Green versus non-green stocks

How to invest on investor sentiment

Abstract

This paper examines the impact of investor sentiment on abnormal returns of green and non-green stocks. Data of 94 stocks is used for the sample period of 1990-2013 and analyzed using time series regression. This paper finds that the green and non-green portfolio both outperform the S&P 500 Energy Index benchmark. Also, the green and non-green portfolios perform equally for the total sample period, while the green portfolio outperforms the non-green portfolio over 1990-2007. Next, this paper finds that investor sentiment has a positive impact on abnormal returns of green and non-green stocks, which is higher for green stocks. Investors should use lagged changes in investor sentiment as a proxy for the formation of a mixed portfolio of either green or non-green stocks in a certain month. This enables investors to receive significantly higher abnormal returns compared to the green, non-green, S&P 500 Energy and market portfolios.

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31-08-2018

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1 Introduction

'Global warming can no longer be ignored as a factor of investing', Citibank, Lehman Brothers and UBS state early 2007.[1] Investing in green stocks is increasing in popularity since then. Next to investors, policy makers are also trying to shift investor's mindset to make finance more sustainable.[2] While some investors don't want to invest in companies that don't have a positive ecological footprint, others could take advantage of these inefficiencies if they don't mind the guilt, which suggests there are possibilities to make profits from investing in non-green stocks.[3] This ethical consideration is an irrational factor on a personal investment level, while there is also an irrational factor on a market level: investor sentiment. This latter factor has the power to increase stock prices when there is mostly optimism among investors and decrease stock prices in periods of pessimism.[4] Investor sentiment concerning socially responsible investing has an impact on returns of green and non-green stocks, but what is this worth exactly?

Research concerning green stocks indicates positive abnormal returns compared to the benchmark of neutral stocks (Derwall et al., 2005; Ng & Zheng, 2018). Kempf & Osthoff (2007) combine green and non-green stocks in one study and find that both have a positive impact on returns compared to benchmark stocks. Ng & Zheng (2018) also find that both green and non-green stocks outperform a benchmark portfolio including the S&P 500 Energy index. Baker & Wurgler (2007) describe that investor sentiment is an irrational factor that is able to influence stock prices both positively and negatively. The ability of investor sentiment to affect asset prices is found more often in empirical literature (Brown & Cliff, 2005; Ho & Hung, 2009). There is a gap in research concerning the impact of investor sentiment on abnormal returns of green and non-green stocks.

This paper focuses on the impact of investor sentiment on green and non-green investing. The sentiment indices of Baker & Wurgler (2007) and the American Association for Individual Investors are used for measuring investor sentiment, while Ng & Zheng (2018) provide measurements for the green and non-green stocks. Monthly data is used for 94 stocks for the sample period 1990-2013, which is analyzed using time series regression.

[1] https://www.wsj.com/articles/SB118239582814643063
[2] https://www.ft.com/content/20a043d8-0674-11e8-9650-9c0ad2d7c5b5
[3] https://www.wsj.com/articles/the-siren-call-of-sin-stocks-1454900933
[4] https://www.ft.com/content/32fea358-e3d8-11e7-a685-5634466a6915

The contribution of this paper is to link investor sentiment to green and non-green stocks. Kempf & Osthoff (2007) conducted a study on corporate social responsibility-linked stocks, while their study focuses specifically on ecological friendly stocks, this paper adds non-green stocks to the sample. This paper extends the framework of Ng & Zheng (2018) by adding investor sentiment to the analysis of green and non-green stocks. Finally, this paper contributes to literature concerning investor sentiment. Baker & Wurgler (2007) suggest that future research should focus on the impact of investor sentiment on specific sorts of stocks. Also, Liston (2016) suggests that future literature on investor sentiment and asset pricing should use different measures of investor sentiment to examine a possible different impact, which is taken into account in this paper. The research question is as follows:

'What is the impact of investor sentiment on returns for green versus non-green stocks.'

This paper provides several findings. Firstly, this paper finds that the green portfolio outperforms the benchmark portfolio of the S&P 500 Energy Index. The same impact is found for the non-green portfolio, which also outperforms the S&P 500 Energy Index. Also, the green and non-green portfolio perform equally for the total sample period, while the green portfolio outperforms the non-green portfolio in 1990-2007. Secondly, this paper finds that investor sentiment has a positive impact on abnormal returns of green and non-green stocks when sentiment survey data from the American Association of Individual Investors is used. The sentiment measure from Baker & Wurgler (2007) provided no significant impact on abnormal returns of both portfolios. Finally, this paper shows that the impact of investor sentiment is higher for the green than for the non-green portfolio.

These findings lead to a specific investment strategy. Investors should use lagged changes in investor sentiment as a proxy for a mixed portfolio of either green or non-green stocks in a certain month. When investor sentiment changes positively, one should take a position in the green stocks. When investor sentiment changes negatively, one should take a position in the portfolio of non-green stocks. Following these steps enables an investor to receive significantly higher abnormal returns compared to the green, non-green, S&P 500 Energy and market portfolio.

The outline of this paper is organised as follows. Section two covers literature regarding this subject. Sections three and four elaborate on the methodology and data used in this paper. Section five describes the results and section six an investment strategy based on the results. Sections seven and eight provide limitations and a conclusion to this paper.

2 Literature & Hypotheses Development

This section presents literature streams concerning the relevant theories. First, the concept of corporate social responsibility investing is discussed. Next, the concepts of green and non-green stocks are presented. Finally, the theory of investor sentiment is discussed. Hypotheses are derived from each of the concepts.

2.1 Corporate Social Responsibility Investing

The discussion on corporate social responsibility started with Milton Friedman, suggesting that public companies hardly have ethical obligations (Friedman, 1970). Murphy (1994) agrees by stating that managers neglect the most important reason for their existence if they put too much focus on social issues. Others disagree, for instance Brigham et al. (1999) question how companies should balance societal concerns with value creation for shareholders. Also, Drumwright (1994) state that corporate social responsibility (CSR) contains a differentiating aspect that can be turned into a successful strategy by companies to be unique in their industry. This paper holds the following definition of CSR:

"An approach to business which takes economic, social, environmental and ethical impacts into account to mitigate risk, decrease costs and improve brand image and competitiveness" (Fulton et al., 2012).

Investors are able to distinguish between firms and align their values and beliefs with those of potential firms to invest in (Kelley & Elm, 2003). The primary way for investors to compare firms is to look at their level of corporate social performance. When investors decide to let their investment decisions depend on the level of corporate social performance of a firm, they encounter in socially responsible investing (SRI). SRI is defined as a combination of financial objectives and investor's social values (Munoz-Torres et al., 2004).

SRI consists of aspects like human rights, governance, social welfare and ecological environment (Ng & Zheng, 2018). The counterpart of SRI entails sin stocks, which have a negative social impact. Sin stocks consist of alcohol, gambling, tobacco and gaming stocks (Liston, 2016). In the stock trading market, there is an increasing trend in funds and indices to invest in ecological friendly companies.[5] Also, Dillenburg et al. (2003) include 'respect for the

[5] https://www.ft.com/content/14787a44-cef6-11e3-ac8d-00144feabdc0

environment' in their list of principles for ethical business behaviour. Thirdly, Ng & Zheng (2018) examine the impact of ecological sin stocks, which they name non-green stocks. This provides ground for adding the ecological aspect to the category of sin stocks. Combining all aspects of SRI and sin stocks in one paper would lead to overlapping effects of individual aspects (Ng & Zheng, 2018). Therefore, this paper focuses on the ecological aspect, including green and non-green (or ecological sin) stocks.

2.2 Green Stocks

Green investing equals investing in firms with positive environmental impact (Boulatoff & Boyer, 2009). The green energy sector is growing enormously on a global scale, which is mostly due to the increase in green energy technologies, like solar, wind, geothermal and biomass (Ng & Zheng, 2018). On an increasing pace over recent years, funds and other equities are founded to meet the growing demand of investors for this kind of socially responsible investing (Mallett & Michelson, 2010).

Being environmental friendly as a firm corresponds to higher shareholder value. King & Lenox (2001) find higher financial performance for companies that score high on environmental performance in their sector. Also, companies that join the Chicago Climate Exchange's emissions reduction program inflate their stock price with around 8% (Boulatoff et al., 2013). Investors pay more and more attention to the ecological environment and specifically to climate change. This leads to increasing actions of investors to invest in green financial products (Inderst et al., 2012). Heinkel et al. (2001) underline this by stating that green investors have significant economic impact.

