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How have ESG-investments performed during the Covid-19 pandemic?

An event study of S&P ESG indices.

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Abstract

In this thesis, we investigate the impact of covid-19 on ESG versions of broad market indices from S&P. We use a cross-market approach and look for abnormal returns in Europe, the US, and the global market. A total of nine ESG indices are used – three from each market – with different approaches to ESG investing. The names of the indices are The Fossil Fuel Free, the Carbon Efficient and the ESG.

Using event study methodology and following Mackinlay (1997) closely we look for abnormal returns 40 days before and after the WHO declaring covid-19 as a pandemic on March 11th. We use a market model for all our data and a two-factor model for a relevant sub-section of our data to calculate abnormal returns. Abnormal returns are investigated immediately before and after the WHO declaration, cumulative abnormal returns in the medium term and buy-and-hold abnormal returns for the full period of the study. We use both a t-test and a sign-rank test of significance of abnormal returns. Furthermore, we use a non-parametric approach to look for any changes to the idiosyncratic risk of our ESG indices.

For the days closest to the event day, results are mixed. In the longer period where cumulative abnormal returns are used, the Fossil Fuel Free indices show positive significant abnormal returns leading up to the event day. The Carbon Efficient indices are a mix of both significant and non-significant negative cumulative abnormal returns following the event day. The ESG indices show both positive and negative cumulative abnormal returns following the event day. In the buy-and-hold approach, only the Carbon Efficient 500, Carbon Efficient 350 and ESG 500 indices are significant. The first two showing negative abnormal returns and the last showing positive abnormal returns. Of these, we consider only the Carbon Efficient 500 index to also be economically significant. These mixed results are further complicated by our two testing methods seldom being in alignment. The picture is clear only when looking at possible changes to idiosyncratic volatility: We find no change in any of the indices in this study.

The Carbon Efficient and Fossil Fuel Free indices react differently to the event and that the different market characteristics play a role in the magnitude of this difference. The ESG indices show signs of regional differences. We believe both these findings can be explained as a stronger tilt towards size in the US and global market than in the European market.

We conclude that these ESG indices are significantly impacted by the event directly around the event day, but in the full event window they are largely unaffected. Their idiosyncratic risk is not impacted by the event.

Preface

This thesis is the final part of our master's degrees in Economics at the Norwegian University of Life Sciences. We wish to thank our supervisor Torun Fretheim and co-supervisor Ole Gjølberg who have supported us throughout the process for their valuable input and constructive criticism.

We also extend a thank you to our friends and family for their support.
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Introduction

The interest in environmental, social, and governance (ESG) investing has increased in recent years. ESG-labeled assets under management (AUM) have increased exponentially as well as the amount of wealth managers professing their intent to follow the UN-backed Principles for Responsible Investment (PRI) guidelines. The environmental-social investment awareness was first published as the U.N. Global Compact 2004 under the title “who cares wins.” The report presented the importance of ensuring the incorporation of environmental, social, and governance factors into investment decision-making. The PRI organization was launched in 2006, and the number of participating members to the principles of PRI “signatories” has increased consistently over time. Over the last year, the number of signatories increased by 28percent, from 2,372 to 3,038. In addition, the collective assets under management (AUM) represented by PRI (2020) signatories increased by 20percent over the same period, from $86.3 trillion to $103 trillion as of March 31st, 2020, as shown in the graph below.

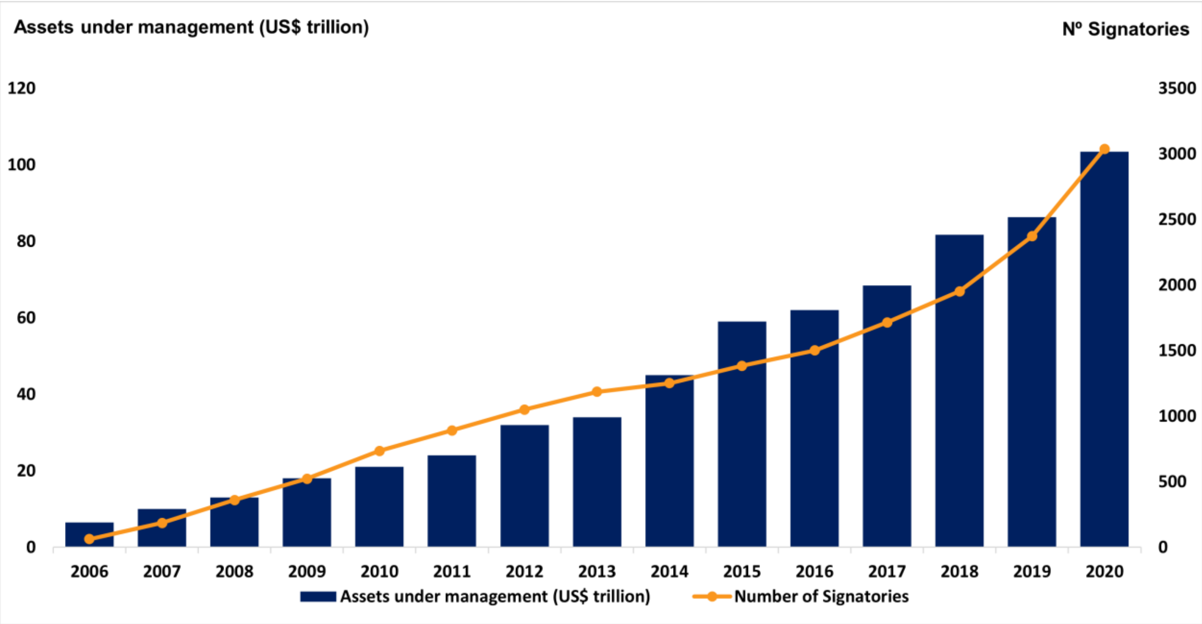

Figure 1: PRI growth 2006-2020

This increase in AUM is perhaps not surprising as the call from politicians and electorates to all of business for greener solutions has been resounding in the last few years - from Green New Deal talks in the E.U. to the Paris Climate accord. In the wake of the veritable deluge of inflow assets to European ESG funds in 2020, this market segment now has over a trillion euros under management (Morningstar, 2021). Additionally, with the E.U. Sustainable Finance Disclosure Regulation coming into effect on March 10th, 2021, all European funds will be classified as either “Sustainable,” “General ESG,” or “All Funds” (E.U., 2019). This is a large step in the direction of a common and comparable definition of ESG across financial markets and away from what Blackrock has called the current “alphabet soup… [of standards]” (Financial Times, October 2020). Together, this illustrates the current appetite for ESG investing and begs the question: Why the increased demand for this sort of investment category? Reducing the investment universe by excluding companies on strictly non-financial terms has long been seen as a sure-fire way of sacrificing returns. If this is true, the preference for ESG-investments over non-ESG ones regardless of – at least moderate – differences in return and risk characteristics could be explained in a simple utility-maximizing framework: Consider an investor concerned with climate change. A dollar in return from a wind farm is preferable to a dollar in return from oil due to the investor’s disutility of emissions from production or consumption. Andersson, Bolton, & Samama (2016) outline a more standard financial approach concerning the environmental part of ESG by conceptualizing investing in low-carbon versions of large benchmark indices as having a “free option on carbon.” Environmental investments are less exposed to the risk of Carbon - either in terms of possible future, stricter Greenhouse gas (GHG) emission regulations or taxation, or changes in consumer preferences. We provide a more comprehensive look at ESG in the next section. Thus, an investor could shift their holdings away from high-intensity GHG-emitting businesses without sacrificing returns - given that the market does not currently appreciate this inherent risk. But does the adage “doing well by doing good” hold true?

The market crisis following the outbreak of covid-19 is the first crisis since the ESG asset class has been thoroughly established. In this thesis we investigate the impact of the pandemic on ESG investments. We use an event study to look for any abnormal returns or changes to the idiosyncratic risk of ESG investments following the onset of the pandemic. The methods are primarily based on the work of MacKinley (1997) and Brooks (2019). We use broad market indices from S&P to alleviate concerns about survivorship bias and different risk characteristics of actively managed ESG funds. We will use data from the U.S., Europe, and globally to make the findings more robust to local market-specific occurrences. In the broadest possible sense, a non-ESG investment could be a market portfolio as represented by a broad market index. That is not to say that none of the companies in such an investment could be classified as ESG - but rather that a market portfolio investment itself is not made according to ESG principles. (Further explanation for this reasoning can be found in the separate ESG chapter) Our benchmark and stand-in for all non-ESG investments will therefore be broad market indices from S&P.

Now that the stage is set in this first (1) Intro chapter, the remainder of the thesis is structured in chapters as follows: (2) Definitions of ESG, as it has been mentioned many times already. After that, we present the relevant (3) Literature Review. Following that, the (4) Methods we use are described with the (5) Data chapter right after. Finally, the (6) Results and (7) Conclusions.

Concepts and definitions in ESG investing.

Today there are many overlapping or interchangeable terms when talking about any non-financial concerns when investing. We therefore include some definitions of how we use the terms in this thesis. We will start with an overview of ESG factors, and we will be using the United Nations Principles of Responsible Investments as well as the CFA institute definitions. Then we look at how ESG factors are or could be implemented.

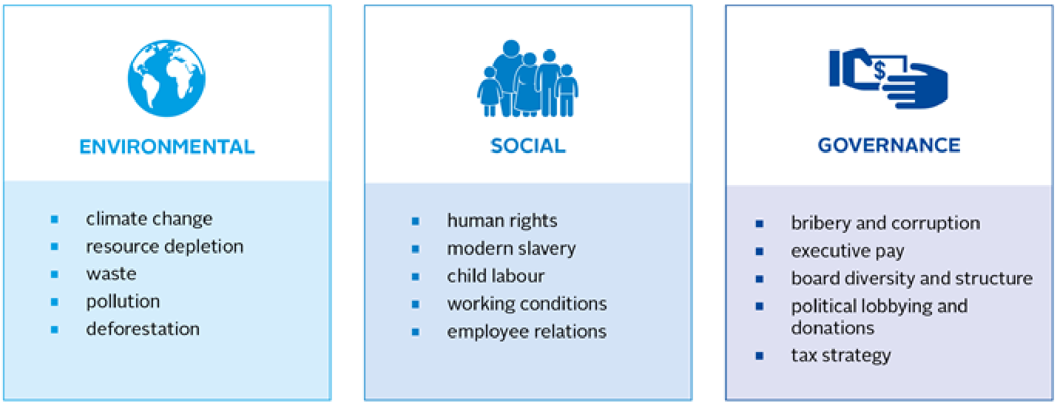

Figure 2: Breakdown of ESG factors. Figure from UNPRI

These are examples and not an exhaustive list of each category. Generally, the three categories will address different parts of a business. The environmental part (CFA, 2018) includes impacts such as waste management - which could be linked directly to a factory - and fuel management in the transport sector. A distinction here is that waste treatment - while laudable and most times indeed mandatory - is costly, fuel consumption concerns are naturally part of any profit-maximizing company. The ESG risk regarding wastewater would be in relation to the people coming into contact with this waste, as we saw with Hydro in Brazil 2018. Fuel, in an ESG sense, would be the external effects of the GHG emissions associated with the consumption of fuel. Social concerns are related to the people involved in the business. It is concerned with working hours, workers having a living wage, workplace safety conditions and other facets of the employer-employee relation. In modern terms, this extends to supply chains and has come into light in recent years following the Rana Plaza collapse as well as child labour in rear earth mining. The final part, governance, is related to the conduct of the executives and leaders of the company. The UNPRI list above mentions board diversity and corruption. These are, at least in some countries, both regulated by law. Lobbying, on the other hand, is a legitimate strategy in a legal sense but can still hurt the brand if the lobbying garners unwanted attention toward some actual or perceived malpractice or attempt at regulatory capture (CFI, 2018).

