The impact of divestment announcements on the share price of fossil fuel stocks

Introduction

Increased concentrations of carbon dioxide emissions, most affiliated with fossil fuel use (Quéré et al. 2013), continue to drive global warming beyond the safe operating space for humanity and must be restricted (van der Ploeg 2018). Though other measures are also needed to achieve the 2°C target (Fernández-Martínez et al. 2014; Forsell et al. 2016; Walsh et al. 2015), no more than one-fifth of the current proven fossil fuel reserves can be burned (Meinshausen et al. 2009).

To address the need to restrict increased greenhouse gas emissions, some institutional investors have put pressure on the fossil fuel industry to decrease their share of carbon emissions in the atmosphere (Cripps 2014; Eltman 2018; Mooney 2017). Since 2012, nearly 1000 institutional investors, managing over $6 trillion in assets have announced to divest their shares in the fossil fuel industry (Arabella Advisors 2015) because of both, ethical (Clark and Monk 2010) and financial rationales (Rubin 2016).

First, divestment might be a tool to force change upon the fossil fuel industry by directly depressing share prices (Paum 2015) or indirectly by stigmatizing the industry (Ansar et al. 2014) for its emissions. Proponents argue that institutional investors have a moral obligation to divest (Moss 2017) as financial gains should not be achieved through investments that harm the climate. Similar to South African divestment (Hunt et al. 2017), the fossil fuel divestment movement attempts to establish an anti-fossil fuel norm (F. Green, 2018). Thus, divestment is perceived as a way to influence the fossil-fuel industry (Dawkins 2016) by raising the costs of capital, restricting corporate solvency to explore and exploit new reserves (Bauer et al. 2018), and by weakening production capacity in the long run (Jaccard et al. 2018).

Second, investors fear reduced financial returns of fossil fuel related investments (Henriques & Sadorsky, 2017; Trinks, Scholtens, Mulder, & Dam, 2018) caused by stranded assets through the rapid devaluation of fossil fuel reserves (Ansar et al. 2014; Green and Newman 2017; Hunt and Weber 2018; Mercure et al. 2018). In a 2°C scenario, grounded reserves could put over $28 trillion at risk mostly concentrated in high-cost and high-carbon sources of production (Lewis et al. 2014). Therefore, some investors try to divest from their fossil-fuel holdings to decrease the GHG exposure of their portfolio (Monasterolo et al. 2017).

Conversely, based on Heinkel et al. (2001), critics argue that the direct impact of divestment is limited given the small sum of funds being divested. Moreover, the divested equity might simply be acquired by less scrupulous investors at a discounted rate (Ansar et al. 2014). Also, the decline in fossil-fuel stock prices in recent years might have been more sensitive to changes in macroeconomic environments than to the reputational risks of divestment (Fischer and Baron 2015). Finally, divestment does not impact national or state-owned corporations like NICO and Saudi Aramco, who own a large bulk of proven reserves (Paum 2015). Institutional investors have also rejected divestment because it might violate fiduciary duty though this is discussed controversially (Waitzer and Sarro 2012).

Recent studies have analyzed the financial returns of fossil fuel investments, (Ansar et al. 2013; Henriques and Sadorsky 2017; Hunt and Weber 2018; Trinks et al. 2018) and found that divestment does not impair portfolio performance. Trinks et al. (2018) even suggest that fossil fuel companies have underperformed on a risk-adjusted base since as early as 1927. Studies on the effect of divestment announcements on the share price of fossil-fuel shares, however, do not exist yet. Therefore, this study strives to understand whether divestment announcements have an impact on the share price of fossil fuel stocks independently from real divestment.

Hence, this paper presents an event study analysis of the effect of divestment announcements on the share-price of fossil-fuel industry members. Our sample consists of traded members of Carbon Underground 200 (Alexeyev et al. 2016). The sample represents the largest oil, gas, and coal companies with regard to the GHG potential of their reported reserves. Through a media analysis, the most relevant divestment announcements, endorsements, and campaigns between 2012 and 2015 have been selected.

