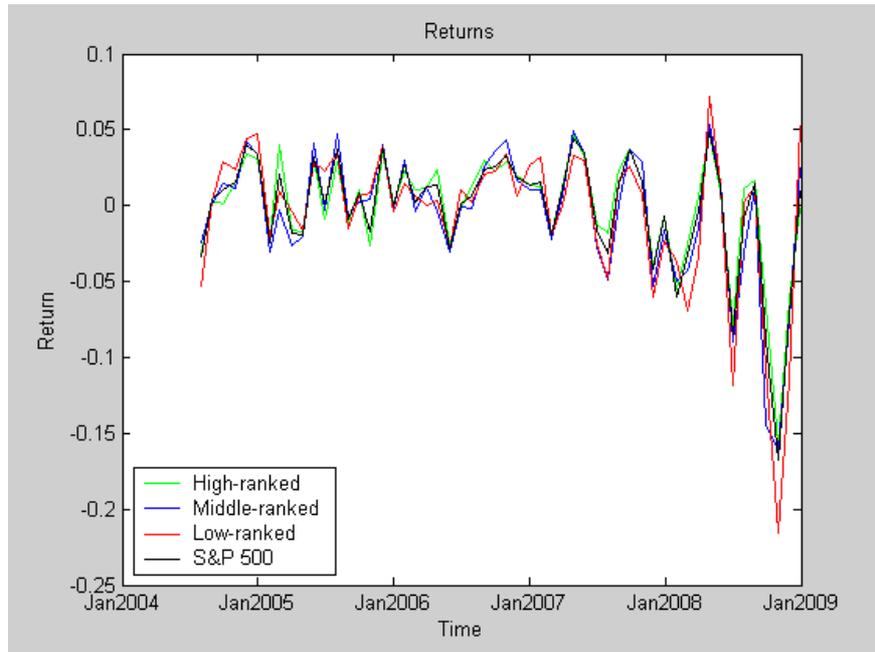


Figure 2.

Returns of high-ranked, middle-ranked, low-ranked portfolios and S&P 500 index

As was expected, high ranked portfolio has the largest mean of returns and information ratio. At the same time it has the smallest standard deviation, downside risk and maximum drawdown.

Thus, in the case of construction portfolio on the basis of environmental scores, without taking into consideration GICS sectors, we got that high-scored companies outperform their counterparts. This result coincides with the conclusions made by Derwall et al, (2005). Their analysis was based on Innovest scores and they have considered time span Jul 1995-2003.

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	0.9553	0.0249	1.9221	0.0287	-0.0104	0.0201
Middle-ranked companies	-0.8146	0.0401	-1.0072	0.0560	-0.4428	0.0281
Low-ranked companies	-0.6850	0.0591	-1.1098	0.0846	0.1493	0.0371

In the Table 3 of current section and Table 2 from Appendix 3. Section 1.3 characteristics computed from bootstrapped data are presented. Information ratio of the size of 0.9381 shows that high-ranked portfolio has much better performance in comparison with benchmark. High-ranked companies also have the largest mean of returns , smallest standard deviation and maximum drawdown.

Therefore, having analyzed the data from 4.5 years period, we can make the conclusion that in this case, investing in the high-ranked companies is more beneficial than investing in other companies.

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-1.5342 $\cdot 10^{-4}$	0.0348	5.6712	0.0461	-0.1268	29.8498	0.9381
Middle-ranked companies	-0.0047	0.0416	4.3828	0.0519	-0.1322	41.8194	-0.8170
Low-ranked companies	-0.0052	0.0471	15.932	0.0645	-0.1763	44.5051	-0.6459
S&P 500	-0.0021	0.0373	4.4882	0.0467	-0.1763	34.7145	

5.3.4 Analysis of the portfolios constructed using human rights factor

In this section portfolios will be constructed in the same way as in Section 5.3.3 with only one difference: in the step 2 of *Algorithm 1* ranking of companies will be made according to human rights scores.

From Figure 1 it can be concluded that middle-ranked companies are better performers than other companies; but in December of 2008 high-ranked portfolio has slightly higher value than other portfolios. Curve of low-ranked portfolio returns has the largest amplitude of oscillations, which shows that investment in these companies is risky.

As before, let us look at descriptive statistics of the portfolios (see Tables 1-2). Middle-ranked portfolio has the largest mean of returns during the period we are considering, but at the same time it has the largest standard deviation, downside risk and maximum drawdown. High-ranked portfolio has the largest information ratio and the smallest tracking error during the whole period we are considering. In their own turn, middle-ranked companies had $IR = 1.0955$ before the crisis, which is very good performance. During the whole period IR for them was also positive.

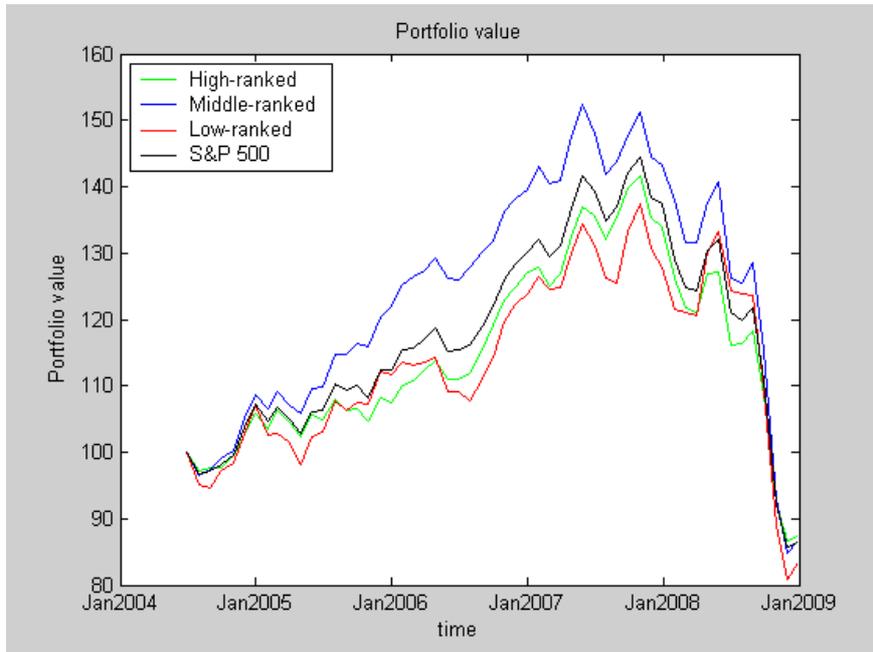


Figure 1.
Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and S&P 500 index

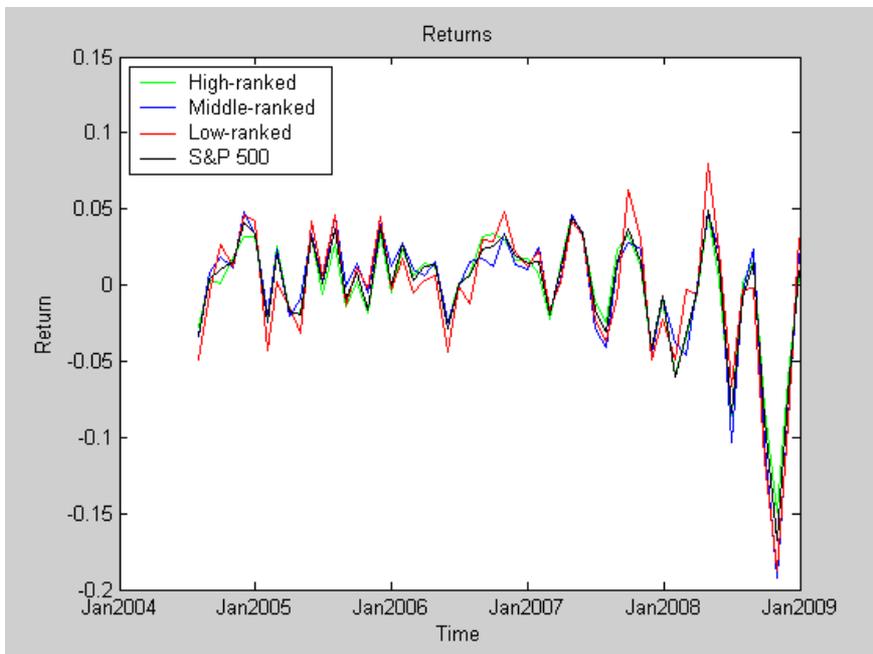


Figure 2.
Returns of high-ranked, middle-ranked, low-ranked portfolios and S&P 500 index

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk ($\cdot 10^{-4}$)	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0018	0.0362	1.6674	0.0469	-0.1494	38.7453
Middle-ranked companies	-0.0017	0.0433	4.1041	0.0484	-0.1922	44.2869
Low-ranked companies	-0.0023	0.0451	3.0518	0.0798	-0.1871	41.1709
S&P 500	-0.0019	0.0388	2.4400	0.0487	-0.1679	40.6817

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	0.0973	0.0198	0.7223	0.0245	-0.6148	0.0164
Middle-ranked companies	0.0087	0.0310	-0.6629	0.0427	1.0955	0.0208
Low-ranked companies	-0.1704	0.0466	0.1699	0.0658	-0.6475	0.0341

In Table 3 of current section and Table 2 from Appendix 3. Section 1.4 characteristics computed from bootstrapped data are given. According to computed values, information ratio is the highest for middle-ranked companies, but at the same time they are more risky than high-ranked companies in terms of standard deviation, downside risk and maximum drawdown.

Hence, according to analysis based on 4.5 years, we can conclude that investing into middle-ranked companies can lead to higher returns, but investors will be exposed to higher risk in this case. Investing into high-ranked companies gives smaller returns, but it is safer. Thus, each investor should make his own portfolio choice according to his preferences. Ranking of portfolios (from best till worse) according to different measures is given in Table 4.

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0019	0.0349	4.7556	0.0452	-0.1236	32.8379	0.0300
Middle-ranked companies	-0.0017	0.0413	8.6542	0.0478	-0.1552	36.8414	0.0974

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
Low-ranked companies	-0.0024	0.0434	5.9525	0.0720	-0.1434	38.4729	-0.1524
S&P 500	-0.0020	0.0372	4.3835	0.0467	-0.1355	34.5991	

Table 4. Summary¹

Rank	Mean	Std. Dev. of monthly returns	Downside risk	Maximum monthly return	Minimum monthly return	MDD (%)	IR	TE
1	M	H	H	L	H	H	H	H
2	H	I	I	I	I	I	M	M
3	I	M	M	M	L	L	L	L
4	L	L	L	H	M	M		

¹ H – High-ranked companies
M – Middle-ranked companies
L – Low-ranked companies
I – Index (S&P 500)

5.4 Analysis of portfolios based on RAFI US Large

5.4.1 Analysis of portfolios constructed using environmental factor and 'best-in-class' selection

In the Sections 5.4.1- 5.4.4 the similar analysis to the Sections 5.3.1-5.3.4 will be done. The only difference is the way we assign weights in the portfolios. In this section the weights will be taken from RAFI US Large. The analysis will be performed on monthly basis for the period: 1 Jul 2004 – 31 Dec 2008.

As before, we assume that we have invested 100\$ in each portfolio in the beginning of the period. In the Figure 1 corresponding portfolio values are plotted. It is easy to notice that high-ranked companies have worse performance in comparison with their counterparts. As in the case with S&P index, we have that amplitude of oscillations has increased after the beginning of crisis and return curves of middle- and low- ranked portfolios have the largest oscillations on the negative side (Figure 2).