Several approaches are used regarding the implementation of ESG measures. An outline of the most common ones follows below.

Incorporation: CFA (2018) argues for the incorporation of ESG measures in normal financial analysis, and the term they use is “ESG integration.” They argue that those ESG measures that are seen as material factors are included in the same way as other business economic or financial factors are included. It is not the exclusion of non-ESG sectors (heavy polluters) or countries (high risk of corruption) as such, but an inclusion of the ESG risk of such investments.

Negative screening: Is the exclusion of certain companies or sectors based on their ESG performance in absolute or relative terms. The Norwegian central bank (norges-bank, 2021) excludes certain companies from the investment universe of the Norwegian Pension Fund based on company practices or production. This is called negative screening, and it is a relatively common practice to exclude tobacco and weapons from any exchange-traded fund (ETF) or other institution that has such an investment approach. A softer version of the negative screening exists where the companies are ranked by ESG, usually within sectors, and some threshold is implemented as to how low on the ranking an investment can be made. This is a common enough approach to be available in large investment management firms.

ESG investing has some adjacent and sometimes overlapping terms that we address briefly.

Impact investment: Such investments are made to first and foremost bring about some social good. The financial returns are purely secondary or only relevant as it allows for the furthering of the investment program. More akin to indirect philanthropy than investments for financial gain.

Socially Responsible Investing: It is used as an umbrella term to encompass all forms of investment based on non-financial reasons. At other times, it is used to describe an investment philosophy with a balance of returns with social improvements.

Literature Review

ESG-Investments are a type of investment that does not strictly consider short-term financial factors but also considers environmental, social, and governance factors. Many studies were published to investigate the effects of ESG factors on financial performance and valuation.

The relationship between ESG factors and financial performance

A meta-study by Friede, Busch, & Bassen (2015) examined the results from more than 2,000 empirical studies and 1,816 vote count studies based on the relation between ESG and Corporate Financial Performance (CFP). The analysis finds that almost 90percent of the studies found a non-negative relationship between CFP and ESG factors. The study concludes a neutral or mixed ESG–CFP performance relation for portfolio studies and a positive ESG-CFP relation from a company-focused perspective. However, misinformation or lack of knowledge in the field of ESG investments can generate negative results damaging the ESG-CFP relation.

Another meta-study done by Clark, Feiner, & Viehs (2015) examined the results from more than 200 academic studies. The study outlines a comprehensive knowledge base on sustainability. The study finds that there is a positive correlation between involved ESG business practices and financial market performance. The authors further reviewed 41 papers on the relationship between ESG factors and financial performance. The study shows that 33 papers (80percent) indicate that sound ESG practices positively influence companies' stock price performance.

An empirical study conducted by Velte (2017) for the German capital market includes 412 firm-years observations listed on the German Prime Standard (DAX30, TecDAX, MDAX) in a short period from 2010 to 2014. The study uses regression analysis and correlation to assess any possible relation between ESG factors and financial performance. The study finds that ESG factors have a positive effect on the company's financial performance and that governance has the most substantial positive effect on financial performance compared to the environmental and social elements.

Fatemi, Glaum, & Kaiser (2018) conducted an empirical analysis that covers 1,640 publicly traded U.S companies in the period 2006 to 2011. The study uses regression analysis and specifically a two-stage least squares model to assess the relation between ESG performance and ESG disclosure on the one hand and the company value on the other hand. The study shows that the relation between the effects of ESG activities on a specific firm is directly linked to the firm's ESG-associated disclosures so that high ESG ratings increase firm value and that low ESG ratings decrease it. According to the study, the impact of disclosures differs depending on other various factors; for example, a positive impact may be predicted since disclosures reduce information asymmetries, which helps the investors comprehend the firm's ESG points of strengths and weakness. Even though ESG disclosures might endanger firm value, if the investor linked them to cheap advertising or greenwashing, generally, any type of negative marketing would harm the firm value. Research stated that firms and industries with ESG concerns often benefit from ESG disclosures; however, those with ESG strengths generate lower valuations when publishing-related disclosures. The paper argues that to reasonably assess the effects of ESG disclosures, one must be aware of the hidden meanings behind the disclosure; instead of just assuming that the firm is empowering its strengths and hiding its weakness, one must understand that more can be picked up from a firm disclosure. Disclosures can be used to announce policy changes and enhance the firm reputation; for example, environment harming firms can alter policies and make them more ESG considerate to avoid alienating investors.

A study conducted by Unruh et al. (2016) called "Investing for a Sustainable Future" was based on a subsample of a global survey of managers about corporate sustainability. The original survey included 7,011 respondents from 113 countries, and the study covered 3,057 respondents from commercial companies. The study finds that 74percent of investors and private managers agree that good sustainability performance matters more to investors today than three years ago, while 65percent of public companies' managers agree with the statement. In addition, the study finds that 76percent of private managers think that a good sustainable performance has a positive impact on investors' decision to buy shares in the company, while 68percent of investors and 55percent of public managers agree with the statement. The study shows that most participants consider sustainability activities essential to be competitive in the future.

Ashwin Kumar et al. (2016) used a quantitative model to analyze the relation between risk-adjusted performance and ESG factors. The study examined 157 companies listed on the Dow Jones sustainability index (DJSI) and 809 non-listed companies for a period of two years. The study finds that companies that incorporate ESG factors seem to generate higher returns and have lower volatility than other companies in the same sector. They further find that the effect of ESG factors differs among various sectors.

Han, Kim, & Yu (2016) covers listed firms in the Korean stock market (KOSPI) in the period 2008-2014. The study used linear and non-linear regressions to analyze the relationship between corporate profit and corporate social responsibility and test the effect of the ESG performance score on the firms' financial performance. The study found diversified results:

1. The environmental factor score has a negative relationship with financial performance.
2. The governance factor score has a positive relationship with financial performance.
3. The social factor score has no relationship with financial performance.

ESG and financial performance during covid-19

Broadstock, Chan, Cheng, & Wang (2020) conducted an event study using data covering China's CSI300 companies. The study found that portfolios with high ESG ratings perform better than portfolios with low ESG ratings during crises. And ESG performance has a positive correlation with short-term cumulative returns during the covid-19 pandemic. The study shows that stocks with high ESG performance are flexible during financial crises, which suggests that investors will look to the ESG performance as a signal for stocks' future performance during crises.

Döttling & Kim (2020) shows the impact of the covid-19 pandemic on retail investor demand for ESG mutual funds. The study consists of 2,720 retail funds and 2,421 institutional funds in the period from January 4th 2020 to April 25th 2020. Through regression analysis, the study finds that funds with high Morningstar sustainability ratings had a sharper decline in net inflows and increased net outflows compared to average funds during the market crash and post-stimulus recovery weeks. The cross-country variation examination suggests that countries with lower economic growth, more covid-19 restriction procedures (e.g., lockdowns), or lower financial support (e.g., stimulus packages) suffer asymmetrical lower retail flows, and the drop in ESG fund inflows was more noticeable during the covid-19 pandemic. The study suggests that retail investors view sustainability as a luxury good and that it is not preferred under extreme economic conditions that impose binding financial constraints.

Folger-Laronde et al. (2020) analyzed the relationship between the financial performance of exchange-traded funds (ETFs) in Canada and their ESG ratings during the covid-19 pandemic using ANOVA multivariate regression models. The study covers a sample of 278 ETFs. The research implies that during a sharp market crash, higher ESG rating levels for ETFs do not protect investments from financial losses.

Díaz, Ibrushi, & Zhao (2021) covers daily data for companies trading in the U.S. stock market from January to April 2020. The research uses regression models to examine the effect of ESG ratings on different industry returns during the covid-19 pandemic. The study uses the control variables from Fama-French and an ESG factor which measures the spread in returns between the top and bottom quarter of firms based on their ESG rankings. The study finds that industry returns are positively correlated with high ESG ratings and that the impact of the ESG ratings on various industries is mainly driven by environmental and social factors. The study results show that ESG factors have:

1. Positive effect on Communications, Consumer Staples, and Technology industries.
2. Negative effect on Consumer Discretionary, Industrials, Energy, Financial and Real Estate industries.
3. No effect on Utilities, Materials, and Health industries.

He, Sun, Zhang, & Li (2020) covers daily data for 2,895 companies listed on the Shanghai and Shenzhen A-share market in the period between June 3^rds 2019 to March 13^th 2020. The study uses an event study method to analyze the effect of the covid-19 pandemic on the financial performance of various sectors in the Chinese market. The study finds that there was a variation across sectors. Some sectors were resistant to the pandemic, e.g., information technology and health care industries, while other sectors were affected negatively, e.g., electricity and heating, and transportation.

Omura, Roca, & Nakai (2021) investigated the performance of ESG investments during the covid-19 pandemic. The study applies asset pricing models and analyzes daily data for 24 ESG Exchange-traded funds (ETFs) in the U.S. and four MSCI SRI indices for the U.S., Europe, Japan, and the world between January 1^st 2018 and June 24^th 2020. The study shows that before and during the covid-19 pandemic, ESG/SRI indices had abnormal returns, and they were significantly positive except for Japan. The same results apply when using Sharpe ratio SRI indices outperformed their benchmarks except for Japan which failed to do so. For ESG Exchange-traded funds, ETFs failed to outperform their benchmarks before and during the covid-19 pandemic both in terms of Sharpe ratio and returns.

Event study methodology

We use event study methodology to examine the impact of the covid-19 pandemic on various ESG indices. This chapter will cover all the methods used in the results chapter.

Event studies in any field of study try to measure the impact of the event in question against the hypothetical that the event did not occur. In finance and economics, stock returns are typically examined. Much work has been done employing event studies on dividend announcements, merger announcements, stock splits, et cetera. We follow the roadmap as laid out by Mackinlay (1997).

1. Define the event of interest and its window in time.
2. Measure the impact of the event on the stocks in question.
    a. Choose a model for estimating normal returns.
    b. Choose when the model parameters should be estimated.

In our thesis, the event is the covid-19 pandemic which is somewhat different from events such as dividend increases. A dividend increase is clearly defined in time as they are presented by the company on a given day. The realization of the severity and scope of covid-19 may have come about at different times in, say, Italy than in the U.S. This might stagger the investor response and lead to a protracted period of readjustment, making it difficult or even impossible to find a single event day. Looking at the S&P Global 1200 in 2020: The price was relatively stable in the beginning of the year and then between February 20th and March 21st it dropped almost 1,000 points or about 30 percent.

Figure 3: S&P Global 1200 total returns, 02.01.2020 – 25.03.2020 rebased 02.01.2020=100

On March 11th, the WHO declared covid-19 to be a pandemic. It was done at 17:15 GMT. We use the following trading day as the event day to be sure all market participants have had a chance to respond. Our event day is therefore March 12th. Next, we define the event window. It is in this period we assume the entire event takes place, and outside the event window the event has no influence on stock prices. As the likelihood of committing a type two error decreases with sample size (holding all else constant), we use daily data instead of weekly or monthly. The event window has a limiting factor as our indices are reconstituted in May each year, leaving us 48 daily observations after the event day for calculations not affected by reconstitution. We reduce the event window to 40 days before and 40 days after the event day (March 12th) to reduce the risk of other factors influencing the results. In total the event window is 81 days. With the event window defined we move on to the estimation window. This is the time where the sample used in model estimation is drawn. The estimation window and the event window should not overlap as that would cause the event to influence the modeling of normal returns – Mackinlay (1997) warns against this. We use 200 observations which is considered normal by Mackinlay (1997) and reasonable by Armitage (1995).