We analyzed expected and abnormal returns around the dates of the events using the standardized cross-sectional (BMP) test that is particularly useful to control for idiosyncrasies between events and shares (Boehmer, Masumeci, & Poulsen, 1991). Expected returns are calculated using the capital asset pricing (CAPM) model (Sharpe 1964; Treynor 1961) and abnormal returns were benchmarked to the MSCI all-country world index. Robustness checks including the mean return and market model expected returns as well as the cross-sectional t-test, crude dependence test, Patell test, and sign test have been conducted to test for conflicting results. We find that divestment announcements decrease the share price of the fossil fuel sample but do not decrease the price of the benchmark index.

Hence, we demonstrate that investment announcements by powerful and legitimate stakeholders have impacts on the price of fossil-fuel shares. We conclude that fossil-fuel ‘divestors’ are compensated for accommodating a demand shift and that financial markets price divestment announcements as market risks.

The study contributes to the divestment literature and the literature on climate-related financial market risks (Diaz-Rainey, Robertson, & Wilson, 2017) because it broadens the knowledge about effects of divestment announcements on the share price of firms.

Furthermore, the study contributes to the event study literature adding knowledge about the impacts of multiple announcements on a cluster of shares in a common industry.

Literature review

Event studies assess the impact of an event on a firm or industry. They analyze the events' effects over a relatively short period through shifts in stock prices rather than over a longer period through productivity-related outcomes (MacKinlay 1997). Event studies test the efficient market hypothesis, which suggests that stock prices adjust to reflect all newly available information that is relevant for the value of a firm (Fama, 1991; Fama, Fisher, Jensen, & Roll, 1969).

The literature that applies the event study methodology is well developed, and some studies using the method have been published (Johnston 2007; Kothari and Warner 2004; MacKinlay 1997; McWilliams and Siegel 1997). Kothari and Warner (2004) estimate that over 500 published studies have adopted the event study method to measure the impact of corporate governance strategies, mergers and acquisitions, financing decisions, post earnings announcements, CEO successions, and effects of regulation. Other review studies by list event studies that analyze the impact of mergers and acquisitions, earnings announcements, announcements of macroeconomic data (MacKinlay 1997), and marketing (Johnston 2007).

Several publications have applied event studies to measure the impact of events related to corporate social responsibility on share prices. Cheung (2010) found a significant but temporary positive (negative) impact of inclusion (exclusion) from the Dow Jones Sustainability World Index on the share prices or the respective firms. Amer (2015) suggests a similar result for member organizations that fail to report to the United Nations Global Compact (UNGC). Ammann et al. (2017) found a significant positive impact of a Morningstar Sustainability Rating on mutual fund flows persisting up to one year after the announcement. Also, event studies analyzed the impact of anti-Apartheid divestment announcements with mixed results (McWilliams et al. 1999). One event study on the fossil fuel industry measures the impact of announcements related to the COP21 on a variety of fossil fuel shares and found moderate effects (Mukanjari and Sterner 2018).

Equally vast is the scope of literature on event study methodology (Boehmer et al. 1991; Brown and Warner 1985; Campbell et al. 1997; Cowan 1992; Lyon et al. 1999). This body of literature emphasizes the pertinence of the event study methodology and offers a valuable background for studying the impact of the fossil fuel divestment movement.

Fossil fuel divestment

Fossil fuel divestment strives to force change on the fossil fuel industry, by directly depressing share prices through sales of shares or by indirectly stigmatizing the industry. It addresses the supply side of fossil-fuels instead of following the more traditional approach to address the demand side (Lazarus and van Asselt 2018). Divestment announcements are instances of discourse, such as pledges to divest, endorsements, or campaigns that present the topic of fossil-fuel divestment to the market.