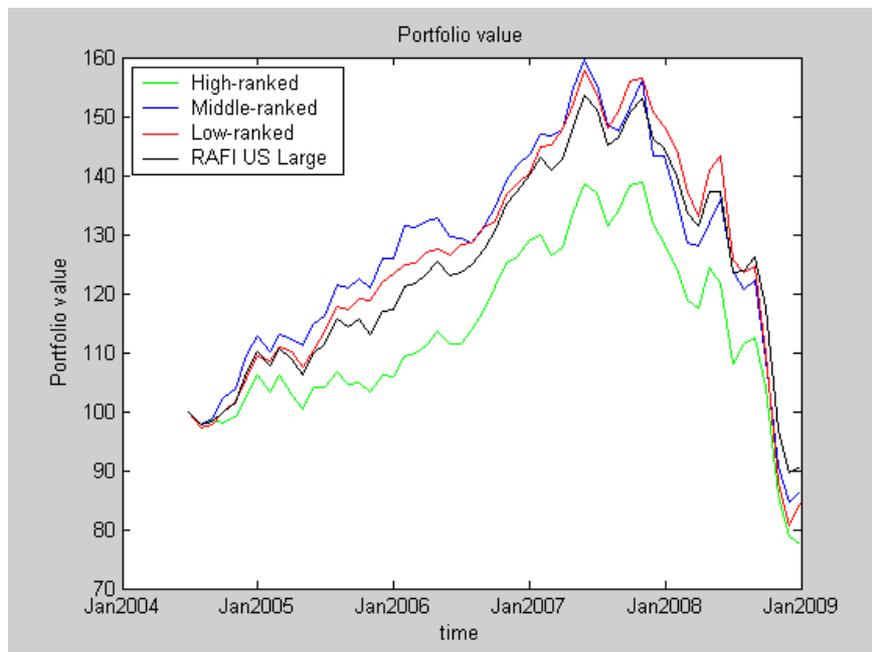


Figure 1.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and RAFI US Large

Let us look at descriptive statistics in Tables 1-2. RAFI US Large has the largest mean of returns, the smallest standard deviation and maximum drawdown. From the Table 2 we can conclude that during the whole period all portfolios underperform the benchmark (RAFI US Large). Before the crisis middle- and low- ranked portfolios had better performance than benchmark, but holders of these portfolios had more losses during the crisis period.

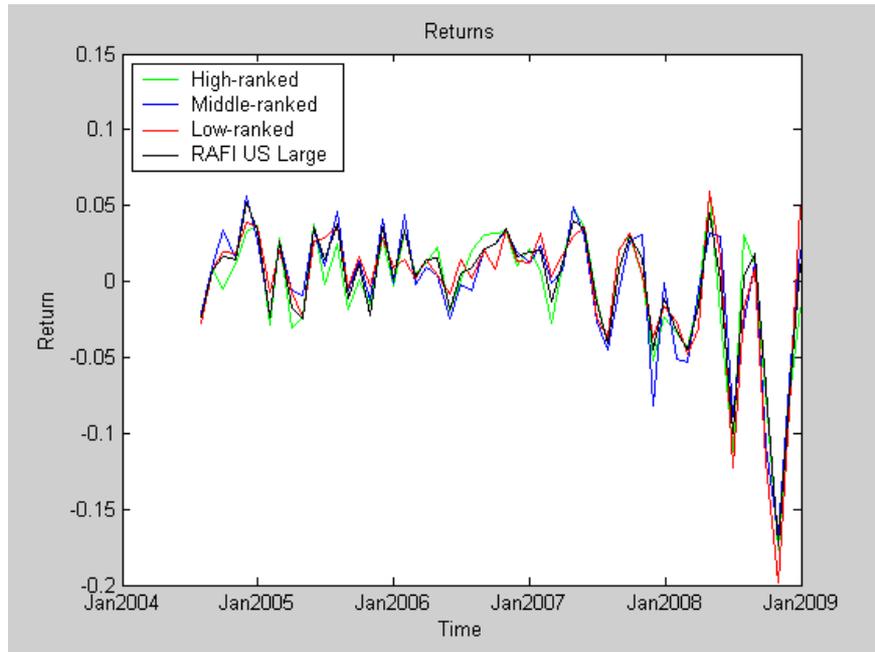


Figure 2.
Returns of high-ranked, middle-ranked, low-ranked portfolios and RAFI US Large

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk $\cdot 10^{-4}$	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0038	0.0412	0.070178	0.0575	-0.1771	44.1050
Middle-ranked companies	-0.0018	0.0420	2.1143	0.0565	-0.1673	47.0048
Low-ranked companies	-0.0020	0.0449	3.5932	0.0591	-0.1983	48.8954
RAFI US Large	-9.9061 $\cdot 10^{-4}$	0.0394	2.9340	0.0519	-0.1735	41.5831

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	-0.9769	0.0342	-0.5848	0.0449	-1.3256	0.0283
Middle-ranked companies	-0.2438	0.0437	-0.5401	0.0652	0.3921	0.0264
Low-ranked companies	-0.3216	0.0469	-0.5938	0.0667	0.1874	0.0329

In Table 3 of current section and Table 2 from Appendix 3. Section 2.1 characteristics computed from bootstrapped data on the basis of 10000 and 1000 samples are given. We see that information ratio is negative for all portfolios, which means that all of them underperform the benchmark.

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0038	0.0396	6.8365	0.0529	-0.1471	38.4473	-0.9955
Middle-ranked companies	-0.0018	0.0403	3.6547	0.0534	-0.1377	38.0699	-0.2077
Low-ranked companies	-0.0021	0.0424	6.7294	0.0546	-0.1629	39.0428	-0.2709
S&P 500	-0.0010	0.0378	7.5414	0.0489	-0.1414	34.0226	

Therefore, portfolios constructed using environmental factor, ‘best-in-class’ selection with weights from RAFI US Large have worse performance than benchmark. That is why investment into benchmark is more beneficial in this case.

5.4.2 Analysis of portfolios constructed using human rights factor and ‘best-in-class’ selection

Again, it is clearly seen from Figure 1 that high-ranked portfolio underperform RAFI US Large, low- and middle- ranked portfolios. Middle-ranked portfolio has more peaks on the negative side of return curve (see Figure 2).

Values in the Tables 1-2 show that RAFI US large has the largest mean, smallest standard deviation and maximum drawdown during the period we are considering. Information ratios are negative for the whole period, which means that portfolios we are looking at do not outperform the benchmark. If we consider the period 1 Jul 2004 – 1 Jul 2007 then information ratio of low-ranked companies is positive. Information ratio based on bootstrapped data is also positive for low-ranked portfolio. Thus, on the basis of such a short history, we may conclude that investing in high-ranked companies does not result in higher profits. Advantages of investing in low-ranked companies are also questionable, longer data history is needed for analysis.

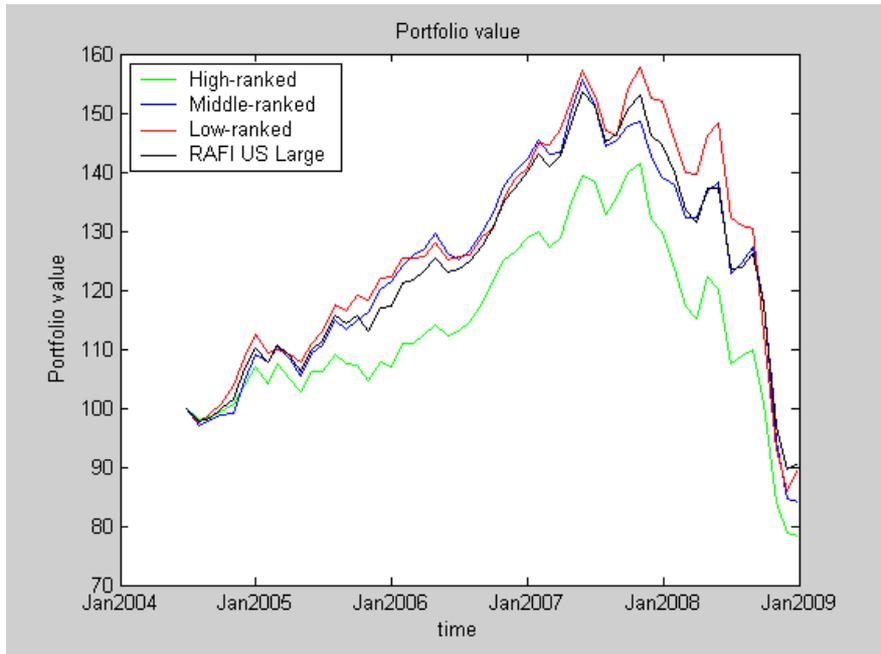


Figure 1.
Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and RAFI US Large

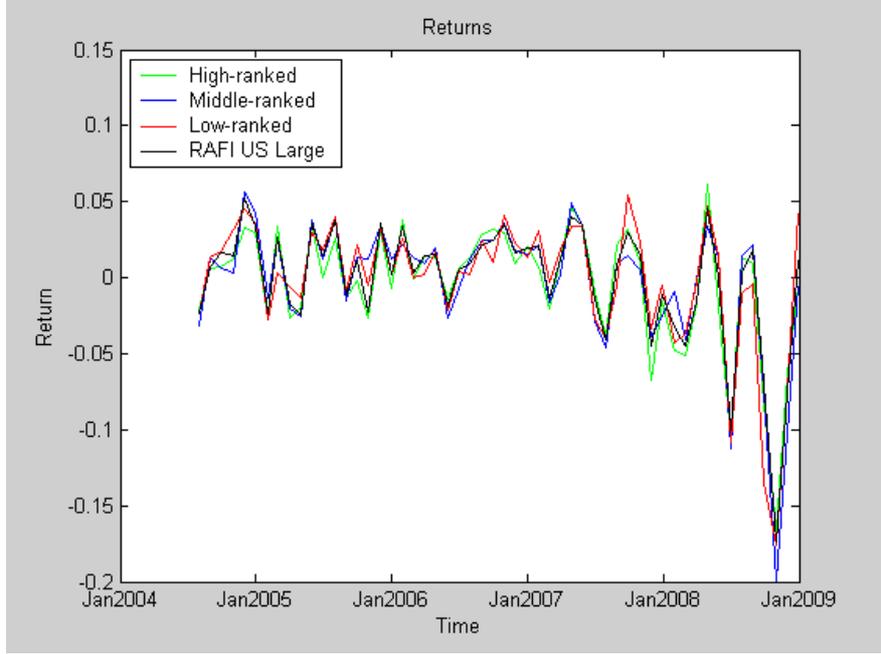


Figure 2.
Returns of high-ranked, middle-ranked, low-ranked portfolios and RAFI US Large

Table 1. Descriptive statistics (1 Jul 2004 - 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0037	0.0401	2.4799 $\cdot 10^{-7}$	0.0620	-0.1662	44.7019
Middle-ranked companies	-0.0022	0.0434	5.0788 $\cdot 10^{-7}$	0.0560	-0.1998	45.9063
Low-ranked companies	-0.0010	0.0435	2.4769 $\cdot 10^{-4}$	0.0541	-0.1759	45.5091
RAFI US Large	-9.9061 $\cdot 10^{-4}$	0.0394	2.9340 $\cdot 10^{-4}$	0.0519	-0.1735	41.5831

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	-1.0527	0.0302	-0.6534	0.0412	-1.4600	0.0234
Middle-ranked companies	-0.4255	0.0382	-0.6934	0.0496	-0.0139	0.0303
Low-ranked companies	-0.0511	0.0485	-0.1459	0.0731	0.1417	0.0305

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-4}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0037	0.0386	0.67121	0.0554	-0.1398	38.3798	-1.0691
Middle-ranked companies	-0.0023	0.0413	1.2713	0.0529	-0.1615	37.2759	-0.4200
Low-ranked companies	-0.0011	0.0413	0.50614	0.0515	-0.1449	36.6377	0.0125
S&P 500	-0.0010	0.0378	0.75527	0.0489	-0.1415	33.9866	

5.4.3 Analysis of the portfolios constructed using environmental factor

In this section we will consider portfolios that were constructed using GES environmental scores and weights from RAFI US Large. We will not take into account GICS sectors during the portfolio construction. In other words, companies' allocation between portfolios was made according to *Algorithm 1* (Section 5.1), where in step 2 US companies were ranked according to Environmental scores and weights in step 4 were taken from RAFI US Large.