Together, this gives the following timeline:

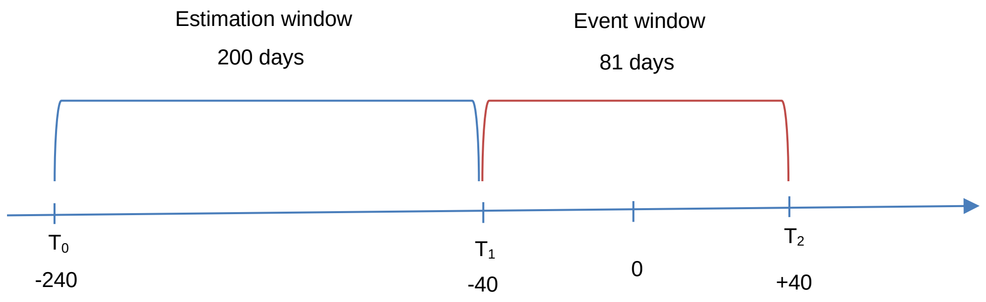

Figure 4: Event study timeline

T_0 is the start of our estimation period, T_1 to T_2 is the event window with the event day March 12th at t=0.

At this point, it is important to note that our event is not the only event that may have affected markets in March 2020. OPEC+ did not agree to cut oil supply as much as they believed demand would fall by, bringing the oil price out of equilibrium according to fundamental analysis. Following this, the price of oil fell by some 24 percent on March8th. This is problematic, as an event study is meant to capture the impact of a single event, and the results could be biased if influenced by multiple events. We do, however, argue that neither the demand-side drop nor the supply-side refusal to reduce production are completely separate events to the pandemic. Demand was reduced following business lockdowns and travel restrictions, and the OPEC+ countries would take an additional hit to tax revenue in an especially trying fiscal period should they reduce production.

With the timeline established we move on to defining normal returns. The market model represents the relation between the return of a stock and the return of the market portfolio, and it is assumed that there is a linear relationship between an individual stock's return and the market return. Mackinlay (1997) considers the market model a possible improvement over the constant mean return model, and market models are the most frequently used (BRENNER, 1979).

The market model is defined as follows:

$$R_{i,t} = \hat{\alpha}_i + \widehat{\beta_i}\, R_{m,t} + \varepsilon_{i,t} \tag{1}$$

Where:

$R_{i,t}$ is the return of the ESG variant index i at time t.

$\hat{\alpha}_i$ is the excess return of holding the asset i.

$\widehat{\beta_i}$ is the measure of systematic risk.

$R_{m,t}$ is the return of the market at time t.

$\varepsilon_{i,t}$ is the residual or the error term.

The beta shows the proportion of the return that can be explained by the market.

For a relevant sub-section of our data, we expand the model to a two-factor model by including the oil price:

$$R_{i,t} = \hat{\alpha}_i + \widehat{\beta_i}\, R_{m,t} + \widehat{\beta_o}\, R_{o,t} + \varepsilon_{i,t} \tag{2}$$

Where:

$R_{o,t}$ is the oil price at time t.

$\widehat{\beta_o}$ is the effect of oil price at time t.

and $R_{i,t}$, $\hat{\alpha}_i$, $\widehat{\beta_i}$ and $\varepsilon_{i,t}$ are defined as in equation (1)

Both models are fitted during the estimation window and fitted values in the event window are considered normal returns. Abnormal return is the actual return on the asset minus the normal returns on a single day in the event window.

$$AR_{i,t} = R_{i,t} - \left(\hat{\alpha}_i + \widehat{\beta_i}\, R_{m,t} \right) \tag{3}$$

$AR_{i,t}$ is the abnormal return, $R_{i,t}$ is the actual return, and $\left(\hat{\alpha}_i + \widehat{\beta_i}\, R_{m,t} \right)$ is the predicted return for the time period t.

After calculating the abnormal return, we calculate the cumulative abnormal returns (CAR) by summing the abnormal returns in different sub-periods of the event window, T_i to T_j where i is smaller than j:

$$CAR_i(T_i, T_j) = \sum_{T=T_i}^{T_j} AR_{i,t} \tag{4}$$

Aggregating the returns is done to allow for the market to absorb and react to the event. Both AR and CAR are often averaged across multiple stocks to account for individual differences in company performance. Since we are using broad indices, such averaging is not useful and we do not include it.

Looking at the event window as a whole we use the buy-and-hold abnormal return (BHAR). This is the measure that is most in line with the experience of a long-term investor as it is the same as the holding period return. Since we believe ESG investors are long-term investors we include this measure. Even if our event window is not "long term" it is significantly longer than "short term" event studies that are concerned with a few days around the event. The formula for BHAR is:

$$BHAR_i = \left[\prod_{t=T_1}^{T_2} (1 + AR_{i,t}) - 1\right] \tag{5}$$

The statistical significance of AR and CAR can be tested with a two-sided t-test with the null hypothesis of there being no abnormal returns. In our case, we want to test whether the covid-19 pandemic has a significant impact.

For AR, the formula for significance testing is given below:

$$SAR_{i,t} = \frac{AR_{i,t}}{VAR\left(AR_{i,t}\right)^{1/2}} \sim N(0,1) \tag{6}$$

Where $SAR_{i,t}$ is the standardized abnormal return and the variance of the abnormal return using the market model is:

$$\sigma^2\left(AR_{i,t}\right) = \sigma^2 \varepsilon_i \tag{7}$$

MacKinley (1997) states that it is common to use an estimation window of 120 days or more. Armitage (1995) argues that an estimation period should contain between 100 to 300 days if daily observations are used in the analysis. As mentioned, we use 200 observations.

For CAR the formula for significance testing is given below:

$$SCAR_i\left(T_i, T_j\right) = \frac{CAR_i\left(T_i, T_j\right)}{VARCAR_i\left(T_i, T_j\right)^{1/2}} \sim N(0,1) \tag{8}$$

Where $SCAR_i\left(T_i, T_j\right)$ is the standardized cumulative abnormal return, which is the t-value for the index in a specific period, and the variance of the cumulative abnormal returns being:

$$VAR\left(CAR_i\left(T_i, T_j\right)\right) = \sum_{T=T_i}^{T_j} VAR\left(AR_{i,t}\right) \tag{9}$$

The t-statistic and variance of BHAR follow the same calculation as the variance of CAR adjusted for using the entire estimation window (81 observations).

The t-test is a parametric test with assumptions of a normal distribution and equal variance. As can be seen from the equations above, the variance is taken from the estimation period. Should the variance increase in the event, we would be at risk of rejecting the null of no abnormal returns when it is true – a type one error. Such time-varying volatility or heteroskedasticity clustering has long been part of financial research, as indicated in the overview by Bollerslev et al. (1992). Basic testing (Breusch-Pagan) rejects homoskedasticity at the normal 5 percent level in an autoregressive one-lag model in the full data set but is mostly *not* rejected for a model fitted in the event window (see Appendix). As such, the t-statistic may not be reliable. To remedy this, we include a non-parametric test of CAR as well, namely the Wilcoxon (1945) test of sign-rank. The non-parametric test has less statistical power, meaning we are more at risk of a type two error using the Wilcoxon sign-rank test rather than the t-test, so it is not a dominant strategy in testing. The Wilcoxon test is used on the residuals of the market model, with under the null that they are not significantly different from zero. The residuals are ordered by size of absolute value. The rank-sign is obtained by reintroducing the sign to the value. The positive and negative values are then summed separately:

$$W_t = \sum_{i=1}^{n} rank(AR_{i,t})^+ \qquad (10)$$

The probability of arriving at any number *r* is given by the equation (12) as described in Wilcoxon's original paper:

$$P = 2\left[1 + \sum_{n}\left(\sum_{i=n}^{i=r-\binom{n}{2}} \Pi_n^i\right)\right]/2^q \qquad (11)$$

Where n is the sample size.

We use a longer time span than what is possible for the t-statistic of CAR due to the sign-rank being a discrete variable, and as such, any set of pairs less than five would not leave us enough observation to achieve significant results at normal levels ($1/4^2$=0.0625). We choose ten as the smallest sample size. The test itself is a z-score, approximating a normal distribution for a sample size larger than ten, with mean and standard deviation:

$$\mu_w = \frac{n(n+1)}{4}, \qquad \sigma_w = \sqrt{\frac{n(n+1)(2n+1)}{24}} \tag{12}$$

The z-score is then calculated using the largest sum of W (equation 10) in absolute terms:

$$z_{Wilcoxon,t} = \frac{W - n(n-1)/4}{\sqrt{(n(n+1)(2n+1)/12)}} \tag{13}$$

If the z-score of the sum of either the negative or positive signs is larger than the critical value at the chosen significance level, the two samples are not likely to be part of the same distribution, meaning that the CAR is significantly different from zero.

Moving on, we investigate the possible impact the pandemic had on idiosyncratic risk. Idiosyncratic risk is the risk taken that *could* have been avoided by holding the market portfolio – often represented as the error term in a market model. Idiosyncratic risk is taken by holding an ESG portfolio of any kind but using broad market indices in our thesis, we would assume that even an ESG restricted index is still well diversified. Nevertheless, our testing indicates (see Appendix) that volatility is time-dependent also in the market model meaning the magnitude of idiosyncratic risk taken on by an ESG investor could significantly change in our event window. In Lee and Mauk (2016), idiosyncratic volatility is measured as residuals from a market model regression. When a model of equal sample size is fitted before and after an event, the residuals can be compared with a paired sign-rank test as described by Wilcoxon (1945). This non-parametric test can indicate if the two samples are from the same distribution or not. First, two simple OLS regression models of equal N are estimated. These are market models regressing the ESG variant on the benchmark index. Residuals are collected from both regressions and paired according to |t| before and after the event. The difference between them will be a positive or negative number or zero. The testing itself is the same as the CAR test described above (equation 10-13). In our case specifically, this approach shows whether the idiosyncratic volatility of ESG investment changed in the event window - before and after March 12th.

Data Description

We use data from S&P Dow Jones as it is well known, well used, and has the necessary global approach. Data is collected from the S&P global web pages. S&P provides multiple approaches to ESG index investing where the companies in the ESG index are all drawn from a parent index but with a combination of exclusion and weighting criteria. European and US markets are the largest for ESG investing (Morningstar, 2021). Since these two markets are both represented in the S&P Global 1200, we also treat them separately to highlight any market-specific differences in the event. The benchmark for the US market is the S&P 500, and for the European market it is the S&P Europe 350.

We must use identical ESG variants of each parent index for cross-market comparison. This limits our data to three ESG variations that are in common for the global, US, and European markets. These are the

1. S&P ESG
2. S&P Carbon Efficient
3. S&P Fossil Fuel Free

As such, our sample consists of nine ESG indices, three from each of the S&P Global 1200, S&P 500, and S&P Europe 350 indices. They are all reconstituted yearly and rebalanced quarterly. We will present a breakdown of the three benchmarks and present the most important aspects of the three ESG indices compared to the parent. All index information is from the S&P index fact sheets.

The S&P Global 1200 is a broad market capitalization-weighted index that consists of approximately 1200 global companies from 30 countries and captures 70percent of the world market cap – about $60 trillion. As such, it is commonly used as an index to represent the world economy. It contains companies from all the Global Industry Classification Standard (GICS) sectors. The largest three sectors in terms of weight are the information technology sector, the financial sector, and the consumer discretionary. Together, these three sectors make up approximately 50percent of the total index.