Ng & Zheng (2018) find that green firms perform at least as well as non-green firms and outperform the S&P 500 Energy Index. Cohen et al. (1995) also find that green stocks outperform the market portfolio. Another paper found that the green portfolio outperformed the market, while a portfolio of polluting stocks coulnd't (White, 1996). Differently, Boulatoff & Boyer (2009) find that environmental companies underperform the NASDAQ Index. On the other hand, they expect that green firms outperform the NASDAQ in the future, because of higher capital expenditures of green firms. A heavier bulk of literature suggests overperformance of green firms compared to a benchmark energy index or market portfolio. Therefore, the first hypothesis is constructed as follows:

H1: Green stocks perform better than the S&P 500 Energy Index benchmark portfolio.

2.3 Non-green Stocks

The term 'Non-green stocks' is used in this paper to indicate the opposite of green stocks. Non-green stocks are also called ecological sin stocks, to explain their negative impact on the ecological environment. Ecological sin stocks have a negative image for their polluting contribution to the ecological environment (Ng & Zheng, 2018). There is a norm in society against the funding of these kind of companies, which are promoting immoral behavior (Hong & Kacperczyk, 2009). Ng & Zheng (2018) position ecological sin stocks in the following categories: petroleum refining, chemicals, energy, oil & gas, mining & crude oil production and metals.

Larger returns are expected for sin stocks in general, because some investors are unwilling to hold them because of the negative image (Liston, 2016). This leads to a premium of holding unwanted stocks. Furthermore, Angel & Rivoli (1997) suggest that sin stocks have higher abnormal returns than conventional stocks. Liston (2016) find non-green stocks to achieve higher abnormal returns compared to the benchmark with the S&P 500 Energy Index. Ng & Zheng (2018) also examine this relationship and find similar results. There is not much research done concerning the performance of non-green stocks. Therefore, based on the limited stream of literature, the second hypothesis is constructed as follows:

H2: Non-green stocks perform better than the S&P 500 Energy Index benchmark portfolio.

If both green and non-green stocks outperform the benchmark portfolio, then the question remains which of both has higher abnormal returns. Lobe & Roithmeier (2008) find that sin stocks have a higher risk-return tradeoff compared to CSR stocks. Ng & Zheng (2018) find that green energy firms at least provide equal returns compared to non-green firms. Tripathi & Bhandari (2012) find that the green portfolio outperforms the non-green portfolio in the Indian stock market. For mutual funds, Ibikunle & Steffen (2017) find that green mutual funds only outperform non-green mutual funds in recent years, however they find no significant difference over a sample period of the last 25 years. Furthermore, Perez Liston & Soydemir (2010) find faith-based stocks to underperform sin stocks. Due to the lack of agreement in literature, the third hypothesis is constructed as follows:

H3: Green stocks perform comparably with non-green stocks.

2.4 Investor sentiment

Investor sentiment is defined as beliefs regarding future cash flows and risks of investment which are not rationally derived from facts (Baker & Wurgler, 2007). Investor sentiment in its early years is mostly used to support findings regarding over- and underreaction (Barberis et al., 1998). Nowadays, studies on investor sentiment are increasing, mainly with the aim of examining stock returns in a broad range of industries (Garcia, 2013). Research has been done regarding the impact of investor sentiment. Baker et al. (2012) find investor sentiment to be a contrarian predictor of returns, meaning that future returns are low when sentiment is high. On the other hand, irrational sentiments are found to have a positive short-term impact on returns (Verma et al., 2008). Also, periods of low investor sentiment are expected to provide a continuous downward pressure on stock prices (DeLong et al., 1990).

The previous paragraph has shown that investor sentiment and stock returns are related, which could also be argued specifically regarding returns of green stocks. King & Lenox (2001) find that firms have higher financial performance when they are viewed as environmental friendly relative to other firms in its industry. Also, Derwall et al. (2005) suggest the existence of an ecological value premium for firms that are evaluated as eco-friendly. There is no previous literature where the impact of investor sentiment on green stock performance is measured. Therefore, based on the finding and suggestion in this paragraph, the fourth hypothesis is constructed as follows:

H4: Investor sentiment has a positive impact on green firm performance.

Not only the performance of green stocks is expected to be affected by investor sentiment. Sin stock returns are also influenced by investor sentiment (Hong & Kacperczyk, 2009; Kumar & Lee, 2006). Literature on the sign of the impact of investor sentiment on stock returns for sin firms is scarce. The only paper examining this impact is the paper of Liston (2016), which finds a positive impact of investor sentiment on sin stock returns. There is no previous literature that captures the impact of investor sentiment on non-green (or ecological sin) stocks specifically. Based on previous literature, the fifth hypothesis is constructed as follows:

H5: Investor sentiment has a positive impact on non-green firm performance.

This paper expects to find a positive impact of investor sentiment on both green and non-green firm performance. The question remains however whether green or non-green stocks are influenced heavier by investor sentiment. It would be relevant for investing purposes to know whether green or non-green stocks are more prone to be impacted by investor sentiment.

Investors could adjust their trading strategy based on this comparison and knowledge about the current state of sentiment in the investment landscape. If for example non-green stocks are prone to be influenced more by investor sentiment compared to green stocks, then this entails a higher risk for investors in a period of high sentiment for these stocks. This indicates that the market for non-green stocks could be prone to higher irrationality of investors. Due to a lack of literature for this comparison and the previously mentioned relevance, the sixth hypothesis is constructed as follows:

H6: The impact of investor sentiment on abnormal returns is equal for green firms and ecological sin firms.

3 Methodology

This section describes the statistical method and process for this paper. First the investment performance measurement is discussed. Secondly, the measurement for investor sentiment is outlined.

3.1 Investment Performance

This paper uses the measurement of investment performance of Ng & Zheng (2018). Investment performance is measured with several estimation models, used to find the risk adjusted returns for the portfolio. The following models capture the first three hypotheses. The first estimation model is the standard Captial Asset Pricing Model (CAPM):

$$(PR_j - RF) = \alpha_j + \beta_{1j}(MKT - RF) + error_{ei}$$

The second one denotes the Fama-French three-factor model (Fama & French, 1992):

$$(PR_j - RF) = \alpha_j + \beta_{1j}(MKT - RF) + \beta_{2j}SMB + \beta_{3j}HML + error_{ei}$$

The third one denotes the Carhart four-factor model (Carhart, 1997):

$$(PR_j - RF) = \alpha_j + \beta_{1j}(MKT - RF) + \beta_{2j}SMB + \beta_{3j}HML + \beta_{4j}MOM + error_{ei}$$

The fourth one denotes the CAPM using the S&P 500 Energy Index:

$$(PR_j - RF) = \alpha_j + \beta_{1j}(S\&P\ Energy\ Index\ return - RF) + error_{ei}$$

Where *(PR – RF)* equals the annual return premium of the portfolio and *j* denotes whether the portfolio consists of green or non-green stocks. α denotes the abnormal return for a portfolio of assets. This alpha explains the difference between the returns of the actual portfolio and the theorized one by asset pricing models. (MKT – RF) denotes the market risk premium in which the market benchmark (MKT) is the value weighted return of the major stock exchanges in the US which include NYSE, AMEX and NASDAQ. RF denotes the risk free rate, which is equal to the US Treasury Bill rate. SMB denotes the small (market capitalization) minus big, measuring the risk premium associated with company size. HML equals high (book-to-market ratio) minus low, measuring the risk premium for value versus growth stocks. Finally, MOM denotes the momentum factor, measuring tendency for a stock price to continue a movement trend.

Finally, the fourth equation uses the S&P 500 Energy Index as benchmark market return to measure the market risk premium. This is necessary because normal Fama and French is a general measurement instrument, while this equation measures this industry specific for the energy industry. Also, returns are more easily interpreted regarding the energy market returns (Ng & Zheng, 2018).