Divestment activities against the tobacco industry (Cogan 2000; Wander and Malone 2004), war crimes (Bechky 2009), and other ‘sin stocks’ (Fabozzi et al. 2008; Hong and Kacperczyk 2009) called for attention to an underrepresented societal concern (Bechky 2009), to influence policy, or to exert pressure on a firms and their operations (Freeman 1996). In certain instances, however, divestment fails to achieve its goals (Patey, 2009) and may even face resistance from competing ideologies (Makdisi, 2003), industries (Wander & Malone, 2004), and representatives of conventional investing who base their decision purely on financial theory such as portfolio theory (Markowitz 1952). However, there is conflicting evidence whether the exclusion of sin stocks like alcohol, tobacco, and gaming, outperforms common benchmarks (Fabozzi et al., 2008) or whether they cause a financial cost to investors abstaining from these stocks (Hong & Kacperczyk, 2009).

Before the fossil fuel divestment movement, the most prolific divestment movement was against the South African Apartheid Government (Arnold & Hammond, 1994; Grossman & Krueger, 1995; Posnikoff, 1997; Rudd, 1979). There is evidence that the fossil fuel divestment movement does share similarities with the anti-Apartheid movement, such as the goal to create change and to manage financial risks (Hunt, Weber, & Dordi, 2016).

Six event studies between 1994 and 1998 assessed the impact of the divestment announcements on the performance of foreign companies and banks involved in Apartheid South Africa (McWilliams & Siegel, 1997; Meznar, Nigh, & Kwok, 1994; Posnikoff, 1997; Teoh, Welch, & Wazzan, 1999; Wright & Ferris, 1997). Nuances in the design framework of these studies have led to conflicting results (McWilliams et al., 1999).

Three studies concluded that divestment has no impact on share prices (McWilliams & Siegel, 1997; Meznar et al., 1994; Teoh et al., 1999). Two studies suggest a negative impact on share prices (Meznar, Nigh, & Kwok, 1998; Wright & Ferris, 1997), and one study states that divestment announcements have a positive impact on the share price of the divestment announcer (Posnikoff, 1997).

Studies analyzing the impact of events and announcements coming from others than the divesting company itself found significant short-term impacts on share prices. These results correspond with the price pressure hypothesis stating that investors who accommodate demand shifts, for instance through divestment, have to be compensated (Harris & Gurel, 1986) though they do not deliver new market information. A study by Klassen and McLaughlin (1996), for instance, suggests that positive news about a firm’s environmental performance increased the share price of a company while negative announcements decreased the value of the share price. Furthermore, Binder (1985) suggests impacts of regulatory announcements on monthly returns rather than on daily returns, contradicting Curran and Moran (2007) who found impacts of both, negative and positive CSR events, on daily prices.

Cheung (2010) used inclusion and exclusion of firms into and from the Dow Jones Sustainability Index and found effects for daily returns but could not find longer lasting effects of these events. An event study analyzing credit announcements for high carbon emitters suggests positive impacts for low carbon emitters and negative impacts on the share price of high carbon emitters (Herbohn et al. 2017). Furthermore, Rubin and Jones (2017) found effects of negative announcements about environmental events if they harm customers or suppliers of firms or a firm's reputation. Finally, Karpoff et al. (2005) suggest impacts of negative announcements on the share price of affected firms.

To summarize, the listed studies found significant impacts of environmentally related events and announcements on share prices. There is no quantitative evidence, however, to support or reject the notion that fossil fuel divestment events are influential. Thus, the objective of this study is to understand whether divestment announcements have an impact on the share price of fossil fuel stocks. Hence, we hypothesize that fossil fuel divestment announcements have a negative effect on the price of fossil fuel shares.