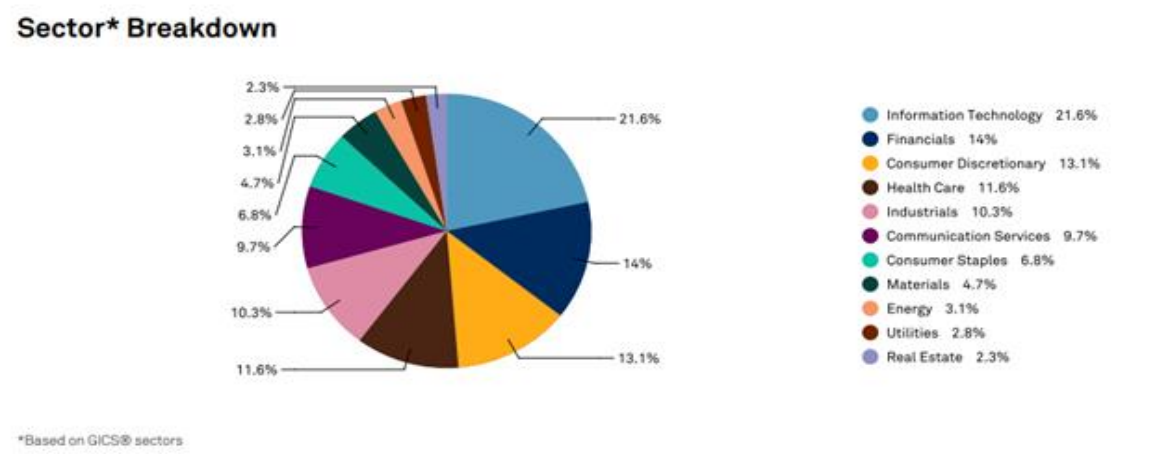

Figure 5: S&P Global 1200 Sector breakdown based on GICS® sectors.

The S&P 500 is a market capitalization-weighted index. It is considered the best gauge of large-cap U.S companies. The index contains the largest 505 companies in the US with a total market cap of $37 trillion– about 80 percent of available market capitalization. The largest three sectors in the index are the information technology sector, the health care sector and the consumer discretionary sector. Together, these three sectors make up approximately 52 percent of the total index.

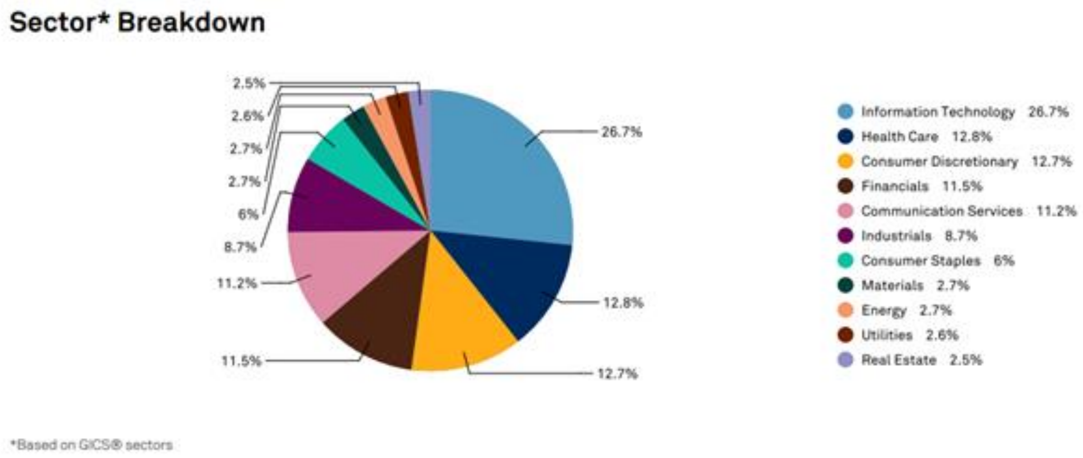

Figure 6: S&P 500 Sector breakdown based on GICS® sectors.

The S&P Europe 350 contains 363 leading companies from 16 developed European markets with a total market cap of about $13 trillion. The largest three sectors in the index are the financials sector, the industrials sector, and the health care sector. Together, these three sectors make up approximately 45 percent of the total index.

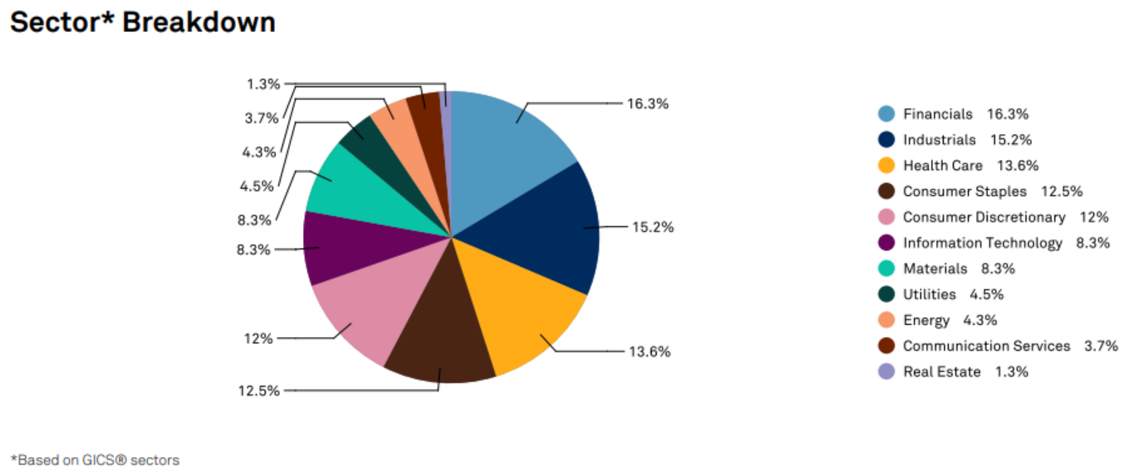

Figure 7: S&P Europe 350 Sector breakdown based on GICS® sectors.

The ESG indices we use all draw their companies from their relevant parent index. The ESG indices are made up of the top 75 percent ESG-scoring companies in the parent index. The Carbon Efficient indices re-weigh the companies in the parent index after the ranking. The Fossil Fuel Free indices have no ranking criteria. The exclusion criteria and re-weighing methodologies that are used in each index are presented in the table below.

Table 1: ESG indices exclusions and ranking methodologies.

Indices	Exclusions	Ranking
S&P ESG	• The lowest 5percent United Nations Global Compact (UNGC) companies. • Thermal coal, tobacco, and controversial weapons manufacturers. • Companies with an S&P DJI ESG score that falls within the worst 25percent of ESG scores from each Global Industry Classification Standard (GICS) industry group.	• Companies are given an ESG score by industry sector and ranked within their sector.
S&P Carbon Efficient	• High, non-disclosing carbon emitters.	• All companies are sorted into the GICS sectors and then ranked according to a modelled carbon footprint per unit of revenue.
S&P Fossil Fuel Free	• Companies that own any fossil fuel reserves directly or indirectly.	

The exclusion criteria above lead to differences in the indices as listed below. The Carbon Efficient and ESG indices aim to maintain sector composition and at least 60 percent of the free float market cap of the parent index. S&P do not list if the ESG and Carbon Efficient indices achieve this goal - only the mean and median total market cap of the companies are listed.

Table 2: Key differences among ESG indices and their parent index

Indices	Num. of constituents	Mean total market cap*	Median total market cap*	Sum sector difference from parent index (%)	Top ten largest companies' (%) of index weight
Global					
S&P 1200	1223	52	24	-	17
S&P 1200 ESG	751	59	27	2.7	23
S&P 1200 Carbon Efficient	1207	51	24	1.7	19
S&P 1200 Fossil Fuel Free	1162	51	24	2.7	18
USA					
S&P 500	505	73	30	-	27
S&P 500 ESG	291	91	35	2.5	36
S&P 500 Carbon Efficient	500	74	30	2.8	28
S&P 500 Fossil Fuel Free	488	74	30	2	28
Europe					
S&P 350	363	29	18	-	19
S&P 350 ESG	227	38	23	1.5	27
S&P 350 Carbon Efficient	359	36	22	1.6	19
S&P 350 Fossil Fuel Free	344	29	18	5	20

*market cap equal to billion USD for Global and USA and billion Euros for Europe.

The ESG, Carbon Efficient and Fossil Fuel Free indices are all different approaches to ESG investing and they could have different results in our event study.

The S&P ESG indices aim to exclude companies that rank the lowest in terms of ESG score within each sector. As such, these indices have far fewer companies in them than the parent indices. The mean total market cap increases compared to the parents and the top ten companies are a larger share of the ESG indices than in their benchmarks. This means that the largest companies in each sector have gotten the highest ESG rankings and the ESG indices tilt towards the biggest companies in their parent indices. While there are fewer companies in the ESG version than in the parent index, the sector composition of the parent index is largely maintained. Unfortunately, we cannot comment on the exact criteria used in the ranking system as that is proprietary information. The S&P Global publishes a Corporate Sustainability Assessment with the rankings as well as the list of exclusions but does not make public the calculation methods of the score. The current largest exclusion by weight in the S&P 500 is Berkshire Hathaway (1.9 percent). The S&P uses a mix of public information and industry specific questionnaires during the ranking process. This is common practise but also a possible source of conflict of interest or undue influence on the index provider. Even if the ranking must be taken at face value, we see that the ESG investment approach here is not just a simple sector tilt. We expect these indices to have positive abnormal returns as we believe larger companies to be more attractive to investors in times of high volatility. While this is not ESG-motivated directly, ESG ranking and size are in these indices inherently linked.

The S&P Carbon Efficient indices exclude only those companies that S&P hold to be likely high emitters of carbon and also not disclosing such information. This makes the company composition of the Carbon Efficient indices almost identical to the parent indices. The carbon footprint of each company is modelled by Trucost, a research centre owned by S&P Global. While the sector weight is very similar to their parent, the weighting within a sector can be quite extreme. The individual company weight can be reduced by as much as 90 percent or increased to 220 percent compared to the weight in the parent indices. Regretfully, the model used in the calculation of GHG emissions is proprietary information. As such, it is difficult to know in advance if these indices will perform better or worse than their parent indices, so we must make some assumptions. We know that the Carbon Efficient indices ranking system attempts to take into account all emissions from all inputs for any given company. We also know that the Carbon Efficient contains almost all the companies of the parent index but is weighted heavily towards companies that have a low carbon footprint per unit of revenue. We therefore hypothesize that the Carbon Efficient index is a version of the parent that reacts less sharply to changes in energy prices since it generates less carbon emissions per revenue and therefore must use less energy - or fewer other inputs - than the parent index per unit of revenue. Simply put: The companies who are more efficient in their energy use react less sharply to changes in energy prices. Since we know the oil price fell, we expect the Carbon Efficient indices to show negative abnormal returns.

The S&P Fossil Fuel Free indices are free of proprietary ranking systems and represent a clear-cut ESG strategy in the form of a divestment from fossil fuel owning and producing companies. The mean and median size and the fraction of total index weight of the top ten companies do not differ much between the Fossil Fuel Free indices and their parent indices. This indicates that the largest companies in the parent indices are not oil companies. The largest companies excluded are Royal Dutch Shell and Exxon Mobil. In comparison to the other indices, the Fossil Fuel Free indices have clear aspects of sector tilt away from the energy sector. This sector is relatively small in all the benchmarks, and the tilting is therefore also modest. The S&P Fossil Fuel Free 350 has the largest tilt. Since the oil price fell in the period we analyse, we would expect the Fossil Fuel Free indices to have positive abnormal returns.