Let us take a look at Figure 1 where the values of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and RAFI US Large are plotted. From graphs follows that RAFI US Large has the largest portfolio value, except for second half of 2008 year (when high-ranked companies showed better performance) and short period in the end of 2005-beginning 2006 (when low-ranked companies were better). From Figure 2 we can see that returns curve of low-ranked companies has the largest peaks on the negative side, whenever high-ranked companies have the largest peaks on the positive side. As was expected, amplitude of oscillations has increased during the crisis.

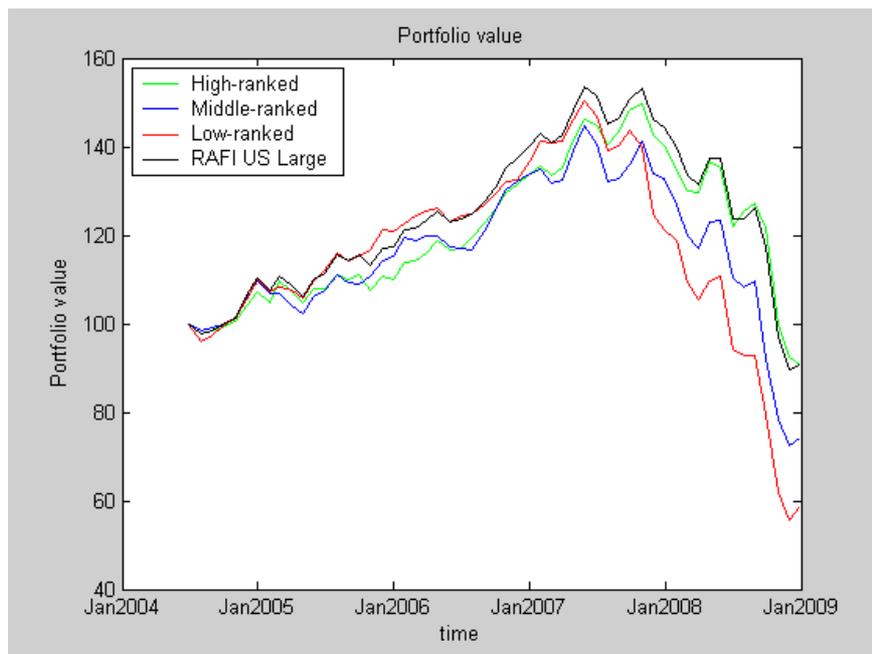


Figure 1.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and RAFI US Large

Let us look at descriptive statistics in Tables 1-2. High-ranked portfolio has the smallest standard deviation, downside risk and maximum drawdown. Its mean value of returns is slightly smaller than mean value of benchmark. Information ratio of high-ranked portfolio is close to zero, but positive when we are considering the whole period (1 Jul 2004 – 31 Dec 2008). It equals to 0.4485 during the crisis period. If we look at the statistics computed on the basis of bootstrapped data (Table 3 and Table 2 from Appendix

3. Section 2.3), we will notice that information ratio is negative, which can be the evidence that investing into index is more beneficial.

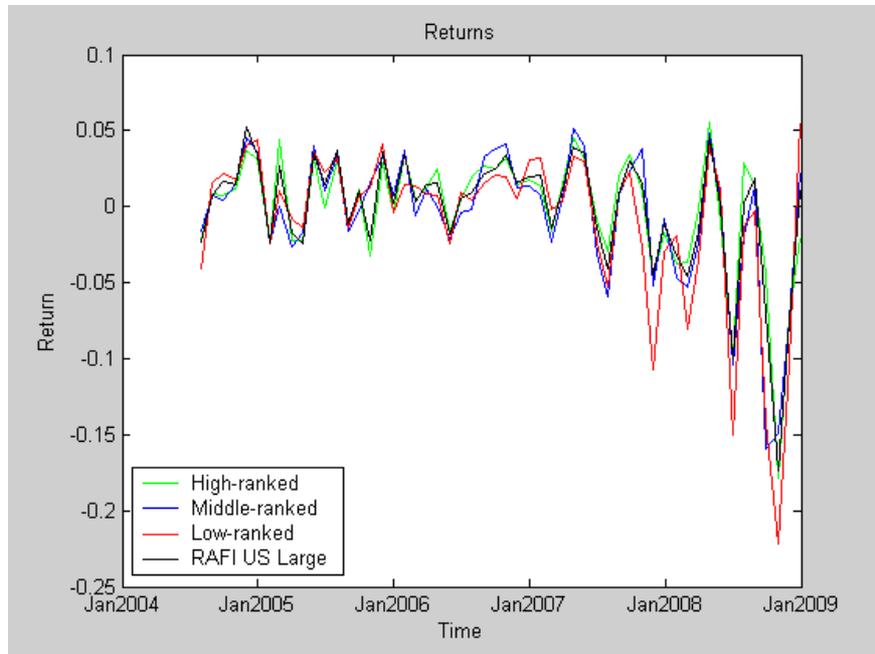


Figure 2.

Returns of high-ranked, middle-ranked, low-ranked portfolios and RAFI US Large

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk ($\cdot 10^{-4}$)	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0009971	0.0391	0.16355	0.0551	-0.1794	39.3496
Middle-ranked companies	-0.0045	0.0441	2.4695	0.0519	-0.1595	49.8811
Low-ranked companies	-0.0083	0.0527	4.8495	0.0558	-0.2215	63.0050
RAFI US Large	-0.00099061	0.0394	2.9340	0.0519	-0.1735	41.5831

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	$3.2194 \cdot 10^{-4}$	0.0328	0.4485	0.0473	-0.7557	0.0221
Middle-ranked companies	-0.7467	0.0571	-0.6845	0.0831	-0.7433	0.0382
Low-ranked companies	-1.2587	0.0716	-1.6959	0.0992	-0.2995	0.0381

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0011	0.0376	6.0317	0.0511	-0.1450	33.4799	-0.0164
Middle-ranked companies	-0.0046	0.0424	4.6894	0.0503	-0.1349	42.3735	-0.8086
Low-ranked companies	-0.0085	0.0504	11.705	0.0514	-0.1900	51.5653	-1.2470
S&P 500	-0.0011	0.0379	7.6625	0.0488	-0.1416	34.2472	

Therefore, we can conclude that during 4.5 years time span, high-ranked companies had much better performance than low- and middle- ranked companies and were slightly better than RAFI US Large index. Although, it is early make the conclusion about superiority of investment into high-ranked companies on the basis of such a short data history.

5.4.4 Analysis of the portfolios constructed using human rights factor

In this case portfolios are constructed in the same way as in the previous section, except for ranking. Companies are ranked according to human rights scores.

From Figure 1 follows that middle-ranked portfolio had the best portfolio value during the whole period, except for the crisis period. During the crisis, RAFI US Large had better performance. It is also easy to notice that before the crisis low-ranked companies had larger amplitude of oscillations and during the crisis middle- ranked companies were the worst (see Figure 2).

High-ranked companies have the smallest standard deviation, although it is almost the same as standard deviation of the benchmark (see Table 1). Low- ranked companies have the smallest maximum drawdown and it is not an exception (see Figure 3 of Appendix 3 Section 2.4). Low-ranked companies have negative, but the highest information ratio, since in the end of 2008 they had better performance than their high- and middle- ranked counterparts (see Table 1). During the crisis period low-ranked companies had the highest information ratio (0.4836), but the corresponding tracking error was the largest too. Before crisis middle-ranked companies had information ratio of the size of 0.5303 and tracking error was slightly larger than tracking error of high-ranked companies. If we look at the characteristics obtained from bootstrapped data (Table 3), we will come to the conclusion that investing into benchmark is more beneficial. Thus, we have obtained that different measures show the superiority of different portfolios. Hence, final decision about investment strategy in this case should be

made by investor in correspondence with his risk attitude. Therefore, more observations are needed for comprehensive study.

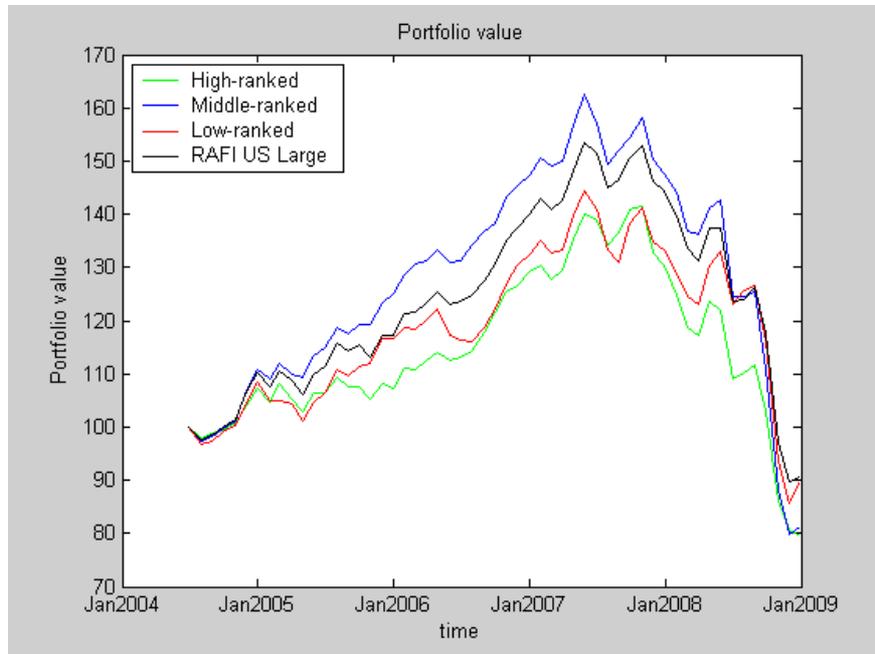


Figure 1.

Value of 100\$ initial investment into high-ranked, medium-ranked, low-ranked portfolios and RAFI US Large

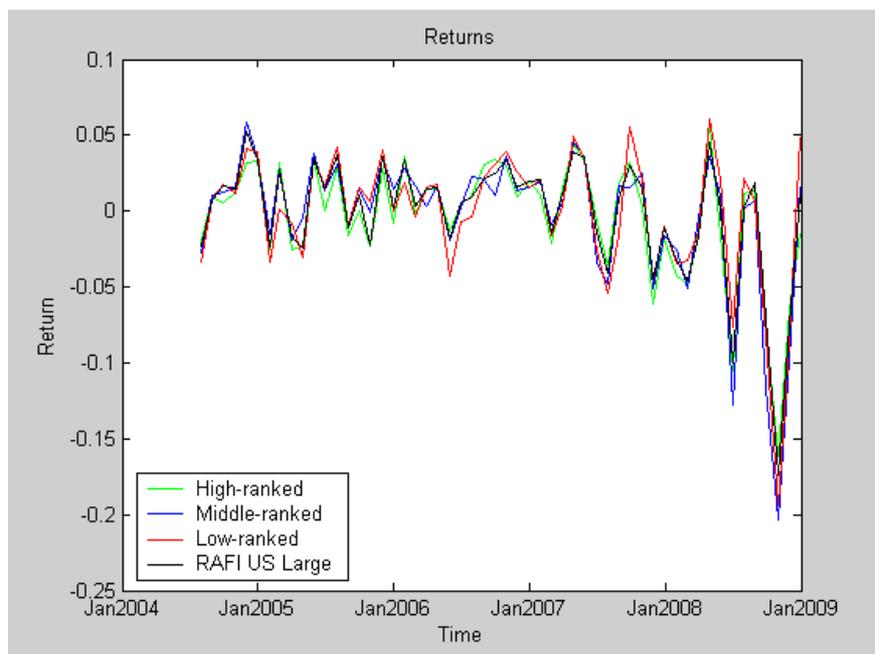


Figure 2.