3.2 Investor Sentiment

This paper uses the measurement of investor sentiment of Baker & Wurgler (2007). This measurement is often used in previous studies (Stambaugh et al., 2012; Yu, 2013; Huang et al., 2015; Avramov et al., 2017) and is suggested as a measurement for investor sentiment by Liston (2016). To measure investor sentiment, Baker and Wurgler construct an index consisting of five aspects: dividend premium (PDND), closed-end fund discount (CEFD), number of (NIPO) and first-day returns (RIPO) on IPO's and the equity share in new issues (S) (Baker & Wurgler, 2007). They initially list more aspects that predict investor sentiment, but narrowed their list because of two reasons. Data should be available from 1960 onwards, which is in line with availability of data of stock returns and aspects should predict long-horizon returns. The index is corrected for macro-economic influences. Investor sentiment is calculated with the following equation, taking the first principal component of each aspect:

$$SENT = -0.23CEFD + 0.24NIPO + 0.29RIPO - 0.32PDND + 0.232S$$

The authors construct a sentiment-levels index to examine predictability of returns depending on the sentiment state and a sentiment-changes index to examine co-movement patterns in returns regarding changes in sentiment. This paper uses only the sentiment-levels index, because Baker & Wurgler (2007) suggest lag structures lead to low-frequency level indicators regarding the sentiment-changes index. Hypotheses four to six are measured by including the sentiment measure into a regression formula with the abnormal returns of the portfolio of stocks. Abnormal returns are calculated with the following formulas:

$$AR_j = \left(PR_j - RF\right) - E_{CAPM}\left(PR_j - RF\right)$$

Where the actual returns are subtracted by the expected returns. The expected returns are calculated by CAPM:

$$E_{CAPM}\left(PR_j - RF\right) = \beta_{1j}(MKT - RF)$$

Where beta is calculated following CAPM in STATA and alpha is assumed zero. Finally, the impact of investor sentiment on abnormal returns is measured with CAPM. The following formula presents the measurement for investor sentiment:

$$AR_j = B_0 + B_{1j}SENT + error_{ui}$$

Where *SENT* measures the impact of investor sentiment on abnormal returns of either the green or non-green stocks. This paper uses the independent samples t-test as measurement whether investor sentiment has a significant bigger or smaller impact on the abnormal stock returns of green or non-green stocks.

Another measurement of investor sentiment is the use of survey data from the American Association of Individual Investors to measure the individual investor sentiment. This measurement is used in several papers (Verma & Soydemir, 2008; Perez Liston et al., 2014; Liston, 2016). However, Liston (2016) suggests to use the investor sentiment of Baker & Wurgler (2007) for further research and Verma & Soydemir (2008) provides several shortcomings of the survey measurement for investor sentiment. Therefore, this paper uses the measurement of Baker & Wurgler (2007) as a primary measure of investor sentiment and uses the survey measurement of individual investor sentiment as a robustness test. This latter test uses data on monthly changes in the bull-bear spread. Investors answer the same question each week: 'Do you feel the direction of the market over the next six months will be up (bullish), no change (neutral) or down (bearish)?[6]

[6] http://www.aaii.com/o/sentimentsurvey

4 Data

This section describes the collecting and use of data in this paper. First the data collection process is discussed. Secondly, the descriptive statistics of the dataset is outlined.

4.1 Data Collection

Stock data is derived and matching is done according to the paper of Ng & Zheng (2018). Green stocks are derived from AltEnergyStocks.com. This website lists 336 green firms, of which 99 firms are chosen that produce energy from renewable or environmental friendly origin. From this pool of stocks, 93 matching non-green energy stocks from the fortune 500 are found. Finally, 49 green stocks are matched to 49 non-green stocks based on several criteria. Firstly, both firms should have ± 30% of sales for the last observational year. Also, matches are made based on the same GIC code and the companies should operate in the same country. Matching companies are done using peer set by custom search on Thomson ONE Banker. Thereafter, data on monthly returns is subtracted for all stocks from the Center for Research in Security Prices. Finally, a sample of 46 green and 48 non-green firms remains, because several years of data was missing for three green and one non-green stock. Table 1 shows several characteristics of the sample of green and non-green firms. Both type of firms are approximately equal regarding market value and IPO age. Green firms have lower total assets and liabilities, but a higher percentage of sales invested in R&D compared to non-green firms.

Table 1: Green and non-green firm characteristics

	Green firms	Non-green firms
Assets	3386,35	3863,08
Liabilities	2101,47	2771,58
Market value	3572,93	3682,05
R&D/Sales	11,06%	6,22%
IPO Age	21,34	21,90

The S&P 500 Energy index is used as benchmark portfolio because it holds S&P 500 firms that are included in the GICS energy sector. This portfolio development strategy is used in the paper of Ng & Zheng (2018), who precisely determine their portfolios. Monthly data is used for all stocks for a time range of 1990 till 2013, because of data availability. A monthly stock return

premium for green and non-green stocks is calculated by adding one to the average of all stocks for each section and then subtract the risk-free rate.

Data on investor sentiment is obtained from the website[7] of Jeffrey Wurgler, while data on individual investor sentiment is taken from the website of the American Association of Individual Investors.[8] This is weekly data, which is turned into monthly data by taking the average of the weeks corresponding to each month. Data on SMB, HML and MOM are derived from the website of Kenneth French.[9] Data on the risk free rate and Energy Index are obtained from the Global Financial Data database. The risk free rate was a yearly rate, and therefore divided by twelve. Log returns are taken from the index prices of the S&P 500 Energy Index. The data source provides monthly data, of which a time period of 1990 till 2013 is used for this paper.

4.2 Descriptive Statistics

Table 2 presents the descriptive statistics of the variables in this paper. The top row presents all variables, including the descriptives of small minus big, high minus low and the momentum. The variables Green Stocks, Non-green Stocks and S&P Energy Index present the descriptive statistics of the log returns of the three variables. The first column presents the descriptive statistics for each variable. Kurtosis for HML and MOM are fairly high, while Skewness for all variables are average outcomes. High kurtosis indicates that data on the tails of the distribution exceeds the one of the normal distribution, which will lead to sporadic extreme returns for investors (Dittmar, 2002). The lowest values of green stocks, non-green stocks and the S&P Energy Index relate to October 2008 when the stock market crashed heavily. The lowest value of investor sentiment relates to April 2009, several months after a severe stock market crash. 24 years times 12 months provides a number of observations of 288.

[7] http://people.stern.nyu.edu/jwurgler/
[8] www.aaii.com
[9] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Table 2: Descriptive statistics

	Investor Sentiment	Green Stocks	Non-green Stocks	S&P Energy Index	SMB	HML	MOM
Mean	0.258 (0.037)	0.018 (0.005)	0.017 (0.004)	0.005 (0.005)	0.248 (0.180)	0.160 (0.224)	0.570 (0.294)
Std. dev.	0.622	0.078	0.064	0.088	3.0480	3.802	4.985
Kurtosis	3.874 (0.286)	0.896 (0.286)	1.196 (0.286)	1.703 (0.286)	2.445 (0.286)	7.206 (0.286)	11.168 (0.286)
Skewness	1.414 (0.144)	-0.063 (0.144)	-0.223 (0.144)	-0.083 (0.144)	0.496 (0.144)	-0.072 (0.144)	-1.611 (0.144)
Minimum	-0.866	-0.270	-0.225	-0.366	-11.60	-20.79	-34.39
Maximum	3.076	0.252	0.220	0.301	14.62	19.72	18.33
N	288	288	288	288	288	288	288

Table 2 presents the descriptive statistics of all variables. Standard deviation is given between brackets.

5 Results

This section presents the results of the time series regression. First, the performance of the green and non-green portfolios is discussed. Second, the relationship between investor sentiment and abnormal returns is shown.

5.1 General Descriptives of Portfolio Performance

Table 3 presents basic statistics of the return performance of the green and non-green portfolio and the S&P 500 Energy Index as a benchmark portfolio for the sample period of 1990-2013. The table shows that the green portfolio has the highest stock and excess return compared to the non-green and S&P Energy benchmark portfolios. The green portfolio only has a significant higher stock and excess returns compared to the S&P Energy benchmark. Furthermore, table 3 concludes that the S&P Energy Index has the highest annualized standard deviation. Finally, the table presents positive values for the Sharpe and Treynor ratios, indicating that the portfolios hold positive risk-adjusted returns. The Treynor ratio covers market risk, while the Sharpe ratio covers total risk for the portfolio.

Table 3: Portfolio return performance (1990-2013)

	G	NG	S&P Energy	Market
Stock return	522.21%	492.02% (-30.19%)	142.87% (-379.34%)*	248.89% (-273.32%)*
Excess return	446.60%	416.40% (-30.20%)	67.26% (-379.34%)*	173.28% (-273.32%)*
Std Dev.	27.16%	22.22%	30.33%	15.25%
Sharpe ratio	0.20	0.23	0.03	0.14
Treynor ratio	0.01	0.01	0.02	0.01

* Denotes a significant difference between the green and other portfolio below the 0.05 level, which is examined with the independent samples t-test. Differences are given between brackets. The Sharpe ratio is calculated by the following formula: (average stock return – risk free rate) / standard deviation. The Treynor ratio is calculated by the following formula: (average stock return – risk free rate) / beta of the portfolio.