We see in the Carbon Efficient and Fossil Fuel Free indices two approaches to the problem of carbon emissions in ESG investing - one divesting from companies either producing or consuming fossil fuel, the other weighted away from companies with high emissions per revenue. This highlights the trouble for anyone looking to invest in an ESG version of a broad market index, as these two approaches could have the opposite reaction to changing fossil fuel prices and neither of them take special consideration to the governance or social parts of EGS investment.

Regarding the three benchmark indices, we see some differences between the S&P 500 and S&P Global 1200 versus the S&P Europe 350 indices. The Big Five (Apple, Microsoft, Facebook, Amazon, and Alphabet), being US companies, have a dominant market position in both the S&P 500 and S&P Global 1200 but are not in the S&P Europe 350. We see a tilt towards the sectors of these companies in the indices we look at. We do not know the ESG score nor the carbon emission per unit of revenue of the Big Five, but we would assume the ESG score to be high and the emissions per unit of revenue to be low since they are high-profit, high-profile companies concerned with their public image. We have seen the Big Five rebound quickly (financial times, May 2020), and the often-heard statement that any excess returns from ESG investing could be replicated with a simple factor tilt - size in this case - could be true. In this paper however, the definitions of ESG-investing are open to it being in effect the same as a factor tilt as long as the reason behind the investment decisions is the incorporation of ESG principles.

Descriptive Statistics

In this part, we will present descriptive statistics for the nine S&P ESG indices and their benchmarks. We use log returns of the total return versions of every index. The graphs below are the relative returns of the ESG indices against their relevant parent indices. The period shown includes the estimation window from 09.04.2019 to 15.01.2020 and the event window from 16.01.2020 to 08.05.2020 as well as a few months into the post-event window. We indicate the start and end of the event window with vertical lines and the event day is 12.03.2020.

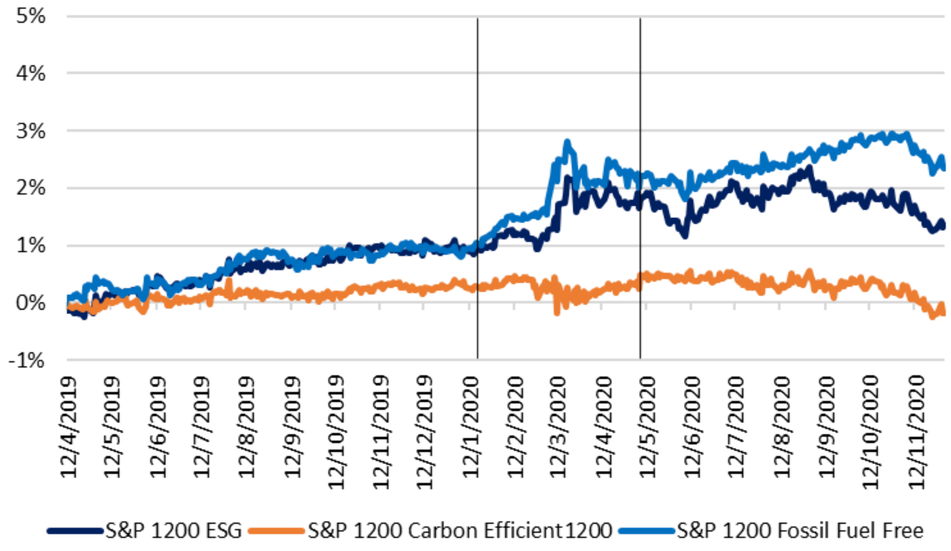

Figure 8: Difference in log returns between S&P Global 1200 and its ESG variants.

In the global market, the Carbon Efficient index has performed the worst staying very close to the parent index. The Fossil Fuel Free is the best performer with the ESG index close behind for the majority of the period. These two indices follow each other more closely in the first half of the period than in the second half. We have previously claimed that the Fossil Fuel Free and Carbon Efficient indices should behave differently in light of the changes in the oil price. This seems to be the case in the global versions.

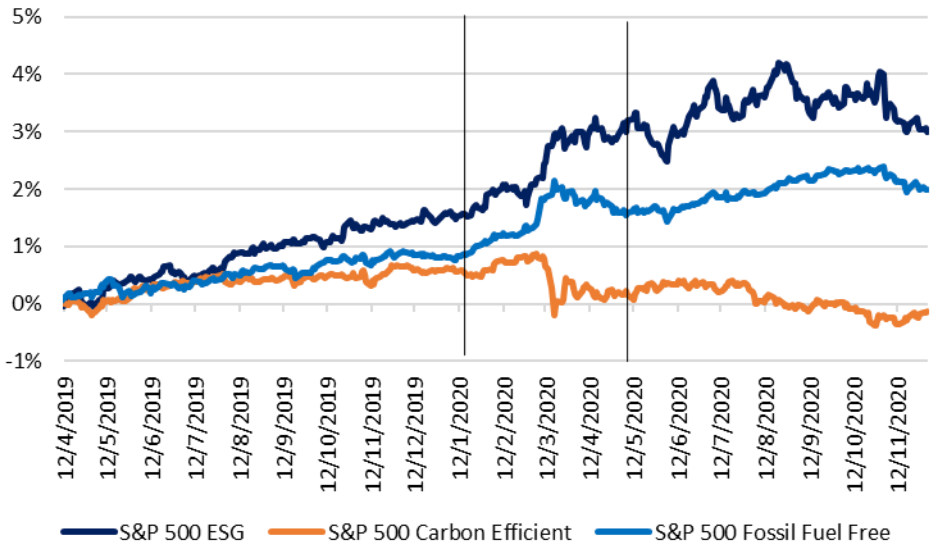

Figure 9: Difference in log returns between S&P 500 and ESG variants

In the US market the Carbon Efficient is the worst performer of the ESG variants. All three indices appear to trend upwards until the 8th of March where the ESG and Fossil Fuel Free indices jump up and the Carbon Efficient index dips. The Fossil Fuel Free and Carbon Efficient indices moving in opposite directions is as expected. The slope of the ESG index does not change much after the jump but the variability seems to increase.

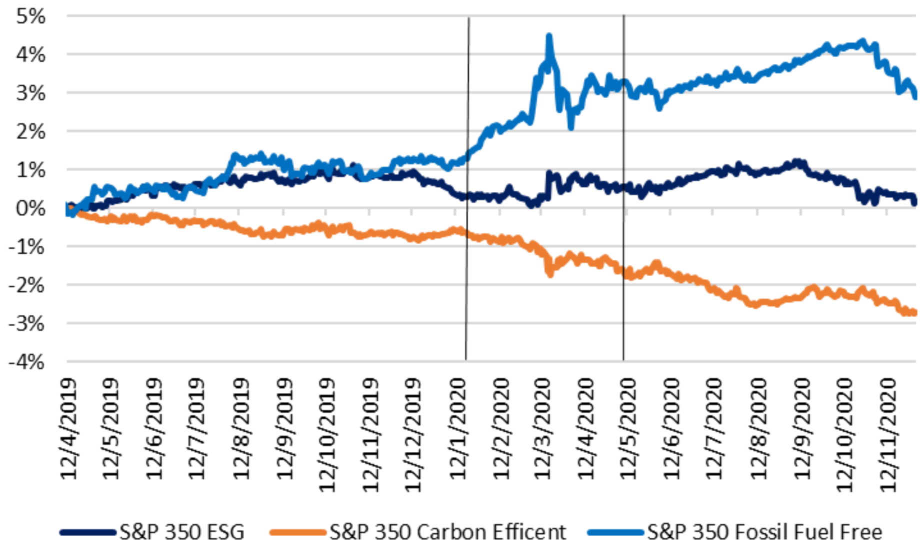

Figure 10: Difference in log returns between S&P Europe 350 and ESG variants

The European market shows the largest spread in relative returns. The Carbon Efficient 350 and Fossil Fuel Free indices end the period with -3 and +3 percent respectively. The ESG index is never below zero but is seldom above 1 percent.

Comparing the returns of the ESG variants, they appear to follow each other more closely before event day than after. There also appears to be more movement in the event window than before and after. This could indicate that our event window is well specified, and that the inclusion of a non-parametric test is warranted.

Table 3 shows mean returns, standard deviations, betas and R^2 for the nine ESG indices in the estimation window from 09.04.2019 to 15.01.2020. The betas and R^2 are from the market model that we use to calculate normal returns. We show only the mean returns and standard deviations in the event window from 16.01.2020 to 08.05.2020 as no model is fitted in the event window.

Table 3: Descriptive statistics, daily log returns, for the estimation window 09.04.2019 – 15.01.2020 and the event window 16.01.2020 – 08.05.2020

	Estimation Window				Event Window	
Indices	**Mean *Ann. (%)***	**St.dev *Ann. (%)***	**β**	**R Squared**	**Mean *Ann. (%)***	**St.dev *Ann. (%)***
S&P 1200	16.2	9.6	-	-	-50.2	45
S&P 1200 ESG	17.3	9.5	0.99	0.99	-47.7	45.2
S&P 1200 Carbon Efficient	16.5	9.7	1	0.99	-50.2	46.3
S&P 1200 Fossil Fuel Free	17.4	9.6	0.99	0.99	-46.9	44.9
S&P 500	21.5	12	-	-	-33.9	54.9
S&P 500 ESG	23.5	12	1	0.99	-29.5	55
S&P 500 Carbon Efficient	22.2	12	0.99	0.99	-34.9	55.5
S&P 500 Fossil Fuel Free	22.6	12.1	0.99	0.99	-31.8	54.6
S&P 350	12.8	11.1	-	-	-63.6	42.4
S&P 350 ESG	13.2	10.9	1	0.99	-63.1	42
S&P 350 Carbon Efficient	12.1	11.0	1	0.99	-66.9	42.5
S&P 350 Fossil Fuel Free	14.4	11.0	0.99	0.99	-57.5	40.3

We see that in the estimation period, the mean returns for all indices are positive with the US indices having the largest returns and the Global indices having the lowest standard deviations in this period. In the event window period, we see large negative mean returns and large standard deviations, which is expected given the market downturn. Even though all returns are negative, the US indices still have better returns than the Global and European indices. European indices have the lowest standard deviation in the event window period. However, neither in the estimation window nor in the event window are there any significant differences in the returns between the ESG indices and their benchmarks nor are there any significant differences in the variances. The R square for all ESG indices is very close to one which means that 99 percent of the variance in the ESG indices returns can be explained by the variance of the returns in their benchmarks. The correlation between each ESG index and its benchmark is close to one in the estimation period. Correlations and betas very close to one is to be expected from indices that aim to follow the benchmark closely.

Results

We first present a graph of the cumulative abnormal returns (CAR) in the full 81-day event window followed by a breakdown of significance testing of the abnormal returns (AR) immediately around the event day. Then we present the significance testing using both our test statistics for CAR followed by buy-and-hold abnormal returns (BHAR) and the results of the idiosyncratic risk test. The results are subdivided by parent index for ease of reading.

S&P Global 1200 and its ESG variants

In the graph of CAR below, all three indices show a clear dip around the event day. The Fossil Fuel Free and the ESG indices move in similar patterns from day three and onward but from different starting points. There is a sharp increase in CAR for the Fossil Fuel Free index in the days before our event day that is likely to do with the falling oil price following disagreements within OPEC+ over oil production cuts. While the Fossil Fuel Free index gains about 1.5 percent from day -40 to day 8, it loses much of these returns by the end of the event window. The Carbon Efficient index stands out as having the smallest movements - hovering around zero in the entire event window. Graphically it is clear that different ESG investment approaches can lead to different outcomes in the global market.