Theory

Theoretically, the efficient market hypothesis (Malkiel & Fama, 1970), a subset of modern portfolio theory, delivers one possible explanation for whether fossil fuel divestment events would impact the share prices of fossil fuel companies. The theory proposes that markets are efficient at reflecting and compounding all available information in the price of a security (Fama, 1970). The efficient market hypothesis is tested through event studies to examine the process by which share prices respond to certain kinds of new information (Fama et al., 1969). Seminal works by Heinkel et al. (2001) and Fama and French (2007) suggest that divestment of fossil fuel company shares is unlikely to have any share price effects, as at least twenty percent of total assets under management would have to divest collectively. Moreover, divestment announcements represent a commitment of the funds to divest over time, further attesting that divestment events might not impact the fossil fuel shares. If, however, divestment announcements do have a measurable impact on fossil fuel shares, we consider other mechanisms at play.

In combination with the efficient market hypothesis stakeholder theory (Freeman 1984) may explain the impact of fossil fuel divestment announcements. If the market perceives stakeholder pressures as relevant to the industry, the change in share price will reflect the impact of the information. Stakeholders can “explain and guide the structure and operations of the established corporation” (Donaldson and Preston 1995, p. 70), in much the same way shareholders can influence corporate objectives of a firm. Consequently, stakeholder pressure can also impact the share price of a firm. A drop in the share price can be expected if the announcing stakeholder is powerful, for instance as a powerful investor, owns legitimacy, or if there is an urgency, for instance, climate change (Mitchell et al. 1997).

There is also evidence that social movements by secondary (non-influential) stakeholders can illicit institutional change (Hirschman 1970) by actively influencing the conditions that led to dissatisfaction. In the context of fossil fuel divestment, demonstrations of protests can be a relevant source of new information that influence share prices (King and Soule 2007). While divestment may not directly threaten the demand for or revenues associated with fossil fuel production, it communicates dissatisfaction among stakeholders which ultimately threatens the firm’s reputation and legitimacy.

While traditional financial theory assumes rationality, studies in behavioural finance find that not only are investors subject to sentiment (De Long et al. 1990b) but betting against sentimental investors is costly and risky (Shleifer and Vishny 1997). Some event studies on the relation between news coverage and stock prices attest that low sentiment generates downward price pressures (De Long et al. 1990a; Tetlock 2007). Conversely, positive sentiment on fossil fuel divestment in news media can have a negative impact on share prices.

The effect of ethically driven announcements on market prices is even stronger in financial markets with higher social norms. Because of knowledge about the connection between the fossil fuel industry and climate change, investors are aware of the environmental issue. Therefore, so-called sin stocks underperform while they outperform their conventional peers in markets with low social norms (Durand, Koh, & Limkriangkrai, 2013; Fauver & McDonald, 2014; Hong & Kacperczyk, 2009). Consequently, we expect an underperformance of fossil fuel stocks because of an increased awareness and investor sentiment (Liston, 2016) about climate change risks.

This study examines whether divestment announcements have an impact on the share price of fossil fuel stocks. If divestment announcements do not create abnormal returns of fossil fuel shares, the efficient market hypothesis attests that the market does not perceive the information as material to the industry (null hypothesis). The alternative hypothesis states that divestment announcements lead to a significant abnormal downturn of share prices, in which case other key mechanisms related to stakeholder influence and sentiment are at play.

Method, Sample, and Data

We follow other studies in using the event study method as a test of the efficient market hypothesis (Fama et al., 1969). Event studies compare stock prices on a specific event day to their expected returns (Corrado, 2011). While the simplicity of the event study methodology has led to a vast collection of empirical research, studies on the same events have led to conflicting results because of variations in the method (McWilliams & Siegel, 1997). The stepwise methodology applied in this study closely replicates a framework highlighted by MacKinlay (1997). The method includes identifying a set of comparable exogenous events and endogenous stock samples, calculating expected returns across an estimation window, and measuring the statistical differences between actual returns and the expected returns.