The path of returns over 24 years is shown in figure 1, indicating the cumulative abnormal returns of the green, non-green, S&P 500 Energy Index and market portfolios. The figure underlines the results from table 3, indicating the highest cumulative abnormal returns for the green portfolio, which almost has the same path as the non-green portfolio. The S&P Energy Index has a nearly horizontal path with periods of negative and positive cumulative abnormal returns, while the market portfolio has positive and quite stable abnormal returns.

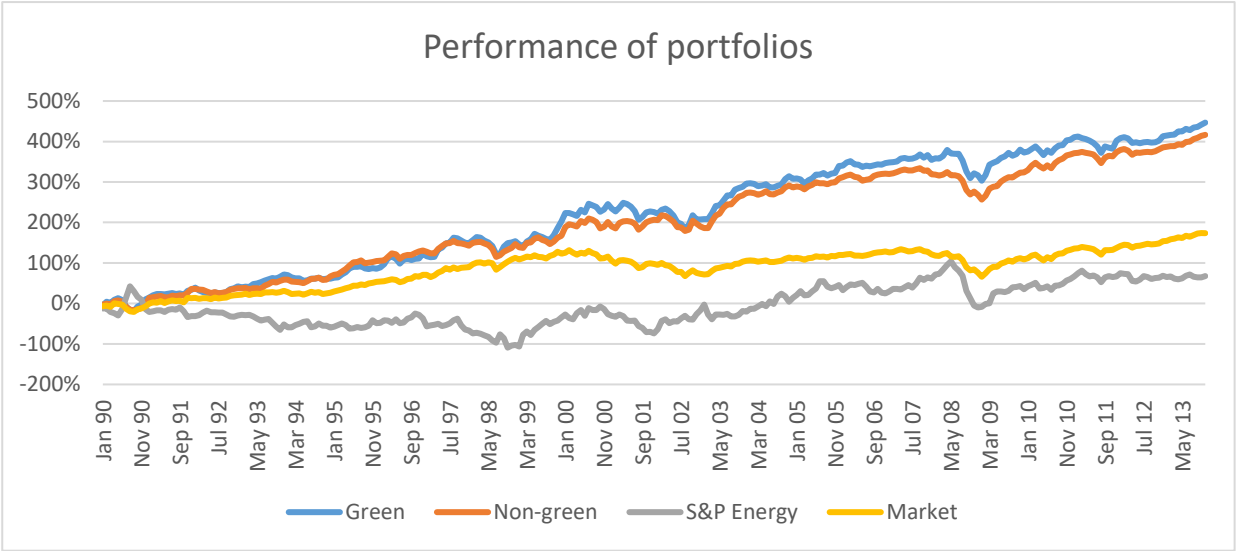

Figure 1: Cumulative abnormal returns for the green, non-green, market and S&P 500 Energy Index (1990-2013)

5.2 Risk-adjusted Performance of Portfolios

Next, the results of the time series regression are discussed. Table 4 shows the risk-adjusted performance of the green portfolio, measured by CAPM, Fama & French three factor, Carhart four factor and CAPM Energy model. Three different time periods are examined, namely the complete period of 24 years (1990-2013), the pre-crisis sample (1990-2007) and the (post-)crisis sample (2008-2013).

The complete period of 1990-2013 provides significant and positive alphas for all estimation models. The highest alpha is that of the CAPM Energy benchmark model, indicating that the green portfolio performs 1.52% better compared to the S&P 500 Energy Index. The other three models state that the green portfolio performs 0.5% to 0.7% better than the market portfolio, consisting of the major stock exchanges in the US. Furthermore, the betas are all significant, except for the betas for high minus low and momentum concerning the Carhart four factor model. The betas are larger than one, indicating that the systematic risk is very high for the green portfolio. This portfolio is 20-45% more volatile than the market.

The sample period of 1990-2007 provides higher significant results. All alphas are significant, for which the CAPM Energy index again provides the highest alpha. The other alphas outperform the market portfolio by approximately 0.7% to 0.9%. The betas provide significant results, except for the high minus low and momentum beta for the Carhart four factor model and the S&P Energy index. The sample period of 2008-2013 provides

insignificant alphas for all estimation models. The betas are all significant, except for the beta of high minus low for the Fama & French three factor model.

This indicates that investing in green stocks in the pre-crisis period provides higher returns than the market portfolio, while the (post-)crisis period doesn't provide good ground for investment in the green portfolio. All values for the adjusted R-squared for the CAPM, Fama & French three factor and Carhart four factor models are between 0.56 and 0.88, meaning that the data fits these models well. On the other hand, the adjusted R-squared values for the CAPM Energy model are between 0.00 and 0.32, indicating that the data doesn't fit this model very well.

Table 4: Green portfolio risk-adjusted performance

1990-2013	CAPM	FF 3 factor	Carhart 4	CAPM Energy
Alpha	0.0069**	0.0053**	0.0057***	0.0152***
	(0.0028)	(0.0021)	(0.0022)	(0.0046)
Rm-Rf	1.4399***	1.2288***	1.2161***	
	(0.0628)	(0.0501)	(0.0527)	
SMB		1.0500***	1.0389***	
		(0.0734)	(0.0748)	
HML		0.1285**	0.0860	
		(0.0565)	(0.0785)	
MOM			-0.0475	
			(0.0610)	
S&P Energy				0.1448***
				(0.0523)
Adj. R-squared	0.6433	0.7912	0.7909	0.0227
1990-2007				
Alpha	0.0088***	0.0073***	0.0079***	0.0170***
	(0.0047)	(0.0025)	(0.0027)	(0.0051)
Rm-Rf	1.3719***	1.2220***	1.203***	
	(0.0815)	(0.0642)	(0.0707)	
SMB		1.0765***	1.0667***	
		(0.0818)	(0.0834)	
HML		0.1911***	0.1493	
		(0.0720)	(0.0974)	
MOM			-0.0470	
			(0.0027)	
S&P Energy				-0.0033
				(0.0580)
Adj. R-squared	0.5679	0.7606	0.7599	-0.0047
2008-2013				
Alpha	-0.0015	-0.0015	-0.0016	0.0109
	(0.0048)	(0.0040)	(0.0039)	(0.0088)
Rm-Rf	1.5350***	1.3456***	1.3766***	
	(0.0904)	(0.0925)	(0.0907)	
SMB		1.1204***	1.0514***	
		(0.1922)	(0.1887)	
HML		-0.1181	-0.4766**	
		(0.1193)	(0.1933)	
MOM			-0.2859**	
			(0.1236)	
S&P Energy				0.5800***

				(0.1005)
Adj. R-squared	0.8020	0.0.8643	0.8724	0.3129

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01.

Table 5 shows the risk-adjusted performance of the non-green portfolio, measured by the four estimation models and sample periods. The complete period of 1990-2013 provides significant and positive alphas for all estimation models. The highest alpha is that of the CAPM Energy benchmark model, indicating that the green portfolio performs 1.42% better compared to the S&P 500 Energy Index. The other three models state that the non-green portfolio performs 0.5% to 0.8% better than the market portfolio. Furthermore, the betas are all significant, except for the beta for momentum concerning the Carhart four factor model. The betas are larger than one, indicating that the systematic risk is very high for the non-green portfolio. This portfolio is 5-25% more volatile than the market.

The sample period of 1990-2007 provides higher significant results. All alphas are significant, for which the CAPM Energy index again provides the highest alpha. The other alphas outperform the market portfolio by approximately 0.6% to 0.9%. The betas provide significant results, except for the momentum beta for the Carhart four factor model and the S&P Energy index. The sample period of 2008-2013 provides insignificant alphas for the first three estimation models, while the alpha for the CAPM Energy estimation model is significant for the 90% significance level. This indicates that the non-green portfolio outperforms the S&P Energy index by 1.2%. Only betas for the market return, small minus big and S&P Energy are significant in this time period.

This indicates that investing in non-green stocks in the pre-crisis period provides higher returns than the market portfolio, while the (post-)crisis period doesn't provide good ground for investment in the non-green portfolio. All values for the adjusted R-squared for the CAPM, Fama & French three factor and Carhart four factor models are between 0.61 and 0.91, meaning that the data fits these models well. On the other hand, the adjusted R-squared values for the CAPM Energy model are between 0.00 and 0.34, indicating that the data doesn't fit this model very well.