Returns of high-ranked, middle-ranked, low-ranked portfolios and RAFI US Large

Table 1. Descriptive statistics (1 Jul 2004 – 31 Dec 2008)

Portfolio	Mean	Std. Dev. of monthly returns	Downside risk ($\cdot 10^{-4}$)	Maximum monthly return	Minimum monthly return	MDD (%)
High-ranked companies	-0.0035	0.0390	0.052313	0.0564	-0.1617	43.8218
Middle-ranked companies	-0.0027	0.0461	4.8936	0.0589	-0.2033	50.8883
Low-ranked companies	-0.0010	0.0434	3.1701	0.0604	-0.1944	40.8236
RAFI US Large	-9.9061 ($\cdot 10^{-4}$)	0.0394	2.9340	0.0519	-0.1735	41.5831

Table 2. Information Ratios and Tracking Errors

Portfolio	IR_1	TE_1	IR_2	TE_2	IR_3	TE_3
High-ranked companies	-0.9904	0.0288	-0.5811	0.0385	-1.4192	0.0226
Middle-ranked companies	-0.5800	0.0414	-1.2150	0.0551	0.5303	0.0266
Low-ranked companies	-0.0539	0.0454	0.4836	0.0607	-0.7860	0.0346

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0036	0.0376	6.2587	0.0512	-0.1362	37.8434	-1.0338
Middle-ranked companies	-0.0029	0.0438	15.485	0.0533	-0.1680	40.5960	-0.4820
Low-ranked companies	-0.0012	0.0416	7.0169	0.0580	-0.1505	35.9974	-0.0528
S&P 500	-0.0012	0.0379	7.8509	0.0488	-0.1416	34.2829	

6. Conclusions

In this thesis work the question of investment expediency into socially responsible companies was considered. Results of the analysis are heavily dependent on the way we are defining environmentally and socially 'friendly' portfolios. Results also depend on the index weights we have chosen to be assigned to our portfolios, i.e. S&P 500 or RAFI US Large weights. In many cases it is hard to conclude unambiguously investment in which strategies is more preferable. Final decision on investment should be made with taking into account whether investor is risk-averse or risk-seeking, i.e. which risk measure he thinks to be of greater importance. Some portfolios produce higher returns and have larger information ratio, but at the same time they have higher standard deviation, maximum drawdown and downside risk. The common thing for all types of analysis is that portfolios that consist of companies with high environmental and human rights scores have lower standard deviation than companies with low ones and benchmarks. The only exception is portfolios based on RAFI US Large index, which were constructed using best-in-class selection. They have higher standard deviation than RAFI US Large index.

Let us now present a short summary of results depending on type of portfolio selection and portfolio construction that was used:

- Portfolios constructed using environmental factor, 'best-in-class' selection and weights from S&P 500:
Middle- and low- ranked companies give higher returns, but at the same time investment into these companies is more risky.
- Portfolios constructed using human rights factor, 'best-in-class' selection and weights from S&P 500:
Low-ranked portfolio gives the highest mean of returns and have positive information ratio. Thus, if investor considers these measures to be the most important then choosing low-ranked portfolio for investment might be reasonable.
- Portfolios constructed using environmental factor and weights from S&P 500:
All measures appeared to be the evidence of superiority of investment into high-ranked companies.
- Portfolios constructed using human rights factor and weights from S&P 500:
High-ranked portfolio outperforms S&P 500 by all measures, but it has lower mean of returns than middle-ranked portfolio.
- Portfolios constructed using 'best-in-class' selection and weights from RAFI US Large:
If portfolio construction was made using human rights or environmental scores, then from analysis based on 4.5 years history, we can conclude that investing into benchmark (RAFI US Large) is more beneficial.
- Portfolios constructed using environmental factor and weights from RAFI US Large:
High-ranked portfolio appeared to be slightly better than RAFI US Large index, although data history is not long enough to make this conclusion with high level of veracity.
- Portfolios constructed using human rights factor and weights from RAFI US Large:

Different measures show the superiority of different portfolios. Hence, final decision about investment strategy in this case should be made by investor, in correspondence with his risk attitude.

Note that if we have neglected GICS sectors in the process of portfolio construction and used environmental scores then investing into SRI portfolios results in higher returns.

The limitation of current study is short performance history (4.5 years), which makes impossible to draw conclusion with high level of certainty. Therefore, more studies based on longer history are needed to be held in order to obtain more precise results.

In the process of empirical study comparison of S&P 500 and RAFI US Large indexes was also carried out. It was based on 47 years and testified the superiority of investment into Research Affiliates Index.

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Appendixes

Appendix 1. Partition of US companies ranked by GES between GICS sectors

	Energy	Materials	Industrials	Consumer Discretionary	Consumer Staples	Health Care	Financials	Information Technology	Telecommunication Services	Utilities	Total
04/06/30	28	22	50	74	27	47	85	69	7	24	433
04/12/31	29	24	49	91	32	47	94	67	7	29	469
05/06/30	24	22	46	86	32	50	88	58	7	29	442
05/12/31	31	22	49	86	32	55	95	65	9	30	474
06/06/30	31	21	46	79	30	49	93	63	10	25	447
07/05/30	30	23	49	82	29	44	99	61	10	27	454
07/10/15	42	27	62	98	35	63	112	81	11	32	563
08/03/31	46	31	65	109	43	67	119	85	13	36	614
08/04/23	39	23	49	65	31	50	83	59	7	25	431

Appendix 2. Number of portfolio constituents

Table 1. Number of high-scored companies

	Number high-scored companies in GES ranking	Number high-scored companies in RAFI	Number of high-scored companies with existing returns
Period 1 2004: 1 Jul – 31 Dec	141	120	120
Period 2 2005: 01 Jan – 30 Jun	152	131	131
Period 3 2005: 01 Jul – 31 Dec	143	130	129
Period 4 2006: 01 Jan – 30 Jun	154	141	140
Period 5 2006: 01 Jul – 31 Dec	147	135	133
Period 6 2007: 01 Jan – 30 May	149	128	128
Period 7 2007: 01 Jun – 14 Oct	148	131	130
Period 8 2007: 15 Oct – 31 Dec	184	160	157
Period 9 2008: 01 Jan – 22 Apr	184	168	166
Period 10 2008: 23 Apr – 31 Dec	133	129	127

Table 2. Number of middle-scored companies

	Number middle-scored companies in GES	Number middle-scored companies in RAFI	Number of middle-scored companies with existing returns
Period 1 2004: 30 Jun – 31 Dec	141	115	114
Period 2 2005: 01 Jan – 30 Jun	152	130	130
Period 3 2005: 01 Jul – 31 Dec	143	122	122
Period 4 2006: 01 Jan – 30 Jun	154	125	122
Period 5 2006: 01 Jul – 31 Dec	147	125	121
Period 6 2007: 01 Jan – 30 May	149	124	122

	Number middle-scored companies in GES	Number middle-scored companies in RAFI	Number of middle-scored companies with existing returns
Period 7 2007: 01 Jun – 14 Oct	148	123	119
Period 8 2007: 15 Oct – 31 Dec	184	153	150
Period 9 2008: 01 Jan – 22 Apr	184	165	164
Period 10 2008: 23 Apr – 31 Dec	133	127	124

Table 3. Number of low-scored companies

	Number low-scored companies in GES	Number low-scored companies in RAFI	Number of low-scored companies with existing returns
Period 1 2004: 30 Jun – 31 Dec	151	110	106
Period 2 2005: 01 Jan – 30 Jun	165	124	122
Period 3 2005: 01 Jul – 31 Dec	156	125	119
Period 4 2006: 01 Jan – 30 Jun	163	131	130
Period 5 2006: 01 Jul – 31 Dec	153	121	118
Period 6 2007: 01 Jan – 30 May	156	125	124
Period 7 2007: 01 Jun – 14 Oct	158	123	120
Period 8 2007: 15 Oct – 31 Dec	195	151	145
Period 9 2008: 01 Jan – 22 Apr	195	164	162
Period 10 2008: 23 Apr – 31 Dec	146	124	123

Appendix 3. Additional Figures and Statistics

1. Portfolios based on S&P 500 index

1.1 Portfolios constructed using environmental factor and ‘best-in-class’ selection

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.7437	7.3625
Middle-ranked companies	-1.6179	6.8813
Low-ranked companies	-1.9257	8.2562
S&P 500	-1.8794	7.9741

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples (monthly)

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0025	0.0365	6.5633	0.0461	-0.1309	34.0413	-0.1078
Middle-ranked companies	-0.0022	0.0413	3.4896	0.0511	-0.1400	37.6300	-0.0115
Low-ranked companies	-0.0018	0.0415	3.4896	0.0658	-0.1494	37.6684	0.1053
S&P 500	-0.0022	0.0375	4.3262	0.0466	-0.1362	35.1230	

Table 3. Descriptive statistics for bootstrapped data based on 10000 samples (monthly)

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0023	0.0363	6.9635	0.0462	-0.1303	33.6588	-0.0855
Middle-ranked companies	-0.0021	0.0410	3.4361	0.0510	-0.1391	37.3358	-0.0326

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
Low-ranked companies	-0.0017	0.0412	5.9878	0.0664	-0.1486	37.2787	0.1033
S&P 500	-0.0021	0.0372	4.4009	0.0467	-0.1354	34.7545	

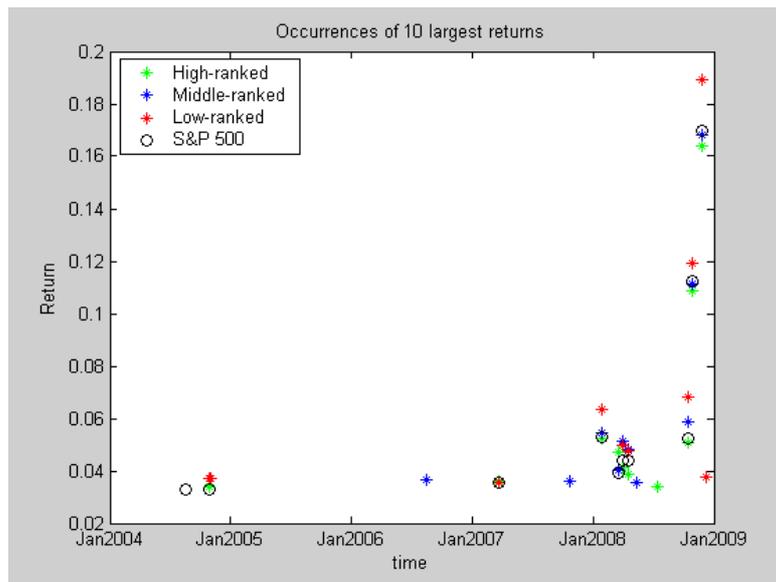


Figure 1.
Occurrences of 10 largest returns (weekly)

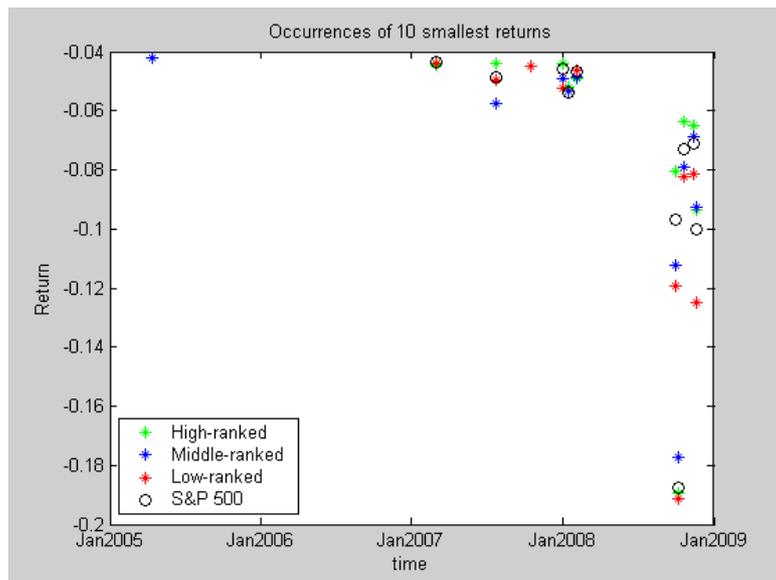


Figure 2.
Occurrences of 10 smallest returns (weekly)