Since fossil fuel divestment announcements share common event days and address only one industry (Hunt et al. 2016), traditional statistical methods that assume securities are uncorrelated and event-induced variance is insignificant, will frequently reject the null hypothesis resulting in a type II error (Brown and Warner 1980). The BMP statistical test (Boehmer et al. 1991), applied in this study, uses an ordinary cross-sectional approach to identify event induced increases in variance but replaces cross-sectional standard deviation of the event days in the event window with standardized residuals over the estimation window (Patell 1976). This method adjusts for event-induced variance when announcements share common event days or stocks share a common industry.

Sample and Data

McWilliams et al. (1999) suggest that the interpretation of divestment announcements and other announcements of corporate social responsibility can lead to inconsistencies between designs. Therefore, a detailed description of an event study includes the defining characteristics of the event, a scope of inclusionary and exclusionary criteria, date range, and the source of the event announcement.

In-line with the efficient market hypothesis, this study analyzes pledges to divest, endorsements, and events related to divestment campaigns. As of June 2016, the Fossil-Free organization (www.gofossilfree.org) lists 538 pledges, 23 high profile endorsements, and nearly 1000 national and local divestment campaigns. To extract the most important events, inclusionary and exclusionary screening criteria have been applied. We considered events between January 1, 2012, to December 31, 2015, to capture events as early as the inception of Bill McKibben's 'Do the Math' campaign (350.org, 2012) until to the symbolic four-year anniversary of the fossil fuel campaign.

We recognize that while the events do fall within a period of underperformance for the industry, we have selected a broad collection of events from the very first inception of divestment (in 2012) to its four-year anniversary campaign (2015). This time-period captures the transition from a fringe campus initiative to the institutionalization of divestment by prominent investors. In-line with Ansar et al.'s (2014) three waves of divestment, this appropriately captures the first two. Furthermore, we particularly analyze the impact of events during windows of upwards developments in fossil fuel share prices.

Our methodological rationale has been to include the most important events from, a financial market participants' lens. Therefore, we used analytic tools that can identify important events through the medium they have been reported and through the frequency of mentions in the media, on the internet and social media. We started by analyzing news outlets that address financial markets players (such as Wall Street Journal). Also, we used internet-based tools to analyze the frequency of appearance of the events to analyze their importance.

A three-step process of inclusionary screening has been conducted. First, news articles published in Wall Street Journal or Financial Times were identified because of their financial relevance and public availability (Dyckman et al. 1984). We extracted 42 publications quoting 'fossil fuel divestment' from the LexisNexis database.

Next, the Google Trends database was queried for the word "divestment" to identify instances of rising public discourse as early warning signs of stock market movements. Queries were conducted on a monthly basis (January 2012 to December 2015) to identify specific days in each month where the discourse of fossil fuel divestment was measurably greater. The day with the greatest public discourse from each of the 48 months was cross-checked for relevant news articles on the LexisNexis database.

Finally, an additional 29 reports of grey literature, such as publications by the Oxford University's Stranded Assets Program, were identified through a standard Google Search, as key drivers in stimulating discourse on fossil-fuel divestment. The entire process of inclusionary screening identified 119 unique events.

To scope the events, four steps of exclusionary screening have been applied. First, publications of general reference (i.e., fossil-fuel divestment is…) or publications that did not include new information compared to former events were excluded. Second, if more than one publication referenced the same event, the earliest publication has been considered. Third, we excluded announcements of piecewise developments or calls to action (i.e. 'Fossil-fuel divestment discussion moves toward Board'). Finally, we did not consider rejections of divestment to guarantee that all events send signals to the market that follow the same direction.

The remaining 24 publications were either pledges to divest, endorsements for divestment, or divestment campaigns. As a result, the sample consists of thirteen pledges, five endorsements, and six campaigns (see Table 4 below).

Event Windows

Generally, the event study method assumes that new information is unanticipated. The earliest instance of disclosure, however, may be difficult to identify for divestment announcements that might be the result of lengthy public debates.