Table 5: Non-green portfolio risk-adjusted performance

1990-2013	CAPM	FF 3 factor	Carhart 4	CAPM Energy
Alpha	0.0071***	0.0058***	0.0060***	0.0142***
	(0.0021)	(0.0016)	(0.0016)	(0.0037)
Rm-Rf	1.2149***	1.0576***	1.0524***	
	(0.0476)	(0.0367)	(0.0387)	
SMB		0.8280***	0.8235***	
		(0.0538)	(0.0549)	
HML		0.1391***	0.1218**	
		(0.0414)	(0.0576)	
MOM			-0.0193	
			(0.0447)	
S&P Energy				0.1058**
				(0.0429)
Adj. R-squared	0.6942	0.8322	0.8317	0.0174
1990-2007				
Alpha	0.0081***	0.0066***	0.0073***	0.0153***
	(0.0027)	(0.0019)	(0.0020)	(0.0042)
Rm-Rf	1.1949***	1.0864***	1.0667***	
	(0.0645)	(0.0478)	(0.0526)	
SMB		0.9136***	0.9033***	
		(0.0609)	(0.0620)	
HML		0.2320***	0.1882*	
		(0.0536)	(0.0724)	
MOM			-0.0492	
			(0.0548)	
S&P Energy				-0.0166
				(0.0486)
Adj. R-squared	0.6140	0.8109	0.8107	-0.0041
2008-2013				
Alpha	0.0043	0.0029	0.0029	0.0120*
	(0.0028)	(0.0026)	(0.0026)	(0.0068)
Rm-Rf	1.2514***	1.1399***	1.1415***	
	(0.0537)	(0.0595)	(0.0606)	
SMB		0.5256***	0.5221***	
		(0.1236)	(0.1261)	
HML		0.0022	-0.0161	
		(0.0768)	(0.1292)	
MOM			-0.0145	
			(0.0826)	
S&P Energy				0.4658***
				(0.0768)
Adj. R-squared	0.8842	0.9070	0.9057	0.3352

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01.

Tables 4 and 5 show that green and non-green risk-adjusted performance is nearly equal, but both outperform the S&P Energy benchmark. Table 6 shows the results of the t-test for the complete sample period of 24 years. For the total sample period of 1990-2013, this table shows that both portfolios perform equal for the CAPM model. For the three and four factor model, the non-green portfolio outperforms the green portfolio. This is the other way around for the CAPM Energy model, here the green portfolio outperforms the non-green portfolio. For the pre-crisis sample period of 1990-2007, the green portfolio outperforms the non-green portfolio

for all estimation models. Concluding that the total sample period shows no clear winner, while the pre-crisis sample period shows that the green portfolio outperforms the non-green portfolio.

Table 6: Differences in risk-adjusted performance between the green and non-green portfolio.

1990-2013	Green portfolio	Non-green portfolio	t-test (p-value)
CAPM	0.0828 (0.0336)	0.0852 (0.0252)	0.9697 (0.3326)
FF 3 factor	0.0636 (0.0252)	0.0696 (0.0192)	3.2140 (0.0014)***
Carhart 4 factor	0.0684 (0.0264)	0.0720 (0.0192)	1.8716 (0.0618)*
CAPM Energy	0.1824 (0.0552)	0.1704 (0.0444)	2.8747 (0.0042)***
1990-2007			
CAPM	0.1056 (0.0564)	0.0972 (0.0324)	1.8980 (0.0584)*
FF 3 factor	0.0876 (0.0300)	0.0792 (0.0228)	3.2763 (0.0011)***
Carhart 4 factor	0.1164 (0.0324)	0.0876 (0.0240)	10.4976 (0.0001)***
CAPM Energy	0.2040 (0.0612)	0.1836 (0.0504)	3.7817 (0.0002)***

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01. Annualized alphas are given for each model, standard error is given between brackets.

5.3 Impact of Investor Sentiment

Next, the impact of investor sentiment on the abnormal returns of the portfolios is discussed. Figure 2 shows the path of investor sentiment over time, indicating a big peak in 2000-2001 and negative values for investor sentiment in 1991, 2003 and 2010.

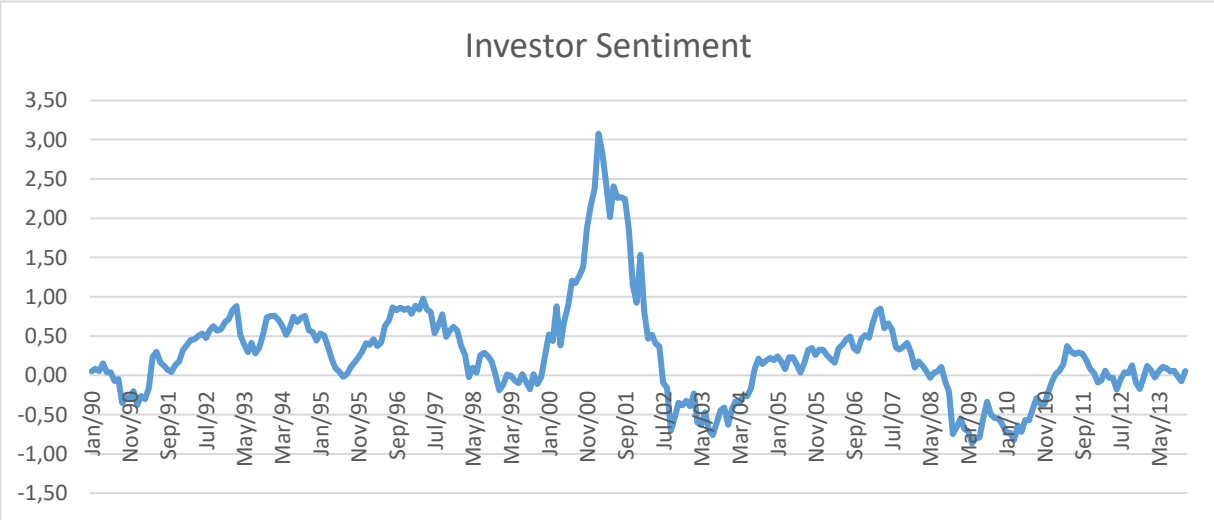

Figure 2: Investor sentiment (1990-2013)

Table 7 shows the impact of investor sentiment on abnormal returns of both the green and non-green portfolio. For the green portfolio, investor sentiment has no significant impact for all three sample periods. The non-green portfolio however, provides one highly significant result.

When investor sentiment increases by one unit, abnormal returns of the non-green portfolio decrease by 0.0223 units regarding the years 2008-2013. Concluding, the Baker & Wurgler (2007) measurement of investor sentiment hardly has any impact on abnormal returns of both the green and non-green portfolio.

Adding the lagged value (t-1) for sentiment in the regression provides no significant values for investor sentiment. Also, applying the difference (sentiment –sentiment (t-1)) of sentiment provides no significant outcomes. Thirdly, including the lagged value for sentiment as the only independent variable in the regression provides one significant outcome. When lagged investor sentiment increases by one unit, abnormal returns of the non-green portfolio decrease by 0.0215 units regarding the years 2008-2013.

Table 7: The impact of investor sentiment on abnormal returns of the green and non-green portfolio.

	Green			Non-green		
	Constant	Coefficient	Adj. R-squared	Constant	Coefficient	Adj. R-squared
1990-2013	0.0067	0.0004	-0.0035	0.0070	0.0005	-0.0034
	(0.0030)	(0.0044)		(0.0023)	(0.0034)	
1990-2007	0.0092	-0.0010	-0.0045	0.0076	0.0013	-0.0042
	(0.0039)	(0.0053)		(0.0031)	(0.0042)	
2008-2013	-0.0012	-0.0147	0.0018	0.0003	-0.0223***	0.0899
	(0.0053)	(0.0139)		(0.0030)	(0.0079)	

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01.

5.4 Robustness Tests

A test for the robustness of the data and comparison with the paper of Ng & Zheng (2018) is to compare their findings with the findings of this paper concerning additional sample periods of 1990-1999 and 2000-2009. Table 8 presents the findings of this paper for the two sample periods for the Fama & French three factor and Carhart four factor estimation models. All alphas in this table are significant, but one for the Fama & French three factor model for the green portfolio in 1990-1999. The results of Ng & Zheng (2018) only indicate a significant alpha for the green and non-green portfolios in 2000-2009 for the Fama & French three factor model. Furthermore, the values for the market beta are significant and positive in both papers. Concludingly, this paper provides more robust findings compared to Ng & Zheng (2018).