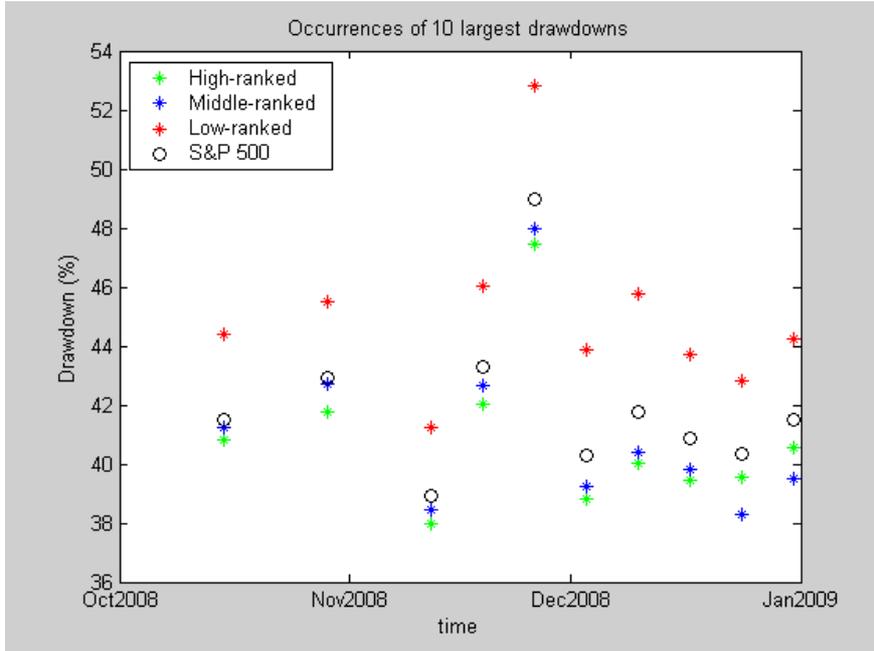


Figure 3.
Occurrences of 10 largest drawdowns (weekly)

1.2 Portfolios constructed using human rights factor and 'best-in-class' selection

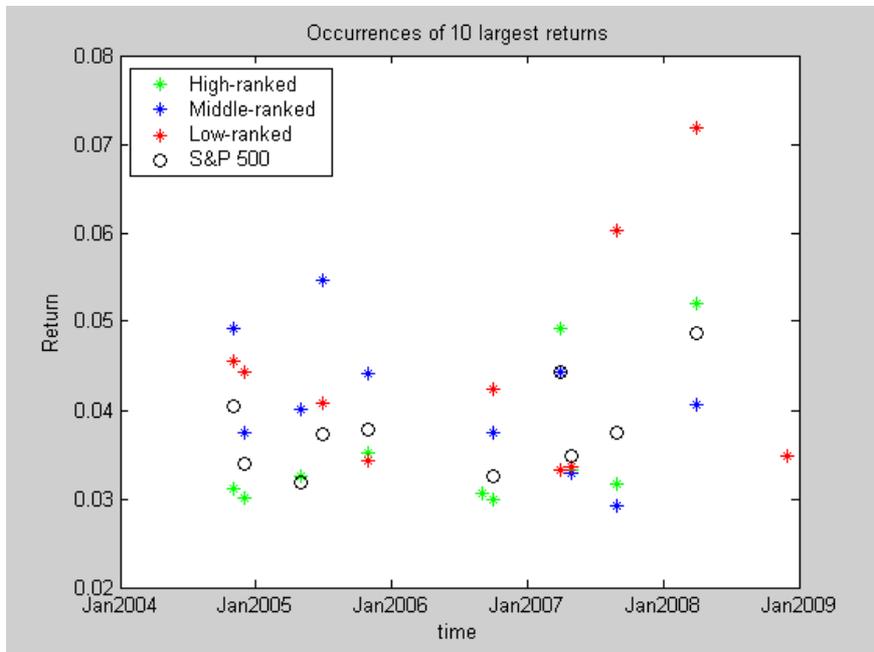


Figure 1.
Occurrences of 10 largest returns

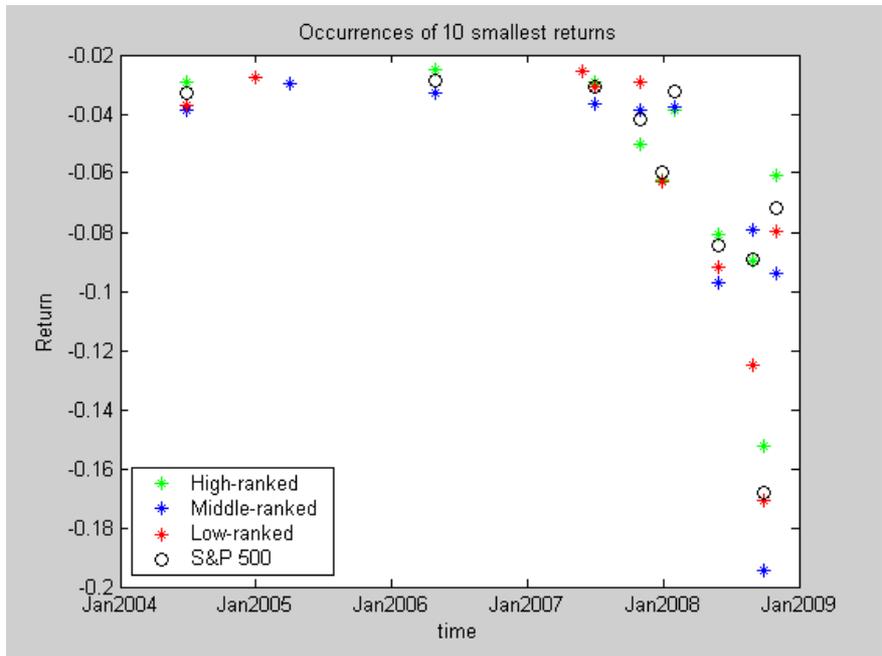


Figure 2.
Occurrences of 10 smallest returns

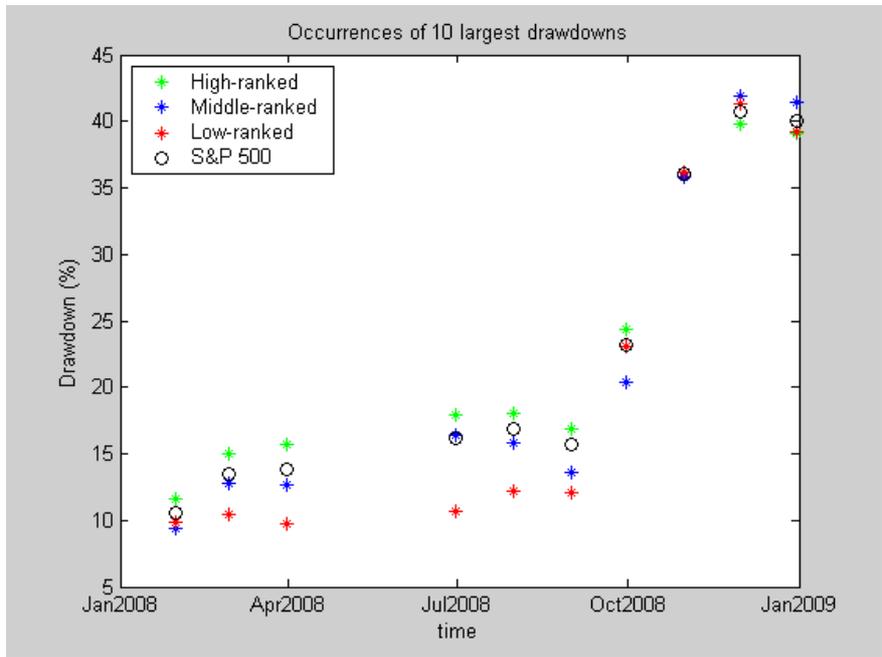


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.6583	6.8125
Middle-ranked companies	-2.0952	9.4014
Low-ranked companies	-1.7391	7.2302
S&P 500	-1.8794	7.9741

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0019	0.0353	4.4329	0.0496	-0.1227	33.2088	-0.1476
Middle-ranked companies	-0.0014	0.0401	10.910	0.0520	-0.1513	34.7824	0.0303
Low-ranked companies	-3.2898 $\cdot 10^{-4}$	0.0403	4.1502	0.0665	-0.1371	33.7641	0.3762
S&P 500	-0.0016	0.0366	4.3490	0.0468	-0.1332	33.7551	