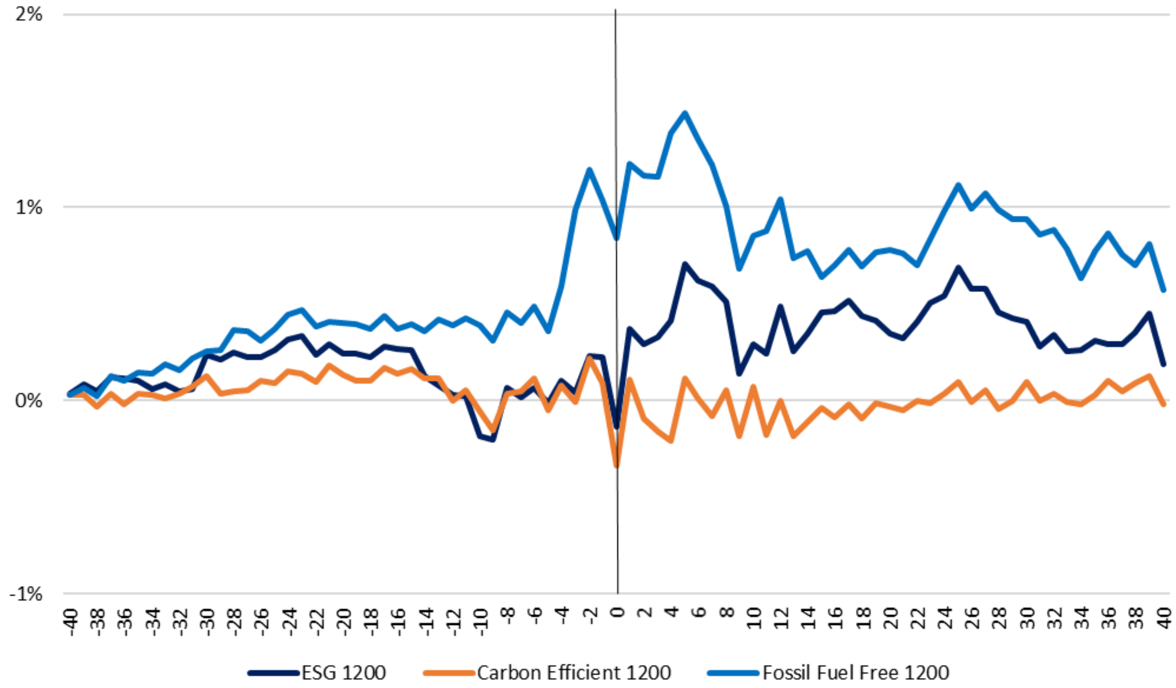

Figure 11: Cumulative Abnormal Returns (-40, +40) for ESG versions of S&P Global 1200

We move on to significance testing of abnormal returns from day -10 to day 10. We see from the table below that all three indices had significant negative abnormal returns on the event day. The Fossil Fuel Free 1200 index had the most days with significant abnormal returns, followed by the Carbon Efficient 1200 and then the ESG 1200 indices. There are many days showing non-significant abnormal returns. This is to be expected as the correlation between the parent index and the ESG variants are all close to one. The significant results are a mixture of negative and positive abnormal returns which is not as we expected. We would have thought the ESG 1200 and Fossil Fuel Free 1200 indices to have mostly significant positive abnormal returns since the ESG 1200 index has larger, possibly more robust companies in it than the parent and the Fossil Fuel Free benefiting from the fall in oil prices. We thought the Carbon Efficient 1200 would have mostly negative abnormal returns also due to the falling oil price.

Table 4: AR and t-values for the ESG versions of the S&P Global 1200

	S&P 1200 ESG		**S&P 1200 Carbon Efficient**		**S&P 1200 Fossil Fuel Free**	
Day	**AR**	**t-value**	**AR**	**t-value**	**AR**	**t-value**
-10	-0.21%	-3.04***	-0.11%	-1.69*	-0.04%	-0.54
-9	-0.02%	-0.24	-0.10%	-1.52	-0.08%	-1.13
-8	0.27%	3.94***	0.19%	2.92***	0.14%	2.07**
-7	-0.05%	-0.77	0.01%	0.22	-0.05%	-0.75
-6	0.05%	0.74	0.07%	1.01	0.08%	1.20
-5	-0.08%	-1.14	-0.17%	-2.54**	-0.13%	-1.83*
-4	0.11%	1.65	0.13%	2.00**	0.23%	3.30***
-3	-0.06%	-0.84	-0.09%	-1.37	0.40%	5.80***
-2	0.19%	2.74***	0.23%	3.52***	0.21%	2.97***
-1	-0.01%	-0.11	-0.13%	-1.95*	-0.16%	-2.27**
0	-0.36%	-5.25***	-0.43%	-6.61***	-0.20%	-2.86***
1	0.51%	7.45***	0.45%	6.85***	0.39%	5.60***
2	-0.08%	-1.19	-0.20%	-3.06***	-0.07%	-0.94
3	0.04%	0.51	-0.07%	-1.03	-0.01%	-0.10
4	0.09%	1.26	-0.05%	-0.73	0.23%	3.27***
5	0.29%	4.26***	0.32%	4.91***	0.10%	1.49
6	-0.08%	-1.20	-0.10%	-1.56	-0.13%	-1.89*
7	-0.03%	-0.51	-0.09%	-1.40	-0.13%	-1.92*
8	-0.08%	-1.13	0.13%	2.02**	-0.22%	-3.14***
9	-0.37%	-5.42***	-0.24%	-3.62***	-0.32%	-4.62***
10	0.15%	2.26***	0.25%	3.89***	0.17%	2.43**

AR represents abnormal return. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

In the table below are the results of the significance testing of CAR, BHAR and idiosyncratic volatility. CAR is broken up into sub-periods within the event window and is tested using both the t-test and Wilcoxon's sign-rank test. The sub-period of CAR is specified in the first column of the table. The ESG 1200 and Carbon Efficient 1200 indices show significant positive CAR in the ten-day period after the event day in the t-test at a five and ten percent level, respectively. The Fossil Fuel Free 1200 shows significant CARs for all sub-periods before the event day in the t-test. However, none of the periods are significant using the Wilcoxon test. This difference in test results is a concern given the homoskedasticity assumption in the t-test and the differences in volatility in our data. Erring on the side of caution, we would be hesitant to conclude that what we see is significant CAR for the global market. The low and non-significant BHAR for also speaks to this. The test on changing idiosyncratic volatility is not significant indicating that no index experiences a change in idiosyncratic risk.

Table 5: CAR, BHAR, Idiosyncratic volatility, and t-values for the ESG versions of the S&P Global 1200

	S&P 1200 ESG			S&P 1200 Carbon Efficient			S&P 1200 Fossil Fuel Free		
Event Window	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**
(-40,0)	0.22%	0.52	-0.04	0.09%	0.23	0.16	1.04%	2.37**	1.37
(-30,0)	0.16%	0.44	-0.24	0.02%	0.05	-0.09	0.82%	2.17**	0.89
(-20,0)	-0.07%	-0.22	-1.00	-0.09%	-0.31	-0.41	0.63%	2.04**	0.56
(-10,0)	0.20%	0.93	0.05	0.04%	0.19	0.15	0.61%	2.79**	0.96
(0, +10)	0.43%	1.99**	0.56	0.41%	1.98**	0.45	0.01%	0.05	0.01
(0, +20)	0.48%	1.59	0.56	0.31%	1.05	0.18	-0.06%	-0.20	0.52
(0, +30)	0.54%	1.45	0.57	0.43%	1.21	0.19	0.10%	0.25	0.21
(0, +40)	0.33%	0.76	0.29	0.32%	0.77	0.04	0.57%	-0.61	-0.17
Idiosyncratic volatility	-	-	-0.09	-	-	0.33	-	-	-0.24
BHAR	0.19%	0.31	-	-0.02%	-0.03	-	0.58%	0.92	-

CAR represents cumulative abnormal return, BHAR is buy-and-hold through the entire event window. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

S&P 500 and its ESG variants

In the graph below we see all three ESG variants follow both each other closely in most of the period before the event day. Then, a divergence occurs on day -4 and continues until day 5. The Carbon Efficient 500 index virtually mirrors the Fossil Fuel Free 500 index and the ESG 500 index and drops to -1 percent, while the others rise to +1 percent. The indices appear to stabilize at day 10, and the gains and losses are carried to the end of the event window. We showed in table 2 that in the S&P 500 the largest ten companies account for less of the index weight than in the 500 ESG index – going from 27 to 36 percent. Included in the top ten companies are the Big 5. What we see could therefore be explained by investors moving into the relative safety of these large companies. The Fossil Fuel Free 500 and Carbon Efficient 500 indices moving in opposite directions of each other is in line with our reasoning from earlier: The Fossil Fuel Free index performs well with a drop in oil price, but the companies in the Carbon Efficient index are on average more frugal with input use than the companies in the parent index and therefor benefit less from falling oil prices.

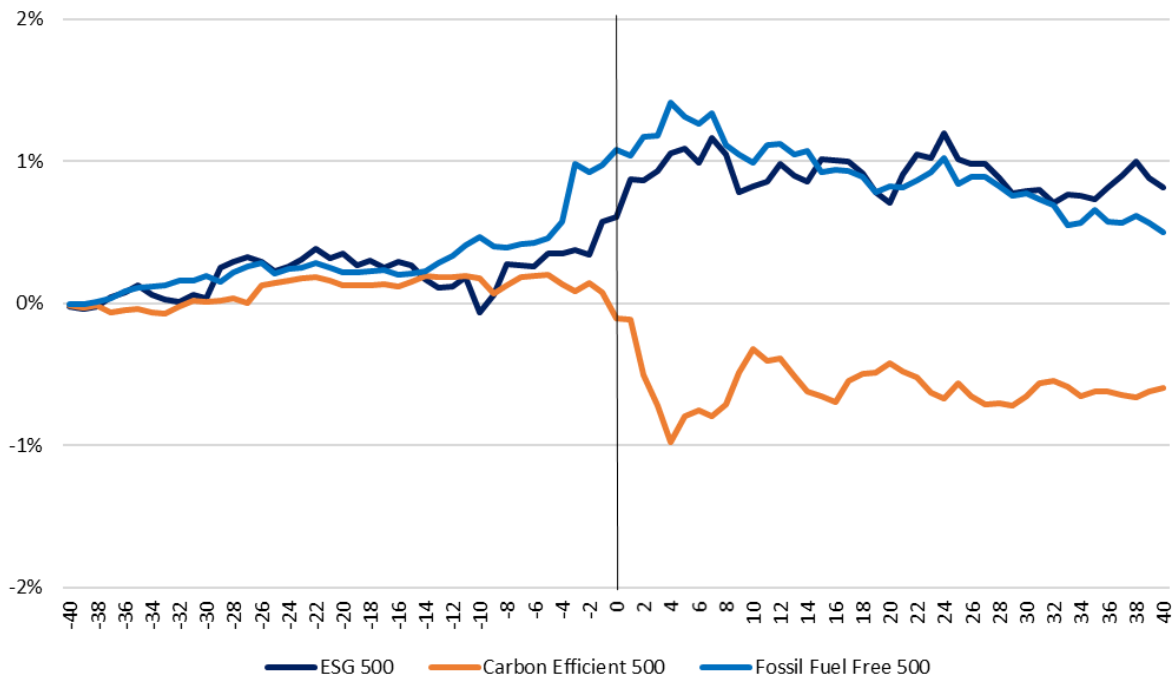

Figure 12: Cumulative Abnormal Returns (-40, +40) for ESG versions of the S&P 500

The abnormal returns for the days in the divergence from day -4 to day 5 are by and large highly significant indicating that the difference between them is not simple chance. The ESG 500 index has the least amount of significant results in this period. These mixed results of the three S&P 500 ESG indices are reminiscent of what we saw in the ESG versions of the S&P Global 1200 but the differences between the S&P 500 ESG indices are more pronounced. A possible cause being that the top ten companies account for a larger percentage of the market cap in the S&P 500 ESG indices than in the S&P Global 1200 ESG indices and we expect large companies to do better during a market downturn due to investors seeing them as safe bets. For the event day itself the ESG index does not show significant abnormal returns but the Carbon Efficient 500 and Fossil Fuel Free 500 indices are both significant at a 1 percent level.