Table 8: Robustness test for the three and four factor models.

	Green		Non-green	
1990-1999	FF 3 factor	Carhart 4	FF 3 factor	Carhart 4
Alpha	0.0047	0.0068**	0.0042*	0.0057**
	(0.0031)	(0.0033)	(0.0024)	(0.0026)
Rm-Rf	1.1027***	1.0767***	1.0097 ***	0.9906***
	(0.0855)	(0.0857)	(0.0671)	(0.0674)
SMB	1.0654***	1.0056***	0.9088***	0.8647***
	(0.1085)	(0.1122)	(0.0852)	(0.0882)
HML	0.1152	-0.0064	0.2921***	0.2024**
	(0.1102)	(0.1274)	(0.0865)	(0.1001)
MOM		-0.1998*		-0.1472*
		(0.1079)		(0.0849)
Adj. R-squared	0.7507	0.7558	0.7787	0.7825
2000-2009	Green		Non-green	
Alpha	0.0124***	0.0118***	0.0109***	0.0104***
	(0.0037)	(0.0038)	(0.0026)	(0.0027)
Rm-Rf	1.3606***	1.3943***	1.1970***	1.2237***
	(0.0825)	(0.0919)	(0.0575)	(0.0640)
SMB	0.9733***	0.9860***	0.7246***	0.7346***
	(0.1114)	(0.1126)	(0.0777)	(0.0785)
HML	0.0348	0.1103	0.0164	0.0761
	(0.0788)	(0.1197)	(0.0550)	(0.0835)
MOM		0.0766		0.0606
		(0.0915)		(0.0638)
Adj. R-squared	0.8149	0.8144	0.8655	0.8654

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01.

A second robustness test is for investor sentiment. The measurement for investor sentiment from Baker & Wurgler (2007) provided mostly insignificant results. Therefore, investor sentiment data from the American Association of Individual Investors is used as a second test.

Figure 3 shows the path for both measurements of investor sentiment over time. The sentiment survey has a less volatile trend compared to the measurement of investor sentiment of Baker, with values between -0.5 and 0.5. The Baker measurement of investor sentiment

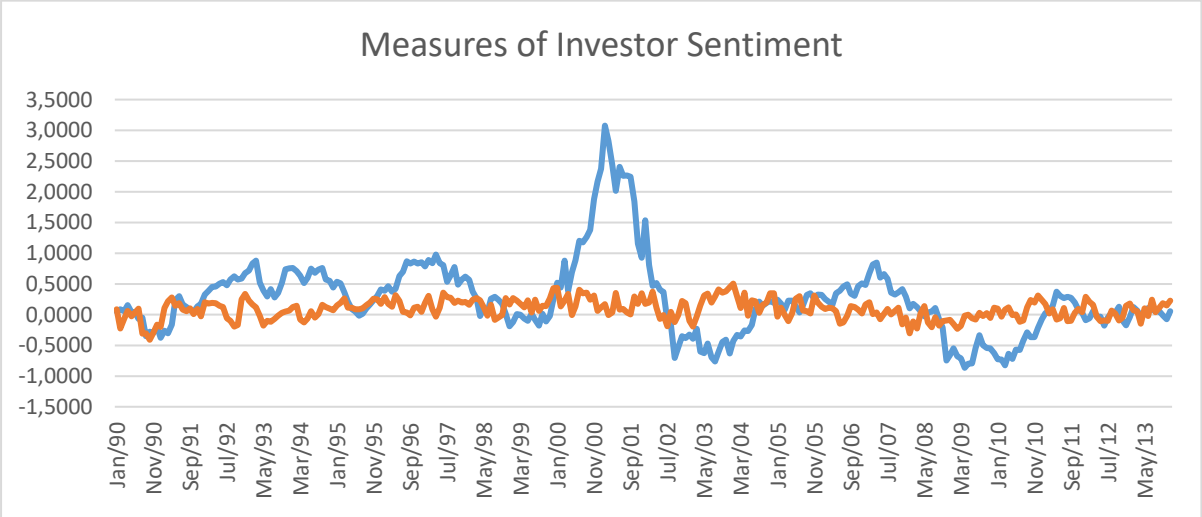

Figure 3: Both measures of investor sentiment (1990-2013)

consists of five financial aspects in the market: dividend premium, closed-end fund discount, number of and first-day returns on IPO's and the equity share in new issues. The sentiment survey is measured using monthly changes in the bull-bear spread. The sentiment survey contains expectations of investors about the market, which always contains values between -1 and 1, while Wurgler's investor sentiment measure fully depends on the state of the financial markets in the past. Due to this difference, different outcomes are expected for the impact of the sentiment survey on the abnormal returns of the green and non-green portfolios.

Figures 4 and 5 show the distribution of the sentiment measurements of Baker and the survey. Figure 4 shows a widespread distribution, while figure 5 shows a narrow distribution. This suggests different results when using the sentiment survey measurement in regression analysis. It also makes more sense to use the sentiment survey measurement in regression analysis compared to the sentiment measurement of Baker.

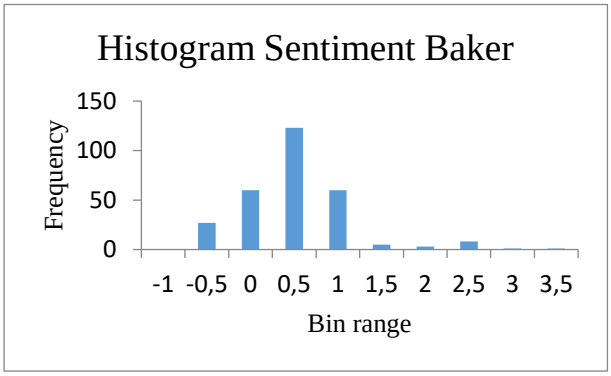

Figure 4: Distribution of Baker's sentiment measurement

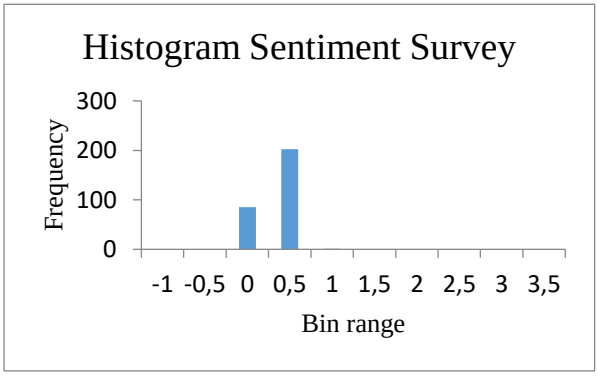

Figure 5: Distribution of sentiment survey measurement

Table 9 shows that this second measure of investor sentiment leads to more significant results. Both sample periods 1990-2013 and 1990-2007 provide solely significant positive outcomes for investor sentiment. For example, when investor sentiment increases by one unit, then the abnormal returns of the green portfolio are expected to increase by 0.0559 units for 1990-2013. The final sample period, 2008-2013, shows no significant impact for investor sentiment on the abnormal returns of the green portfolio. On the other hand, investor sentiment has a significant impact on the abnormal returns of the non-green portfolio for this sample period. Both the lagged variable for sentiment and the difference (sentiment – sentiment (t-1)) for sentiment provide slightly less significant outcomes.

Table 9: Robustness test for investor sentiment.

	Green			Non-green		
	Constant	Coefficient	Adj. R-squared	Constant	Coefficient	Adj. R-squared
1990-2013	0.0020	0.0559***	0.0324	0.0026	0.0518***	0.0503
	(0.0031)	(0.0172)		(0.0023)	(0.0129)	
1990-2007	0.0022	0.0590***	0.0322	0.0020	0.0550***	0.0464
	(0.0040)	(0.0207)		(0.0031)	(0.0162)	
2008-2013	0.0010	0.0353	0.0003	0.0038	0.0427**	0.0458
	(0.0047)	(0.0350)		(0.0027)	(0.0203)	

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01.

To answer the final hypothesis, a t-test is used to find out whether the impact of investor sentiment is bigger on green or non-green abnormal returns. Table 10 presents the results of the t-test, indicating that there is a significant difference between the impact of investor sentiment on green and non-green stocks in 1990-2013 and 1990-2007. There is no significant difference for 2008-2013, because the coefficient for the green portfolio is not significant in this sample period. Both sample periods show a significant higher coefficient for the green portfolio relative to the non-green portfolio. This indicates that the impact of investor sentiment on green and non-green stocks is not equal, but significantly higher for the green portfolio.