1.3 Portfolios constructed using environmental factor

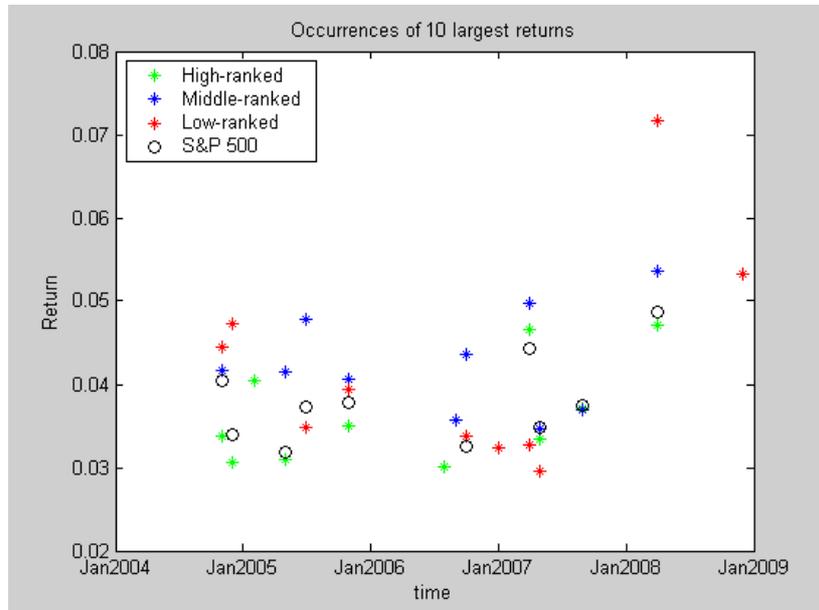


Figure 1.
Occurrences of 10 largest returns

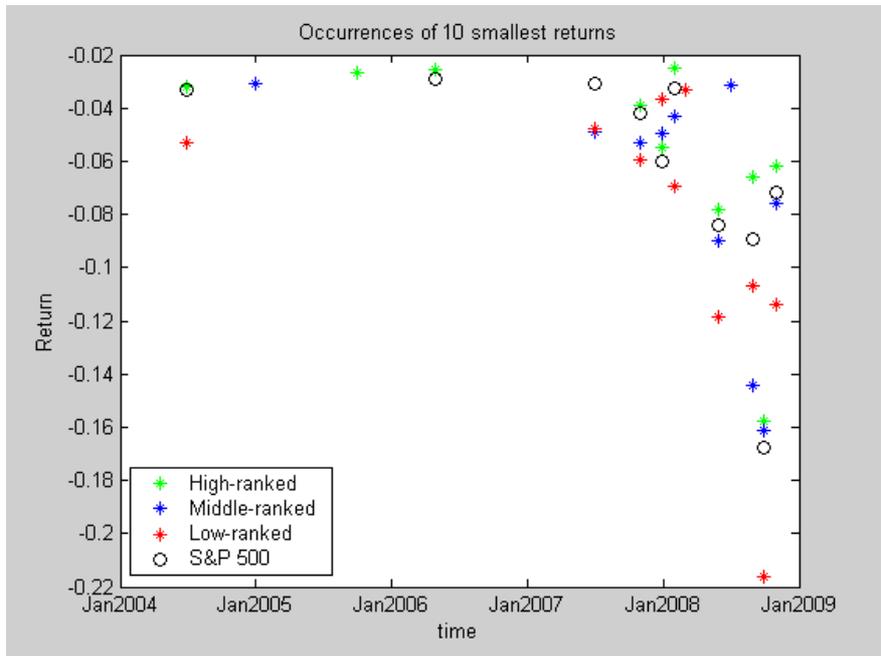


Figure 2.
Occurrences of 10 smallest returns

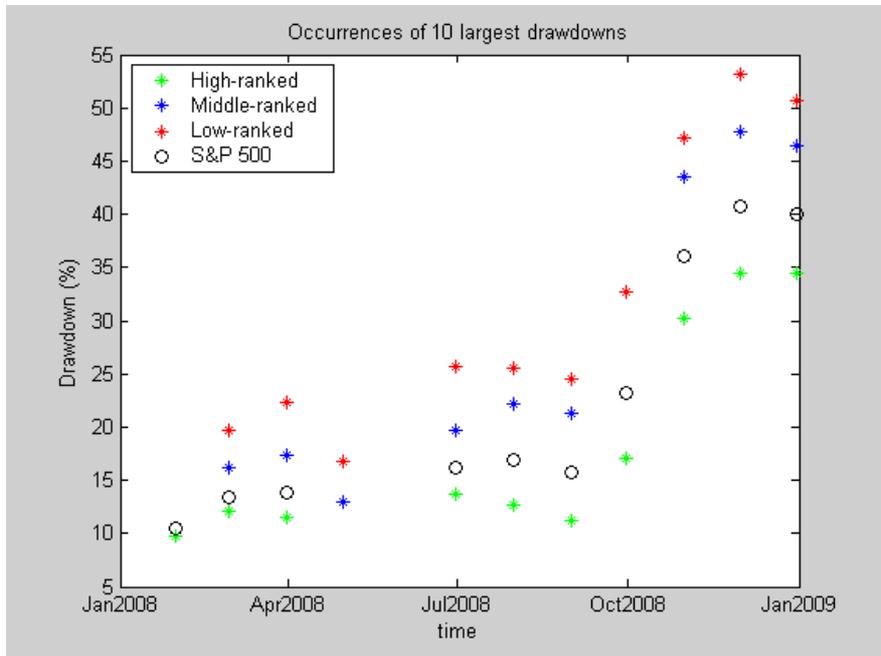


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.8738	8.2761
Middle-ranked companies	-1.5624	6.2335
Low-ranked companies	-1.9825	8.2530
S&P 500	-1.8794	7.9741

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	$-4.7962 \cdot 10^{-4}$	0.0349	5.3400	0.0461	-0.1263	30.5435	0.9601
Middle-ranked companies	-0.0052	0.0417	4.4085	0.0518	-0.1314	42.4897	-0.8317
Low-ranked companies	-0.0057	0.0472	15.807	0.0638	-0.1752	45.2229	-0.6656
S&P 500	-0.0025	0.0374	4.3544	0.0466	-0.1349	35.4092	

1.4 Portfolios constructed using human rights factor

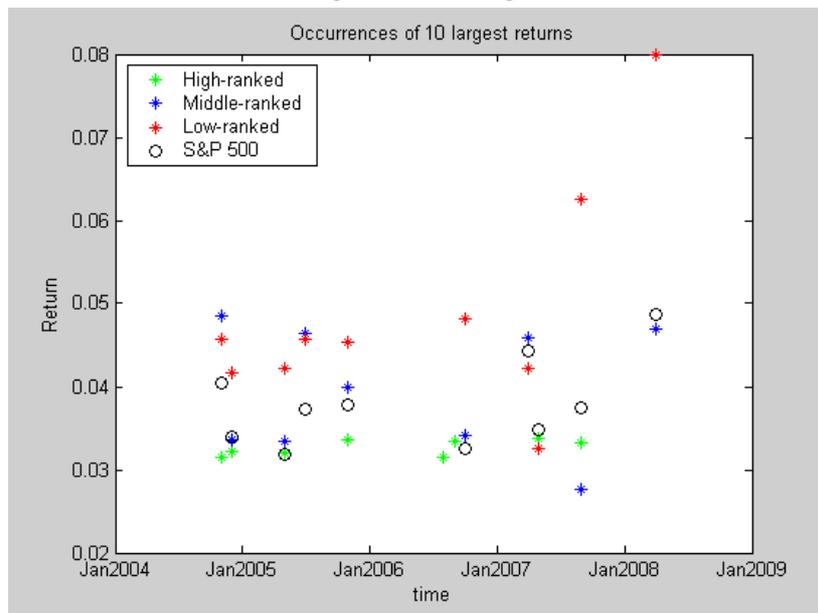


Figure 1.
Occurrences of 10 largest returns

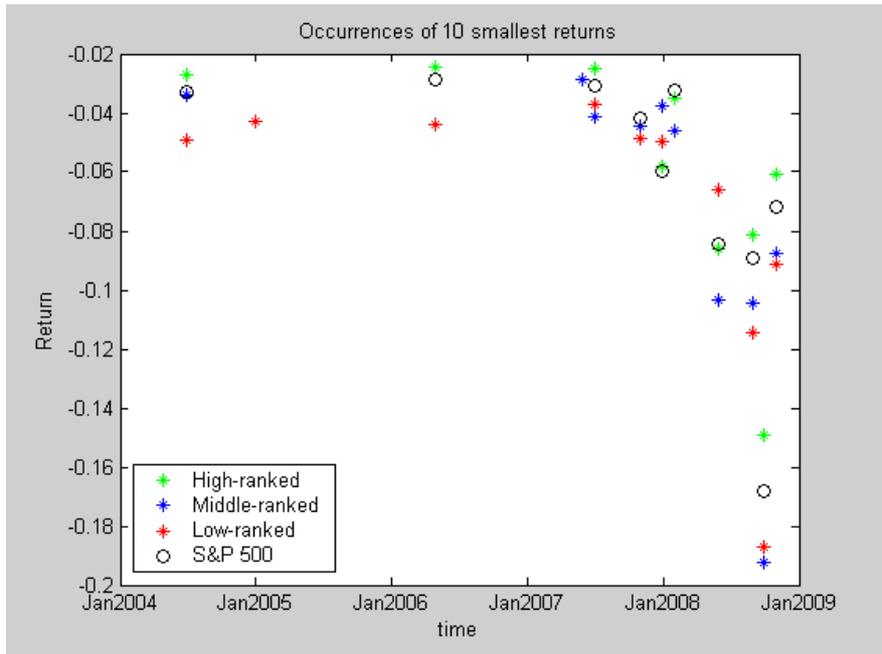


Figure 2.
Occurrences of 10 smallest returns

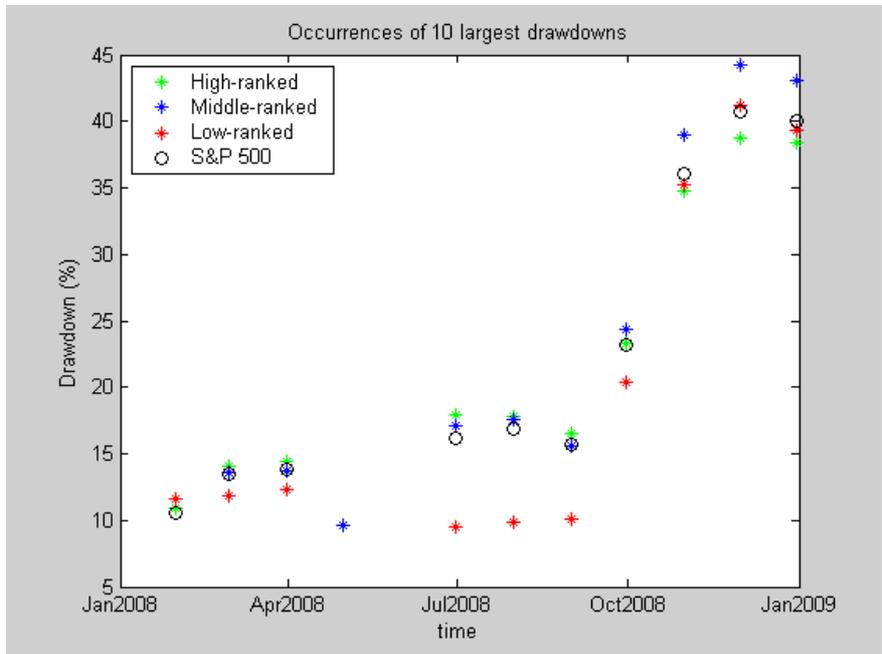


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.6847	6.9622
Middle-ranked companies	-2.1525	9.0042
Low-ranked companies	-1.5385	7.1123
S&P 500	-1.8794	7.9741

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0019	0.0348	5.0059	0.0450	-0.1233	32.9523	0.0077
Middle-ranked companies	-0.0017	0.0412	8.8218	0.0479	-0.1548	36.9286	0.1192
Low-ranked companies	-0.0024	0.0433	5.9378	0.0721	-0.1432	38.5020	-0.1501
S&P 500	-0.0020	0.0372	4.5914	0.0466	-0.1352	34.7158	