This raises issues around clustering and confounding effects related to autocorrelation among shares and between events. Regarding confounding effects across independent announcements, several steps are taken to mitigate interaction between events. In-line with (Meznar et al. 1994) we checked for other events within a three-day window immediately surrounding the selected events. Moreover, (Brown and Warner 1985) attest that confounding effects can be masked by averaging returns across a large sample size. Finally, we use the capital asset pricing model (Treynor 1961) over the mean returns model, such that idiosyncrasies from prior events would not influence future events.

Clustering effects are more problematic for this study because the sample firms share a common industry. However, large sample size and short event windows can adequately control for industry effects (Brown and Warner 1985). Furthermore, clustering effects are mitigated by averaging the event windows of all events together to mask outlying influences. The impact of clustering events can also be mitigated by including an industry variable in the select expected return models (Collins and Dent 1984). However, the inclusion of an industry variable may depress the excess returns and lead to a false negative type II error.

Adjusting the studies' time horizons can mitigate some of these limitations. Event windows were categorized into an estimation window before the event where expected results are calculated, an event window surrounding the event, and a post-event window to identify persisting impacts. Long event windows are necessary to account for longer-term effects, but expose the study to extraneous influences and typically have weaker statistical power (MacKinlay, 1997). In line with other studies (Curran and Moran 2007; Jones and Rubin 2001; Wai Kong Cheung 2011), this study adopts a combination of single day event windows for up to ten days prior to and after the respective event date, and four multi-day windows spanning 1, 2, 5, and 10 days around the event. Anti-Apartheid event studies adopted a 200 or 250-day estimation period for all expected return models. Therefore, this study adopts an estimation window and post-event window of 250 trading days (approximately one year) before and after the event window.

The estimation window for Bill McKibben's "Do the Math" inception event on September 19, 2012, for instance, covers September 5, 2011, to September 5, 2012. The single day event windows assess financial data during each working day from 10 days prior (September 5) to 10 days after (October 3) the announcement date. The multi-day event windows aggregate the dates in a way that a 1-day window covers September 11 to September 13, a 2-day window spans September 10 to September 14, and so on. Thus, a total of 14 single and multi-day tests have been considered.

Sample Selection

This study analyzes 200 publicly listed coal, oil, and gas companies. Government-owned corporations are out of scope for this study because financial market analyses cannot assess changes in their market value.

We used publicly listed companies of Carbon Underground 200 (Alexeyev et al. 2016) for our analysis. Carbon Underground 200 is a list of the top 100 coal and top 100 oil and gas companies ranked by the carbon emissions content of their reported reserves. The selection is an adequate representation of publicly traded fossil fuel companies since the largest corporations account for the largest share of potential fossil fuel production and GHG emissions (Ekwurzel et al. 2017; Heede 2013; Shue 2017). Moreover, the Carbon Underground 200 sample of corporations includes 98 percent of all coal and gas reserves and 97 percent of the oil reserves held by listed companies (Alexeyev et al. 2016). The sample size of 200 firms is large enough to suppress the idiosyncratic influences of individual firms and for using statistical tests.

Stock returns are collected from the Center for Research in Security Prices (CRSP) database of daily stock prices. End of day returns have been adjusted for the effects of stock splits, mergers, and dividends. Prices for the MSCI all-country world index have been used as a benchmark since this index most accurately reflects global market performance (Ohlson and Rosenberg 1982). Since absolute financial returns cannot be compared directly because of different market sizes and currencies, all outputs were normalized into continuously compounded returns, to best conform to normality assumptions (Fama 1976).

Calculation of Expected and Abnormal Returns

The purpose of the event study methodology is to test the deviation between expected returns and actual returns. Differences in the result of such studies might occur from the choice of the expected return model, the abnormal return aggregations, and the statistical tests applied.