Table 10: Impact of investor sentiment on the green and non-green portfolios.

	Green	Non-green	t-test (p-value)
1990-2013	0.0559 (0.0172)	0.0518 (0.0129)	3.2362 (0.0013)***
1990-2007	0.0590 (0.0207)	0.0550 (0.0162)	2.2365 (0.0258)**
2008-2013	0.0353 (0.0350)	0.0427 (0.0203)	1.5519 (0.1229)

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01. Standard errors are given between brackets.

The next part covers possible correlation between the variables. Table 11 presents the correlation matrix of the green, non-green, S&P 500 Energy Index, Market portfolio and both sentiment measures. The table shows the highest correlation for the green and non-green portfolio. When the value of the green portfolio increases, then the non-green portfolio increases in 88.73% of the time in a similar fashion. Furthermore, the market portfolio has a high correlation with the green and non-green portfolio. The S&P 500 Energy Index shows low correlation results with all other portfolios. This indicates that the Energy Index hardly follows a similar trend compared to the other portfolios. This Index turned out to be an insufficient benchmark index for the green and non-green portfolios, while Ng & Zheng (2018) were in favor of using this benchmark because it consists of big energy firms.

Next, the correlation between both datasets of investor sentiment is discussed. Table 11 displays a correlation of 0.1466, indicating a slight positive linear relationship between the two constructs. These two measures hardly show a similar trend over time. This can be explained through the differences in both datasets. Data of investor sentiment provides a mean which is three times higher and a standard deviation which is four times higher compared to the dataset of the sentiment survey.

Table 11: Correlation Matrix

Green Portfolio	1					
Non-green Portfolio	0.8873	1				
S&P 500 Energy Index	0.1616	0.1437	1			
Market Portfolio	0.8032	0.8335	0.1218	1		
Investor Sentiment					1	
Sentiment Survey					0.1466	1

Table 11 presents the correlation matrix with all relevant variables.

5.5 Discussion of the Results

The findings of this paper contribute to literature in several ways. Firstly, this paper finds that the green portfolio outperforms the benchmark portfolio of the S&P 500 Energy Index. This finding is in line with the paper of Ng & Zheng (2018), who find approximately similar values for alpha in their paper. This finding is also supported by the paper of Cohen et al. (1995). The authors of the paper find a positive premium for being a green firm compared to a portfolio of S&P 500 firms. On the other hand, the finding of this paper is contrarian to the findings of Boulatoff & Boyer (2009), who find their portfolio of green firms to underperform the NASDAQ index over a five-year period. This difference can be explained by the shorter sample period in their paper or the comparison with another index. The authors expect however, that the green portfolio outperforms the NASDAQ index in the near future, because of higher capital expenditures of green firms.

Secondly, this paper finds that the non-green portfolio outperforms the benchmark portfolio of the S&P 500 Energy Index. This finding is in line with the paper of Ng & Zheng (2018), who find approximately similar values for alpha, however they find less significant alphas compared to this paper. The paper of Liston (2016) also underlines the findings of this paper. The author presents positive and mostly significant Jensen's alpha values of 0.6 for approximately the same sample period as the current paper, using GARCH estimations to turn data into results. Also, Angel & Rivoli (1997) suggested that sin stocks have higher abnormal

returns compared to conventional stocks. This suggestion is supported by the findings of this paper, specifically for ecological sin stocks.

Thirdly, this paper finds that the green and non-green portfolio perform equal. This finding confirmed the hypothesis, which was stated in a neutral sense because of a lack of agreement in previous literature. For the shorter time period (1990-2007), this paper finds similar results to the papers of Ng & Zheng (2018) and Tripathi & Bhandari (2012). Both papers find (some) significant higher returns for green stocks compared to non-green stocks. Over the whole time period (1990-2013) however, the non-green stocks display significant higher returns compared to green stocks. This is partly in line with the findings of the papers of Lobe & Roithmeier (2008) and Perez Liston & Soydemir (2010). Both papers find higher returns for stocks regarding corporate social responsibility than for sin stocks, while the current paper looks specifically at the ecological side. This paper finds no premium for investors that invest in green firms compared to non-green firms. However, this is an unexpected finding according to the paper of King & Lenox (2001). The researchers state that higher environmental performance leads to higher financial performance. In this paper, the green and non-green portfolios show high correlation, which leads to nearly equal results.

Next, this paper finds that investor sentiment has a positive impact on abnormal returns of green and non-green stocks. There is no previous literature on the impact of investor sentiment on abnormal returns of green stocks. However, there are some papers that suggest a positive impact. The papers of King & Lenox (2001) and Derwall et al. (2005) suggest that firms that are perceived as eco-friendly have higher financial performance. This paper validates this suggestion. Then, the impact of investor sentiment on abnormal returns of the non-green portfolio is discussed. There is no previous literature that specifically measures the impact of investor sentiment on non-green stock abnormal returns. However, there is literature on the impact of investor sentiment on sin stock returns in general. This paper contributes to the papers of Hong & Kacperczyk (2009) and Kumar & Lee (2006), which suggest that sin stock returns are influenced by investor sentiment. This paper also contributes to the paper of Liston (2016), which finds a positive impact of investor sentiment on returns of sin stocks in general. This paper finds the same impact, narrowed down on non-green stocks.

Finally, this paper finds that the impact of investor sentiment is higher for green than for the non-green portfolio. There is no previous literature to compare this finding with. Therefore, this subject needs further examination to be able to generalize statements about the difference in impact of investor sentiment on green and non-green stocks. The finding of this

paper is relevant because it enables investors to receive a premium when they invest in green and non-green stocks based on a signal of investor sentiment. Stating an investment strategy indicates relevance regarding investor sentiment in an out-of-sample setting, where regressions provide only in-sample conclusions. This investment strategy is outlined in section six.

6 Investment Strategy

This chapter discusses a new strategy, which could entail higher returns compared to a pure green or non-green portfolio. Firstly, reasoning for this investment strategy is explained. Secondly, the results when following this strategy are outlined.

6.1 A Mixed Portfolio

Table 10 provides information that Baker's investor sentiment has a positive impact on returns of both the green and non-green portfolio. Therefore, it would be interesting to know whether a mixed portfolio of green and non-green stocks, based on investor sentiment, would outperform either portfolio. Investor sentiment has the highest impact on the green portfolio. Therefore, a portfolio is constructed where an increase in investor sentiment is linked to an investment in the green portfolio for that month and a decrease in investor sentiment leads to an investment in the non-green portfolio. To be able to trade on the positions in time, the lagged value of the change in investor sentiment is taken.

Figure 6 shows abnormal cumulative returns for the newly formed mixed portfolio, based on the lagged difference of the sentiment survey, and both the green and non-green portfolios. This figure is a visual representation of table 13, showing that the mixed portfolio earns the highest abnormal returns. All three portfolios show similar patterns, but from the year 2000 onwards, the mixed portfolio provides higher returns compared to the green and non-

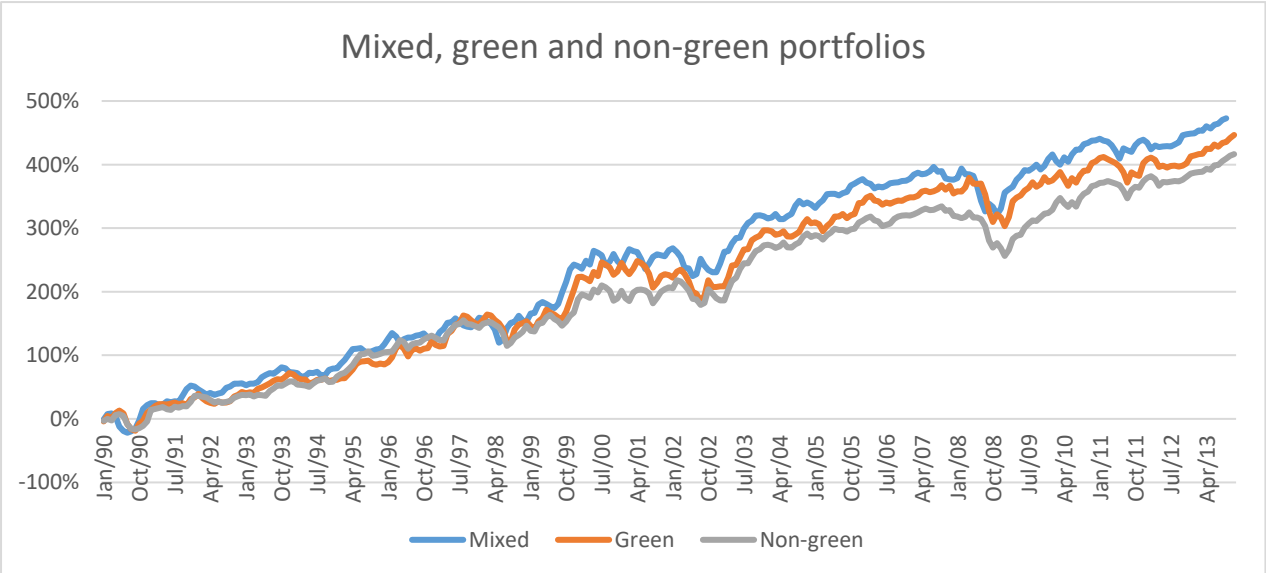

Figure 6: Cumulative returns of the mixed, green and non-green portfolios (1990-2013)

green portfolios. The cumulative abnormal returns for the mixed portfolio are 472.76%, while the green and non-green portfolios provide 446.60% and 416.40% respectively.