2. Portfolios based on RAFI US Large

2.1 Portfolios constructed using environmental factor and 'best-in-class' selection

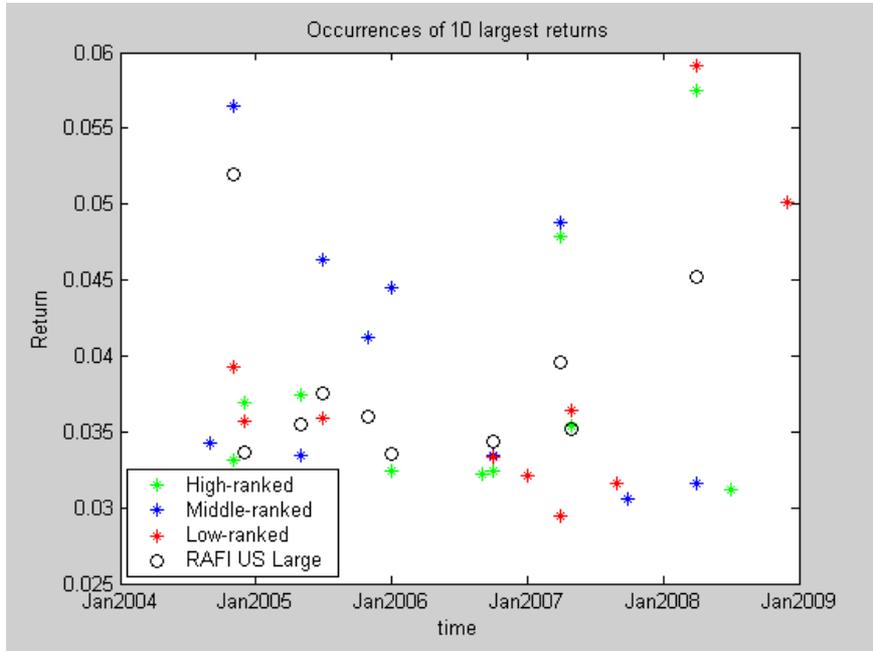


Figure 1.
Occurrences of 10 largest returns

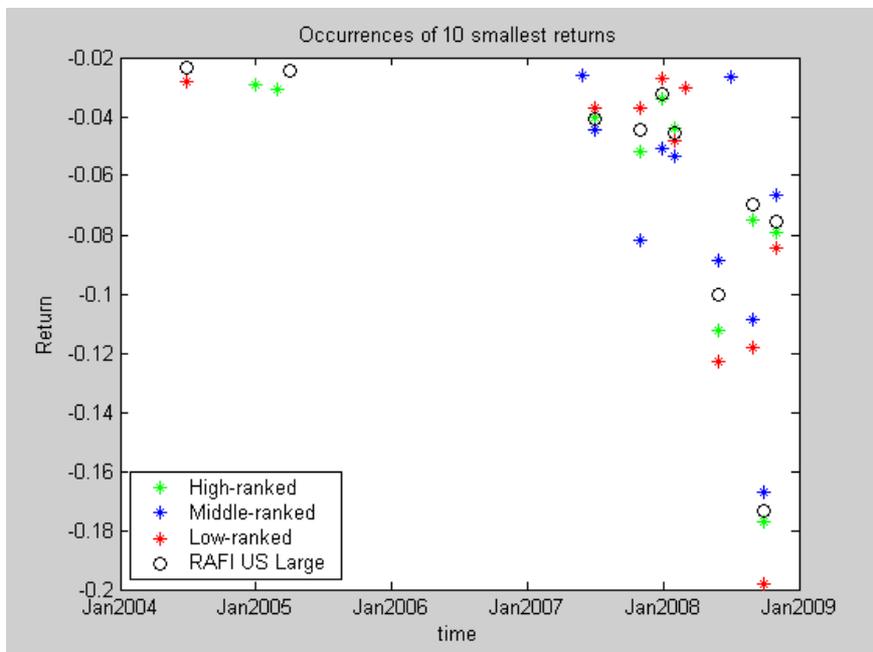


Figure 2.
Occurrences of 10 smallest returns

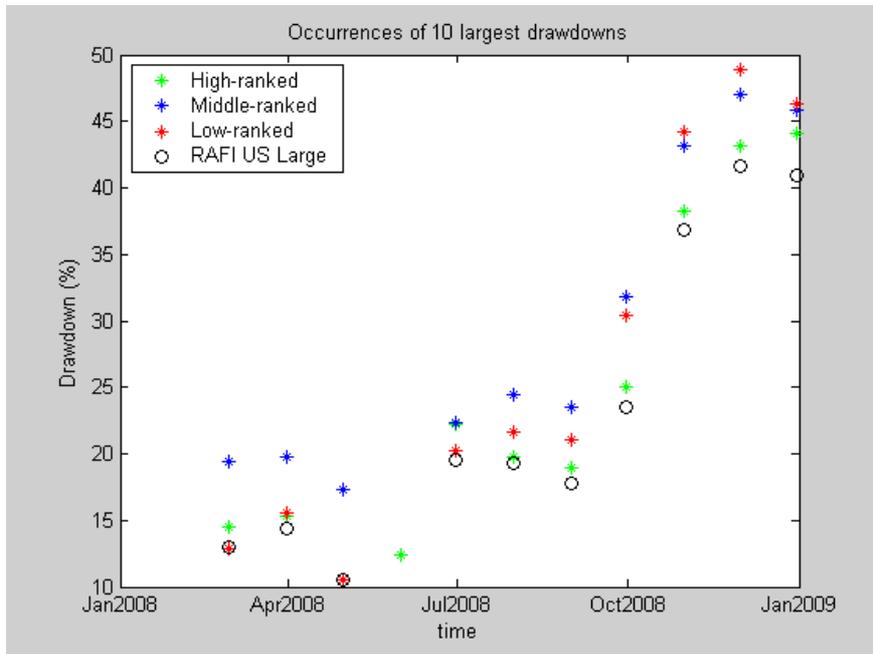


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.7790	7.6841
Middle-ranked companies	-1.6806	6.5240
Low-ranked companies	-2.2764	9.3811
RAFI US Large	-1.9905	8.5970

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0041	0.0398	7.3937	0.0531	-0.1478	38.8448	-0.9688
Middle-ranked companies	-0.0022	0.0405	3.6366	0.0535	-0.1379	38.5420	-0.2240
Low-ranked companies	-0.0024	0.0427	6.7062	0.0551	-0.1638	39.4788	-0.2967
S&P 500	-0.0013	0.0380	8.1376	0.0491	-0.1420	34.3921	

2.2 Portfolios constructed using human rights factor and ‘best-in-class’ selection

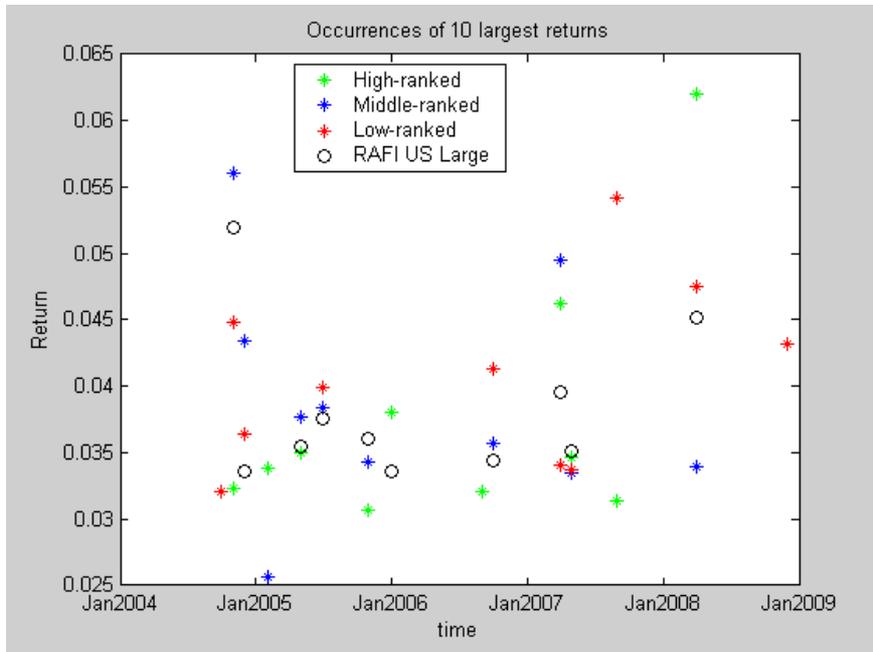


Figure 1.
Occurrences of 10 largest returns

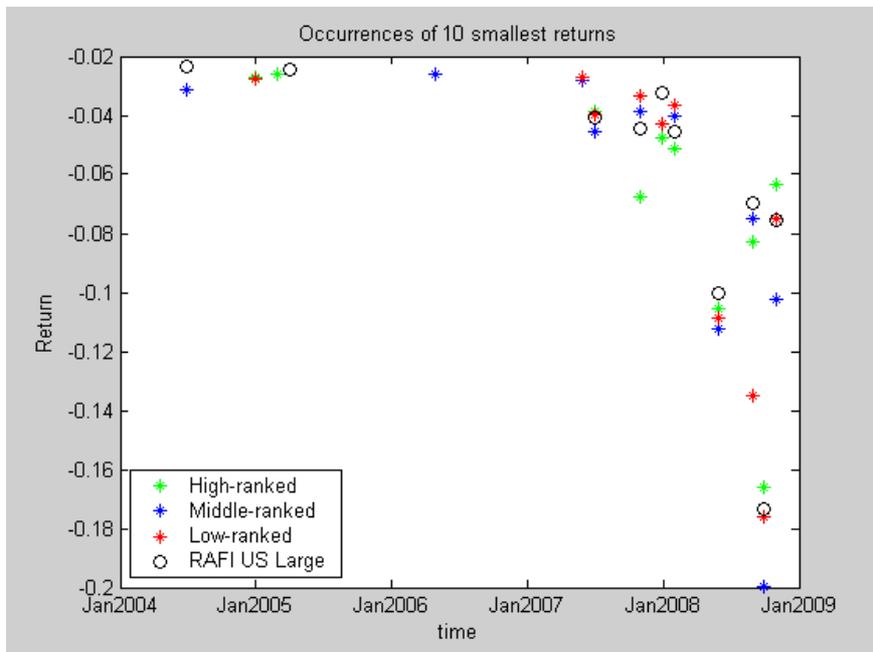


Figure 2.
Occurrences of 10 smallest returns

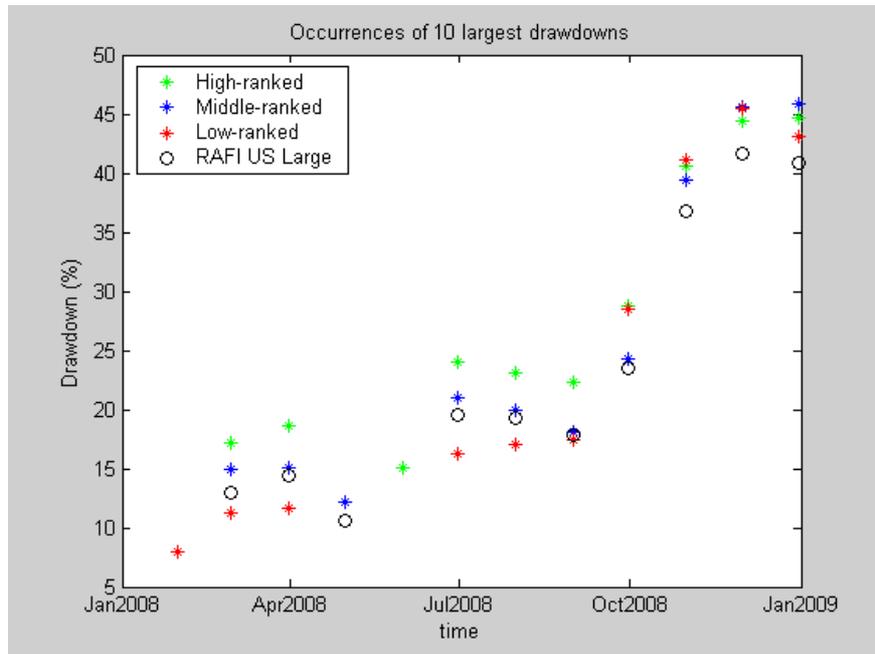


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.6429	6.8933
Middle-ranked companies	-2.2810	10.0053
Low-ranked companies	-2.0153	7.9342
RAFI US Large	-1.9905	8.5970

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0041	0.0391	6.9416	0.0559	-0.1405	38.8942	-1.0564
Middle-ranked companies	-0.0026	0.0418	13.751	0.0529	-0.1626	37.9476	-0.4323
Low-ranked companies	-0.0015	0.0419	5.0387	0.0516	-0.1461	37.3324	-0.0050
S&P 500	-0.0014	0.0382	7.7331	0.0489	-0.1425	34.5432	