Table 6: AR and t-values for the ESG versions of the S&P 500

	S&P 500 ESG		S&P 500 Carbon Efficient		S&P 500 Fossil Fuel Free	
Day	**AR**	**t-value**	**AR**	**t-value**	**AR**	**t-value**
-10	-0.25%	-4.81***	-0.01%	-0.39	0.05%	1.49
-9	0.13%	2.54**	-0.11%	-3.06***	-0.07%	-1.89*
-8	0.21%	4.14***	0.06%	1.66*	-0.01%	-0.14
-7	-0.01%	-0.17	0.05%	1.52	0.03%	0.76
-6	-0.01%	-0.24	0.01%	0.36	0.00%	0.12
-5	0.09%	1.79*	0.01%	0.16	0.03%	0.90
-4	0.00%	0.07	-0.07%	-1.88*	0.12%	3.13***
-3	0.03%	0.49	-0.05%	-1.33	0.41%	11.16***
-2	-0.04%	-0.71	0.06%	1.65	-0.06%	-1.54
-1	0.23%	4.49***	-0.06%	-1.81*	0.05%	1.22
0	0.04%	0.78	-0.19%	-5.35***	0.11%	3.03***
1	0.26%	5.11***	0.00%	-0.05	-0.05%	-1.30
2	-0.01%	-0.12	-0.39%	-11.0***	0.14%	3.76***
3	0.06%	1.20	-0.22%	-6.06***	0.00%	0.12
4	0.13%	2.44**	-0.26%	-7.19***	0.23%	6.30***
5	0.03%	0.63	0.18%	4.93***	-0.10%	-2.69***
6	-0.10%	-1.93*	0.05%	1.34	-0.05%	-1.32
7	0.17%	3.38***	-0.05%	-1.34	0.08%	2.09**
8	-0.11%	-2.18**	0.08%	2.34**	-0.23%	-6.12***
9	-0.27%	-5.24***	0.23%	6.49***	-0.07%	-1.82*
10	0.05%	0.88	0.16%	4.58***	-0.06%	-1.62

AR represents abnormal return. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

The ESG 500 index shows positive and significant CAR in three of the sub-periods before the event day. The Carbon Efficient 500 has negative and significant CAR for the sub-periods after the event day. Neither index shows significant results using the Wilcoxon test for CAR. The Fossil Fuel Free 500 has significant positive CAR at a 1 percent level in both the t-test and the Wilcoxon test for the (-40,0) window as well as varying levels of significance in the other sub-periods before the event day. For the (0,40) window, this index falls and has negative and significant CAR in the t-test but not in the Wilcoxon test. This difference in the tests is perhaps best explained by viewing the graph of CAR and paying particular attention to the period (-5,0) where the index jumps sharply. Such a large change over a short period does not influence the Wilcoxon test much as it is concerned with sign-rank, not magnitude. As such, we are not so concerned with the difference in our test methods in the (-20,0) and (-10,0) window and believe the positive CAR before the event day to be a significant finding. The Fossil Fuel Free nevertheless sheds some of these gains in the post-event period and is the only 500-index without a significant BHAR for the whole period. The BHAR for the ESG 500 and Carbon Efficient 500 indices are both significant at the 10 percent level but have opposite signs. However, we do not believe less than 1 percent to be economically significant. Idiosyncratic volatility does not appear to change for the ESG variants of the S&P 500. These results emphasize that not all ESG indices are created equal.

Table 7: CAR, BHAR, Idiosyncratic volatility, and t-values for the ESG versions of the S&P 500

	S&P 500 ESG			**S&P 500 Carbon Efficient**			**S&P 500 Fossil Fuel Free**		
Event Window	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**
(-40,0)	0.57%	1.75*	0.95	0.08%	0.35	0.37	0.97%	4.17***	2.58***
(-30,0)	0.51%	1.82*	0.77	0.06%	0.32	0.40	0.81%	4.02***	1.82*
(-20,0)	0.25%	1.10	0.37	-0.08%	-0.53	-0.29	0.72%	4.40***	1.83*
(-10,0)	0.39%	2.40**	0.76	-0.11%	-0.98	-0.66	0.56%	4.82***	1.07
(0, +10)	0.21%	1.32	0.56	-0.21%	-1.89*	-0.15	-0.10%	-0.82	-0.25
(0, +20)	0.10%	0.42	0.07	-0.31%	-1.99**	-0.11	-0.26%	-1.56	-0.74
(0, +30)	0.18%	0.63	0.17	-0.54%	-2.78***	-0.56	-0.31%	-1.55	-0.66
(0, +40)	0.20%	0.63	0.19	-0.48%	-2.16**	-0.49	-0.58%	-2.52**	-1.19
Idiosyncratic volatility	-	-	0.06	-	-	-0.25	-	-	-0.17
BHAR	0.82%	1.76*	-	-0.59%	-1.86*	-	0.50%	1.50	-

CAR represents cumulative abnormal return, BHAR is buy-and-hold abnormal returns. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

S&P Europe 350 and its ESG variants

The ESG 350 and Carbon Efficient 350 indices both show negative CAR for virtually the entire event window. The European version of the S&P ESG is the only one to be in negative CAR – the ESG 1200 and ESG 500 indices are virtually never in negative CAR. We believe this regional difference is due to the differences in the size of the companies in the global and US markets vs. the European market. From table 2, we see the screening done in the ESG indices leads to larger mean market cap than the parent indices - we therefore say that ESG ranking and size are linked. If size and performance are also linked, it is not strange that the ESG 350 index does worse than the ESG 1200 and ESG 500 indices since European companies have smaller mean market cap and benefit less from any size effects. Both the ESG 350 and Carbon Efficient 350 indices have relatively flat curves, and they end the period in the negative. The opposite is true for the sign of the Fossil Fuel Free 350 as it is constantly in positive CAR. The peak in the Fossil Fuel Free 350 CAR is also the most pronounced of any of the indices we have looked at, reaching about 2.5 percent on day 4, a full percentage point more than the Fossil Fuel Free 500, which has the second-largest peak. However, the Fossil Fuel Free 350 does shed all its positive CAR and returns to zero on day 15 before rising to a relatively stable one percent CAR for the remainder of the event window. The energy sector is a larger percentage of the total parent benchmark for the European benchmark index than in the US and global benchmark indices. As such it is not surprising that we see the largest change of the Fossil Fuel Free indices in the European market.

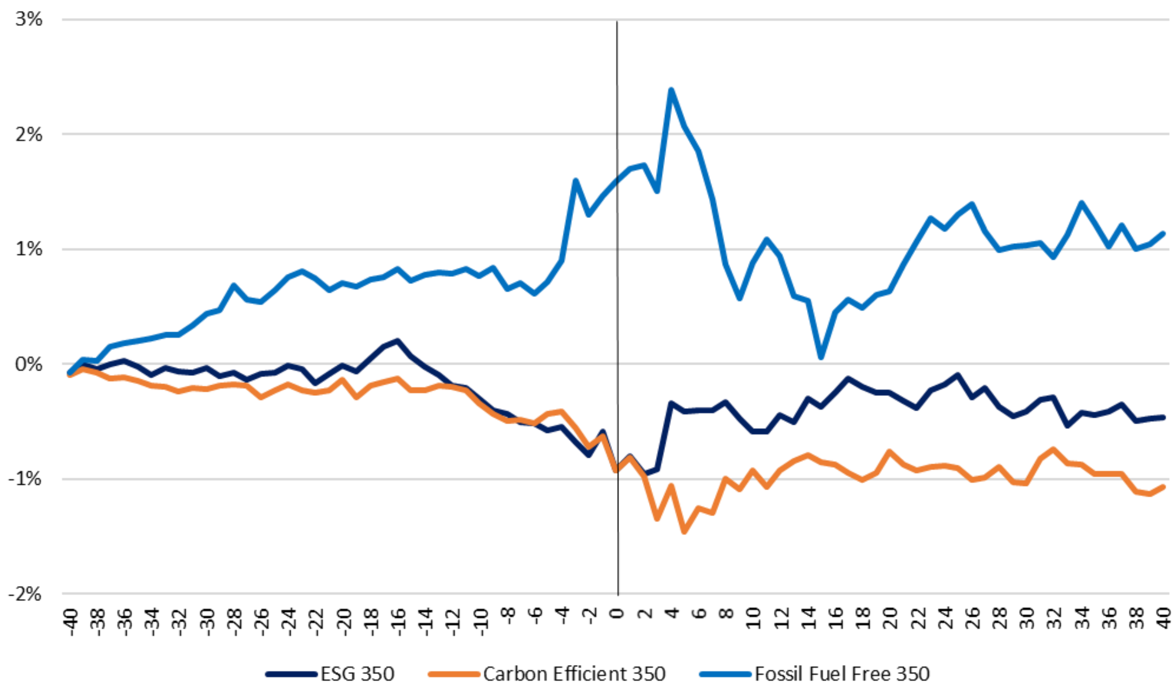

Figure 13: Cumulative Abnormal Returns (-40, +40) for ESG versions of the S&P Europe 350

Table 9 shows that the ESG 350 and Carbon Efficient 350 indices had significant negative abnormal return on the event day. The Fossil Fuel Free 350 index had mostly negative and significant results after the event day. Abnormal returns are a mixture of positive and negative abnormal returns - as we saw in the global and US indices.

Table 8: AR and t-values for the ESG versions of the S&P Europe 350

	S&P 350 ESG		**S&P 350 Carbon Efficient**		**S&P 350 Fossil Fuel**	
Day	**AR**	**t-value**	**AR**	**t-value**	**AR**	**t-value**
-10	-0.10%	-1.55	-0.11%	-1.85*	-0.06%	-0.72
-9	-0.10%	-1.47	-0.10%	-1.63	0.07%	0.82
-8	-0.03%	-0.52	-0.06%	-1.04	-0.19%	-2.07**
-7	-0.07%	-1.06	0.01%	0.21	0.05%	0.61
-6	-0.01%	-0.14	-0.04%	-0.67	-0.09%	-1.03
-5	-0.07%	-1.02	0.08%	1.43	0.09%	1.05
-4	0.03%	0.40	0.02%	0.30	0.19%	2.07**
-3	-0.13%	-2.05**	-0.14%	-2.44**	0.70%	7.85***
-2	-0.11%	-1.71*	-0.16%	-2.72***	-0.29%	-3.28***
-1	0.20%	3.15***	0.09%	1.58	0.16%	1.75*
0	-0.33%	-5.14***	-0.30%	-5.10***	0.13%	1.45
1	0.13%	1.94*	0.11%	1.95*	0.10%	1.16
2	-0.15%	-2.38*	-0.16%	-2.81***	0.03%	0.34
3	0.04%	0.54	-0.37%	-6.35***	-0.22%	-2.51***
4	0.58%	8.88***	0.29%	4.95***	0.88%	9.87***
5	-0.07%	-1.08	-0.40%	-6.89***	-0.32%	-3.54***
6	0.01%	0.14	0.21%	3.61***	-0.22%	-2.42***
7	0.00%	-0.01	-0.05%	-0.77	-0.42%	-4.66***
8	0.08%	1.20	0.30%	5.10***	-0.57%	-6.35***
9	-0.15%	-2.26**	-0.09%	-1.61	-0.30%	-3.32***
10	-0.11%	-1.73*	0.17%	2.89***	0.32%	3.53***

AR represents abnormal return. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

The CAR for ESG 350 hovers around zero until day -15, where it drops and remains below zero for the rest of the event window. The t-tests of the sub-periods closest to the event day are all significant at a ten or five percent level, but the Wilcoxon test is not. For the Carbon Efficient 350 t-test of CAR shows significant negative results in the (-10,0) and (-40,0) periods, and we observe the only BHAR significant at a five percent level showing a -1.06 percent buy-and-hold abnormal return for the event window. While small, we hold this to be economically significant since index investing is a lower risk, lower returns strategy. The Fossil Fuel Free 350 has the most movement in CAR of all our indices. It has a gain of 1.46 percent in the pre-event window that is subsequently lost in the 15 days following the event day before it slowly rises again. As such, all but the (0,30) and (0,40) windows are significant in our t-test, but none of the gains or losses are significant in the Wilcoxon test. The CAR appears to show larger changes after the event day indicating heteroskedasticity and possibly making the t-test unreliable. This coupled with BHAR not being significant for the Fossil Fuel Free 350 index makes us doubt if the CARs after the event day are significant even if the t-test indicates that it is. Idiosyncratic risk does not appear to change as was the case in the US and global markets.