6.2 Analysis of the Mixed Portfolio

Table 12 shows results of the time series regression for the mixed, green and non-green portfolios over the total sample period. The table shows significant values for the mixed portfolio, except for the momentum value for the Carhart four factor model. The green and non-green portfolios show approximately equal significant results.

Table 12: Time series regression for the mixed, green and non-green portfolios

	Mixed		Green		Non-green	
1990-2013	FF 3 factor	Carhart 4	FF 3 factor	Carhart 4	FF 3 factor	Carhart 4
Alpha	0.0064***	0.0064***	0.0053**	0.0057***	0.0058***	0.0060***
	(0.0020)	(0.0021)	(0.0021)	(0.0022)	(0.0016)	(0.0016)
Rm-Rf	1.2003***	1.2018***	1.2288***	1.2161***	1.0576***	1.0524***
	(0.0470)	(0.0497)	(0.0501)	(0.0527)	(0.0367)	(0.0387)
SMB	0.9217***	0.9230***	1.0500***	1.0389***	0.8280***	0.8235***
	(0.0685)	(0.0699)	(0.0734)	(0.0748)	(0.0538)	(0.0549)
HML	0.1547***	0.1597**	0.1285**	0.0860	0.1391***	0.1218**
	(0.0527)	(0.0735)	(0.0565)	(0.0785)	(0.0414)	(0.0576)
MOM		0.0056		-0.0475		-0.0193
		(0.0572)		(0.0610)		(0.0447)
Adj. R-squared	0.7955	0.7948	0.7912	0.7909	0.8322	0.8317

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01. Standard error is given between brackets.

All alphas of the three portfolios are significant. The alphas of the mixed portfolio appear to be higher than the ones of the green and non-green portfolios. Table 13 provides the results of the t-test, comparing the mixed portfolio to both the green and non-green portfolios. The table shows that the mixed portfolio significantly outperforms both portfolios. The Sharpe ratio of the mixed portfolio is higher than that of the green portfolio and slightly lower compared to the non-green portfolio. This latter comparison is due to the higher standard deviation of the mixed portfolio. Concludingly, the mixed portfolio is deemed to be the optimal portfolio in this paper.

Table 13: Differences in performance between the mixed, green and non-green portfolios.

1990-2013	Mixed	Green	t-test (p-value)	Non-green	t-test (p-value)
FF 3 factor	0.0768	0.0636	6.4371***	0.0696	3.9755***
	(0.0240)	(0.0252)	(0.0001)	(0.0192)	(0.0001)
Carhart 4 factor	0.0768	0.0684	3.9059***	0.0720	2.5712**
	(0.0252)	(0.0264)	(0.0001)	(0.0192)	(0.0104)
Sharpe Ratio	0.22	0.20		0.23	

* Indicates a significance level below 0.10, ** indicates a level below 0.05 and *** indicates a level below 0.01. Annualized alphas are given for each model, standard error is given between brackets.

6.3 Investment strategy for the mixed portfolio

Table 13 concludes that investors should use changes in investor sentiment as a proxy for an investment in the green or non-green portfolio in each month. The next step is to bridge the gap between theory and practice. When signing up for the investor sentiment survey from the American Association of Individual Investors, investors receive a weekly e-mail containing the expectations of the bull-bear spread of the next six months. Taking the average for each month and calculating the difference per month, provides a proxy for investing in the green or non-green portfolio. When investor sentiment changes positively, one should take a position in the green stocks. When investor sentiment changes negatively, one should take a position in the portfolio of non-green stocks. This analysis includes the lagged values for the change in investor sentiment, making it possible to take a position in the green or non-green portfolio in time. Following these steps enables an investor to receive significantly higher abnormal returns compared to the green, non-green, S&P 500 Energy and market portfolio.

7 Limitations

This section provides several limitations for this research. Ideas for implementations for further research are named next, to provide researchers with an interest in green investing with inspiration for further research.

The first limitation concerns firm characteristics. Table 1 shows several characteristics of the sample of green and non-green firms, for instance total assets, total liabilities, percentage of sales invested in R&D and IPO age. This is not included in the regression model, because this wasn't in line with the focus of this research. Even though the Fama & French estimation model takes some risk factors like size (SMB) and value (HML) into account, further research should examine the impact of these and more firm characteristics on green and non-green performance in a panel regression model

The second limitation concerns the sample of this research. Green and non-green stocks are only taken from the United States. Results of the statistical analysis could be different if stocks from other continents would be added to the sample or used as different subsamples. Stocks concerning socially responsible investing from Continental European and Asian countries perform different compared to stocks from the UK and US when being compared to conventional funds (Renneboog et al., 2008). Therefore further research should take green and non-green stocks from these countries into their sample to examine possible differences between continents.

The third limitation concerns possible cultural differences for investor sentiment. This study uses two measures for investor sentiment, which both contain US data. Baker et al. (2012) suggest however, that the impact of investor sentiment on returns in the stock market is different for different cultures and countries. With this knowledge, investment strategies for investor sentiment could differ per country. Therefore, further research should examine possible differences across countries regarding the impact of investor sentiment on stock returns.

8 Conclusion

This paper examines the impact of investor sentiment on abnormal returns of green and non-green stocks. This research contributes to literature by extending the paper of Ng & Zheng with investor sentiment. It uses two different measurements of investor sentiment, as suggested by Liston (2016). Literature suggested that green and non-green stocks both outperform the benchmark portfolio, while abnormal returns are expected to be equal for both portfolios of stocks. Furthermore, investor sentiment was expected to have a positive and equal impact on returns of both the green and non-green portfolio.

Data of 94 stocks is used for the sample period of 1990-2013. Matching the green to the non-green stocks is previously done by Ng & Zheng (2018) according to several indicators. Data of both investor sentiment measures is gathered from the website of Jeffrey Wurgler and the American Association of Individual Investors. Times series regression is used to turn the data into results.

The findings of this paper are mostly in line with previous papers. Firstly, this paper finds that the green portfolio outperforms the benchmark portfolio of the S&P 500 Energy Index. The same impact is found for the non-green portfolio, which also outperforms the S&P 500 Energy Index. Next, this paper finds that the green and non-green portfolio perform equally for the total sample period, while the green portfolio outperforms the non-green portfolio in 1990-2007. Secondly, this paper finds that investor sentiment has a positive impact on abnormal returns of green and non-green stocks when sentiment survey data from the American Association of Individual Investors is used. The sentiment measure from Baker & Wurgler (2007) provided no significant impact on abnormal returns of both portfolios. Finally, this paper finds that the impact of investor sentiment is higher for the green than for the non-green portfolio.

These findings lead to a specific investment strategy. To be able to trade on information about investor sentiment, investors should use the lagged value for changes in investor sentiment as a proxy to form a mixed portfolio of either green or non-green stocks in a certain month. When investor sentiment changes positively, an investor should take a position in the portfolio of green stocks. When investor sentiment changes negatively, an investor should take a position in the portfolio of non-green stocks. Following these steps enables an investor to

receive significantly higher abnormal returns compared to the green, non-green, S&P 500 Energy and market portfolios.

Finally, limitations and possible implementations in further research are discussed concerning firm characteristics, the sample of this research and cultural differences regarding investor sentiment.

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