2.3 Portfolios constructed using environmental factor

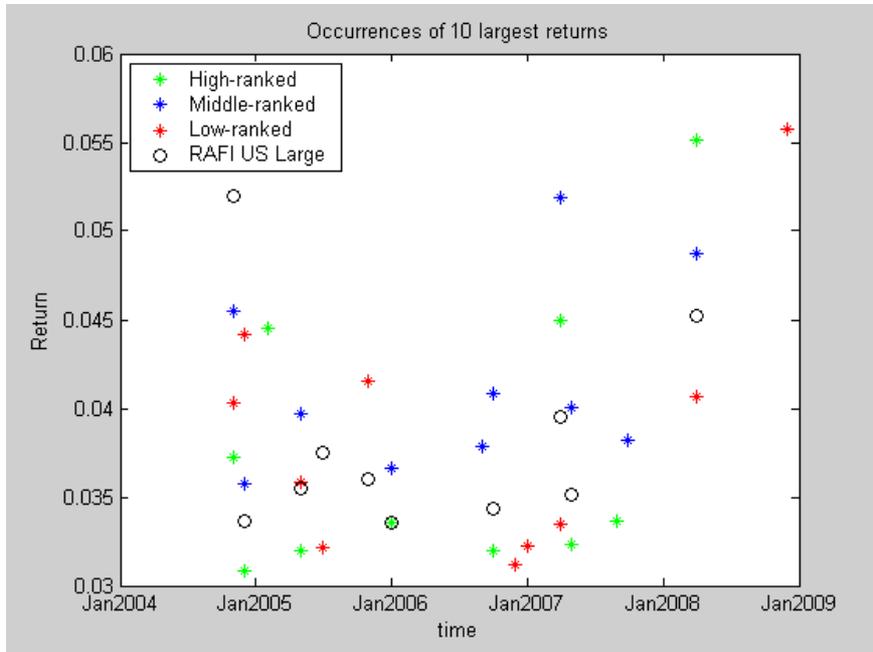


Figure 1.
Occurrences of 10 largest returns

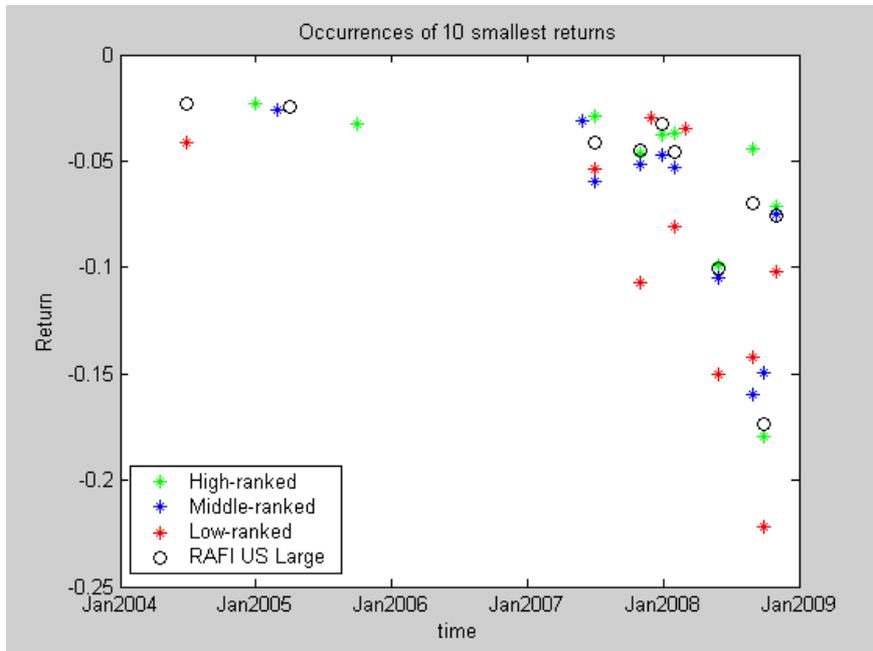


Figure 2.
Occurrences of 10 smallest returns

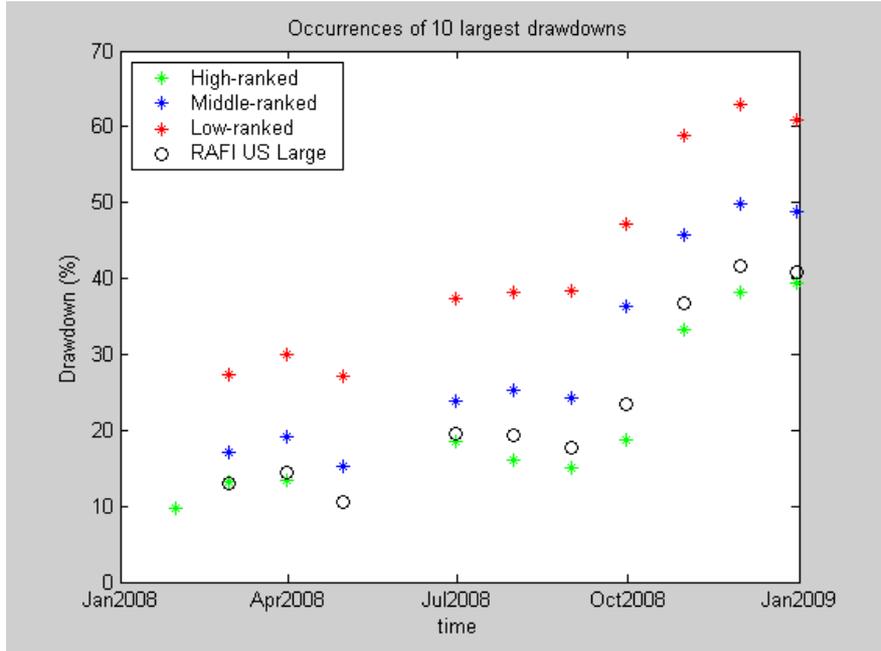


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-2.0731	9.6445
Middle-ranked companies	-1.6411	6.2319
Low-ranked companies	-2.0602	7.6290
RAFI US Large	-1.9905	8.5970

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0013	0.0378	5.6745	0.0511	-0.1472	33.7712	-0.0171
Middle-ranked companies	-0.0049	0.0425	4.8965	0.0502	-0.1366	42.8278	-0.8147
Low-ranked companies	-0.0087	0.0507	12.063	0.0516	-0.1918	52.0043	-1.2427
S&P 500	-0.0013	0.0381	7.6061	0.0488	-0.1437	34.5254	

2.4 Portfolios constructed using human rights factor

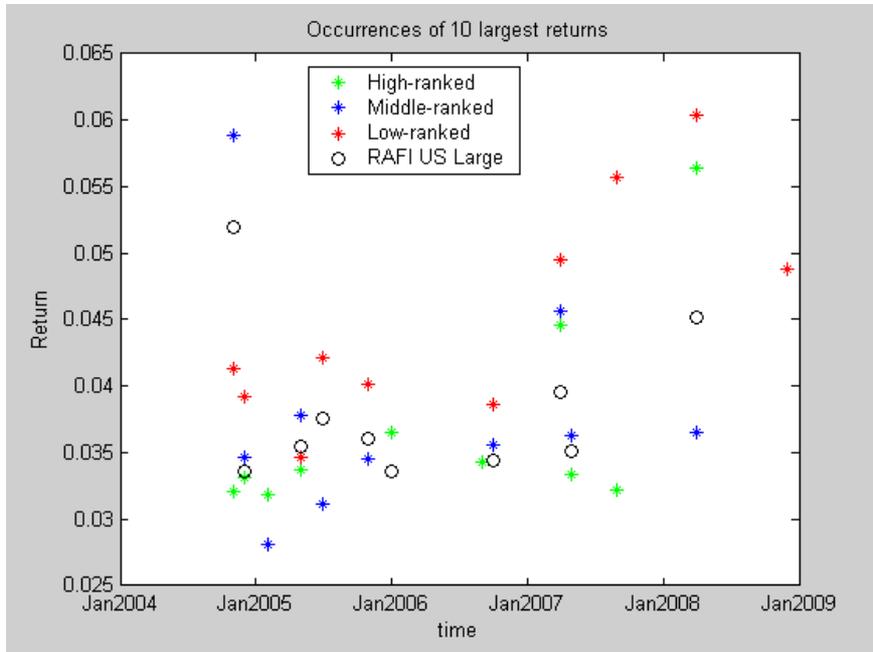


Figure 1.
Occurrences of 10 largest returns

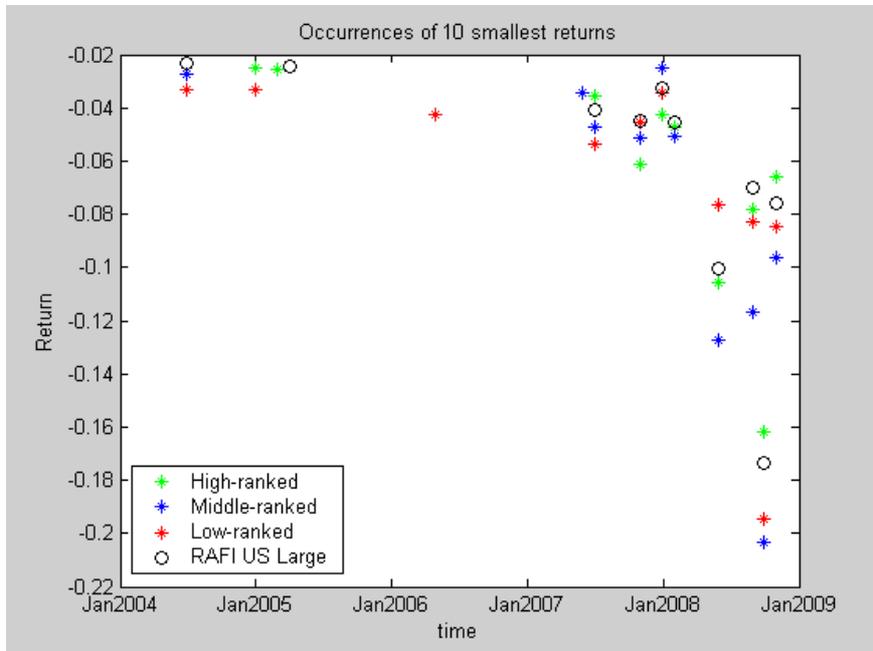


Figure 2.
Occurrences of 10 smallest returns

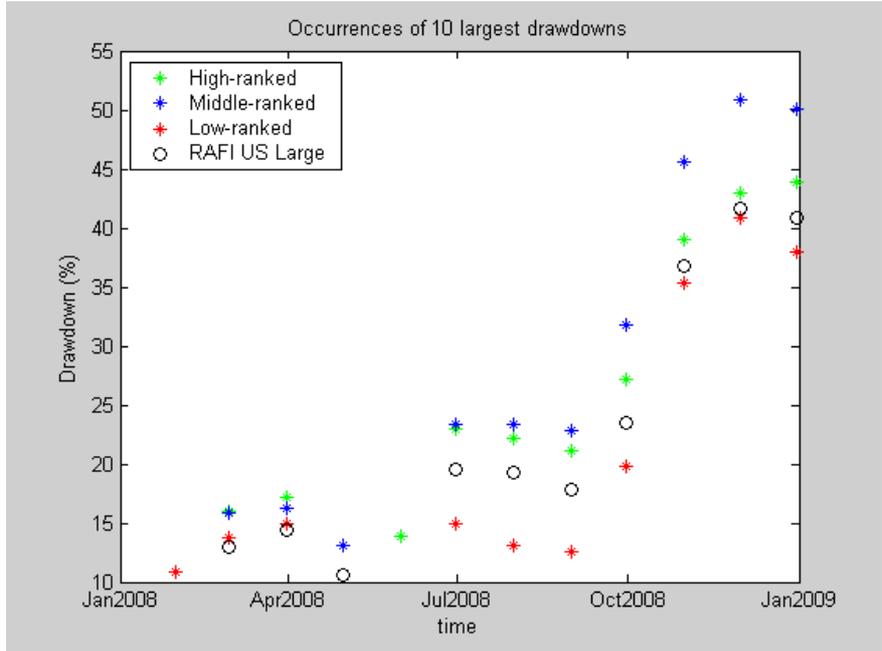


Figure 3.
Occurrences of 10 largest drawdowns

Table 1.

Portfolio	Skewness	Kurtosis
High-ranked companies	-1.6567	6.9545
Middle-ranked companies	-2.2900	9.2190
Low-ranked companies	-1.8743	8.7197
RAFI US Large	-1.9905	8.5970

Table 2. Descriptive statistics for bootstrapped data based on 1000 samples

Portfolio	Mean	Std. Dev. of weekly returns	Downside risk ($\cdot 10^{-5}$)	Maximum weekly return	Minimum weekly return	MDD (%)	IR
High-ranked companies	-0.0036	0.0375	5.1589	0.0511	-0.1358	37.8973	-1.0355
Middle-ranked companies	-0.0029	0.0435	13.540	0.0533	-0.1674	40.6186	-0.4844
Low-ranked companies	-0.0011	0.0414	6.3495	0.0579	-0.1499	35.9296	-0.0478
S&P 500	-0.0011	0.0377	7.0403	0.0489	-0.1411	34.3608	