Table 9: CAR, BHAR, Idiosyncratic volatility, and t-values for the ESG versions of the S&P Europe 350

	S&P 350 ESG			S&P 350 Carbon Efficient			S&P 350 Fossil Fuel Free		
Event Window	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**
(-40,0)	-0.59%	-1.44	-1.39	-0.63%	-1.70*	-1.15	1.46%	2.58***	1.85*
(-30,0)	-0.52%	-1.46	-1.35	-0.42%	-1.32	-0.71	1.12%	2.29**	1.28
(-20,0)	-0.50%	-1.75*	-1.34	-0.39%	-1.51	-0.85	0.82%	2.06**	0.97
(-10,0)	-0.39%	-1.90*	-1.58	-0.40%	-2.16**	-1.37	0.63%	2.23**	0.45
(0, +10)	0.34%	1.66*	-0.05	0.00%	0.02	0.15	-0.71%	-2.50**	-0.86
(0, +20)	0.68%	2.33**	0.56	0.16%	0.61	0.44	-0.95%	-2.38**	-0.97
(0, +30)	0.52%	1.46	0.23	-0.11%	-0.34	-0.03	-0.56%	-1.14	-0.54
(0, +40)	0.46%	1.11	0.26	-0.15%	-0.40	-0.18	-0.46%	-0.81	-0.47
Idiosyncratic volatility	-	-	0.37	-	-	-0.02	-	-	-0.44
BHAR	-0.47%	-0.80	-	-1.06%	-2.02**	-	1.14%	1.41	-

CAR represents cumulative abnormal return, BHAR is buy-and-hold abnormal returns. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

Oil and the two-factor model

Looking at these findings with large differences, especially between every version of the Fossil Fuel Free and the Carbon Efficient indices, we feel it is necessary to return to our previous concern about the oil price change in the event window. We quickly remind the reader that the Fossil Fuel Free indices have no fossil fuel owning companies in them, the Carbon Efficient indices weighs companies higher or lower by carbon footprint per unit revenue and the "ESG''-labeled index has a proprietary ESG ranking system. The link between the oil price and the Fossil Fuel Free indices is obvious. The weighting in the Carbon Efficient indices towards companies that are efficient with their emissions – lower emissions per unit of revenue – means it gets less benefit as the cost of oil drops. For the sake of completeness, the results should be redone with a two-factor model, including the oil price. From the prior discussion, we assume the beta on oil will be negative and significant for the Fossil Fuel Free indices, positive and significant for the Carbon Efficient indices, and not significant for the ESG indices. We use the West Texas Intermediate (WTI) free on boat (FOB) spot price for the US and global markets and the Europe Brent FOB spot price for Europe. Prices are downloaded from the St. Louis Federal reserve database. We run the two-factor model in the estimation window and present the beta estimates with t-values for the coefficients below. The sample size is 200 days as it was in the market model.

Table 10: Betas with t-values and adjusted R^2 from the two-factor model regression

	ESG 1200	**Carbon Efficient 1200**	**Fossil Fuel Free 1200**	**ESG 500**	**Carbon Efficient 500**	**Fossil Fuel Free 500**	**ESG 350**	**Carbon Efficient 350**	**Fossil Fuel Free 350**
Adjusted R^2	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Brent t-value	-	-	-	-	-	-	0.00 0.54	0.00 1.73*	0.00 0.71
WTI t-value	0.01 0.68	0.01 2.36**	-0.01 2.81***	0.01 0.71	-0.01 1.82*	-0.00 0.53	-	-	-

***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

For the ESG-labeled indices the results are as expected - the betas on oil are not significant. The results are surprising for the US and European markets as the beta estimators are both very small and, for the most part, not significant at standard levels. The signs are also different from our expectations for the Carbon Efficient 500 and the Fossil Fuel Free 350 indices. For the global market, the results are as expected. The adjusted R^2 of the two-factor model is larger than for the simple market model for these two global indices but only at the fourth decimal. Given these results, we limit the use of the two-factor model to the Carbon Efficient 1200 and Fossil Fuel Free 1200 as we do not want to use estimators not significant at the normal 5 percent level.

Table 11: CAR, BHAR, Idiosyncratic volatility, and t-values for Global Indices

	S&P 1200 Carbon Efficient			**S&P 1200 Fossil Fuel Free**		
Event Window	**CAR**	**t-value**	**Wilcoxon z-score**	**CAR**	**t-value**	**Wilcoxon z-score**
(-40,0)	0.25%	0.62	0.05	0.81%	1.89*	1.10
(-30,0)	0.14%	0.40	-0.27	0.64%	1.74*	0.75
(-20,0)	0.00%	-0.01	-0.63	0.51%	1.68*	0.41
(-10,0)	0.16%	0.79	0.05	0.44%	2.04**	0.25
(0, +10)	0.66%	3.23***	0.56	-0.34%	-1.61	-0.45
(0, +20)	0.48%	1.67	-0.03	-0.31%	-1.02	-0.29
(0, +30)	0.90%	2.55**	0.15	-0.57%	-1.55	0.03
(0, +40)	0.52%	1.26	-0.45	-0.55%	-1.28	0.00
Idiosyncratic volatility	-	-	0.86	-	-	0.82
BHAR	0.32%	0.54	-	0.10%	0.16	-

CAR represents cumulative abnormal return, BHAR is buy-and-hold abnormal returns. ***, **, and * are significant at 1%, 5%, and 10% confidence levels, respectively.

The CAR for Carbon Efficient in the two-factor model is, in general, *more* significant than CAR from the simple market model in the t-test. An increase in CAR is against our expectation since significant betas and increased adjusted R^2 should lead to lower abnormal returns and less significant results. The Wilcoxon test changes little and is never significant for the Carbon Efficient 1200. The Fossil Fuel Free 1200 CAR is in line with our expectations before the event day, with reduced values across the board. But following the event day, CAR is larger in absolute terms using the two-factor model. The very small numerical value of the beta estimators and mixed results in terms of changes to abnormal returns do not demonstrate a clear benefit from using the two-factor model instead of the simple market model. Our assumption is that these broad market indices already incorporate the oil price and because of this a two-factor model is not warranted in our event study.

Conclusions and implications

In this thesis we have investigated the impact of the covid-19 pandemic on S&P ESG indices. Going into this thesis, we believed ESG investments to be more robust to market shocks than the market as a whole. The results of the event study show that our Carbon Efficient indices have negative abnormal returns after the event day, but the Fossil Fuel Free indices have positive abnormal returns before the event day. Both results are likely due to the falling price of oil. The three ESG-labeled indices show mixed results between markets. The two-factor model was generally in line with these findings when we applied it to the global market but ultimately the market model seems a better choice given significance levels of estimators and adjusted R^2s. A weak point of this study is the data amount. Our chosen indices follow their benchmarks closely and other ESG investment approaches could have given different results. The period of study is also short. As such, the long-term effects of covid-19 on ESG indices are not known to us. Due to the high correlation between the benchmarks and the ESG variants, long-term abnormal returns could tend toward zero.

The results we find are somewhat of a warning to anyone wanting to invest in an ESG index. The exclusion criteria employed by ESG index providers can lead to differences in returns, especially when it comes to the effect of the oil price. Market concentration can also play a role – an effect we find when comparing the European indices to the global and US ones. ESG investing is not a sure-fire way of generating abnormal returns, and even when positive abnormal returns are seen, the results could be accomplished by other means such as sector or factor tilts. That said, it is not against ESG principles to resemble other investment strategies and that similar results could be accomplished with non-ESG reasoning is, in our opinion, a somewhat unconvincing argument against ESG investing.

If we had to pick just one of our indices to represent EGS investing, we would pick the S&P 350 ESG index. The Carbon Efficient and Fossil Fuel Free indices show no consideration to the “governance” or “social” part of ESG investing and Europe has the largest market for ESG investment and is to a lesser extent than the US and global markets dominated by a handful of big firms. The S&P ESG 350 index has more negative significant abnormal returns than positive significant abnormal returns around the event day - as well as negative (though non-significant) BHAR. This does fly in the face of the idea of ESG investing being a so-called alpha generator – at least in a large event such as a pandemic.

Collectively for our indices, abnormal returns around the event day are split down the middle - half of them being significant and half of them not. The significant results are again split equally between positive and negative results. The full period BHAR is mostly not significant. It is also worth mentioning that even our statistically significant results are numerically small and perhaps not of economic significance to an investor. What we have found to be the case is that the idiosyncratic volatility of these ESG indices does not change in our event—indicating that ESG investments were no more unsystematically risky in the pandemic. This leads us to a final remark. If an investor is of the opinion that ESG investment is a way to improve the world, even if it is only improved slightly, then the fact that we cannot find conclusive results for ESG indices having positive abnormal returns should not be a deterrent to choosing an ESG screened version of a broad market index. For if the expected returns generated from ESG investing are no different from what the market index offers, the utility of the expected returns will always be higher.

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Appendix

Heteroskedasticity testing - AR (1) and market model results

Table A1: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity in autoregressive one lag model

Indices	Full data set	Estimation window
	p-value	p-value
ESG Global 1200	0.00	0.53
Carbon Efficient Global 1200	0.00	0.63
Fossil Fuel Free Global 1200	0.00	0.64
ESG 500	0.00	0.89
Carbon Efficient 500	0.01	0.00
Fossil Fuel Free 500	0.00	0.94
ESG Europe 350	0.00	0.01
Carbon Efficient Europe 350	0.00	0.01
Fossil Fuel Free Europe 350	0.00	0.04

Table A2: Breusch-Pagan / Cook-Weisberg test for heteroskedasticity in market model

Indices	Full data set	Estimation window
	p-value	p-value
ESG Global 1200	0.00	0.53
Carbon Efficient Global 1200	0.11	0.01
Fossil Fuel Free Global 1200	0.00	0.64
ESG 500	0.02	0.85
Carbon Efficient 500	0.03	0.00
Fossil Fuel Free 500	0.00	0.94
ESG Europe 350	0.00	0.01
Carbon Efficient Europe 350	0.00	0.01
Fossil Fuel Free Europe 350	0.00	0.04

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