Some commonly adopted expected return models include the mean returns approach (Meznar et al., 1998; Teoh et al., 1999), the ordinary least squares approach (Posnikoff, 1997), and the capital asset pricing model (Fama & French, 2004; Wright & Ferris, 1997).

The simplest method to calculate expected returns is the mean return model. This method calculates the average rate of return for a specific security, over a predetermined estimation period and is rather useful for short event windows (Brown and Warner 1980).

Proponents of the market model argue that isolating variations in market returns can analyze the effects of events studied more effectively (MacKinlay, 1997). The capital asset pricing model (CAPM) expands the market model to price securities using both, the market and market risks (MacKinlay, 1997). Brown and Warner (1980) further specify that in the presence of non-synchronous trading, the ordinary least squares (OLS) market regression model can further mitigate biases in returns. Finally, multi-factor models allow researchers to internalize variations in stock prices, to increase the explanatory power of abnormal returns (MacKinlay 1997).

W conducted the analysis using the mean returns, market returns, and capital asset pricing model. The primary expected returns model applied in this study is the capital asset pricing model that calculates expected returns of securities based on systematic risks (Malkiel and Fama 1970). We used the MSCI all-country world index and the one-year US treasury price over an estimation window of 250 trading days before the event window as the external market index and as the risk-free return rate respectively. The expected returns model mitigates instances of non-normality by using logarithmic continuous compounding returns. Finally, mean and market OLS models (see Function 1) were applied as robustness checks for instances of serial correlation and nonsynchronous trading (Lo and MacKinlay 1990).

$$(1)\ R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

The abnormal return (AR) is the difference between the expected and actual return of a given firm on the event day (Function 2). However, this simple calculation only measures abnormal returns for one security at a time, only considers accounts for one trading day, and does not address distributional errors.

$$(2)\ AR_{it} = R_{it} - (\alpha_i + b_i R_{mt})$$

In contrast, cross-sectional aggregation combines abnormal returns of multiple firms in a sample into one average abnormal return (AAR) (Function 3). Furthermore, time series aggregation can extend the event window by combining abnormal returns over many days to one cumulative abnormal return (CAR) (Function 5). Therefore, abnormal returns have been aggregated to a cumulative average abnormal return (CAAR) that takes both, time and the number of shares, into account (Function 6). Finally, in-line with other studies, we used the standardized abnormal return (SAR) to divide the residuals by their standard error for normalizing the data (Dodd and Warner 1983) (Function 4).

$$(3)\ AAR_{it} = \frac{1}{N}\sum_{i=1}^{N} AR_{it}$$

$$(4)\ SAR_{it} = AR_{it}/SD_{it}$$

$$\text{Where } SD_{it} = s_i^2\sqrt{1 + 1/T_i + \frac{(R_{mt}-R_m)^2}{\sum_{t=1}^{T}(R_{mt}-R_m)^2}}$$

$$(5)\ CAR_{it} = (1/k^{0.5})\sum_{t=1}^{k} SAR_{it}$$

$$(6)\ CAAR_{it} = 1/n \times 1/[(T-2)/(T-4)]^{0.5}\sum_{i=1}^{n} CAR_{it}$$

Statistical Model

We tested the difference between expected and abnormal returns for statistical significance. Several test statistics have been applied depending on aggregation and probability distributions. One possible test statistic is a t-test for the ratio of the mean excess return for one firm on the event day to its estimated standard (Wright and Ferris 1997). This ratio, however, raises concerns of cross-sectional correlation among firms on the event day and of event-induced volatility over multiple days.

In contrast, cross-sectional adjusted t-tests, (Posnikoff 1997), divide the average residual by the cross-sectional standard deviation. The test implicitly assumes that abnormal returns are uncorrelated and that event-induced volatility is insignificant (Brown & Warner, 1985). However, if events are correlated, standardized returns can be used (Armitage, 1995). Tests of standardized returns have a greater statistical power than the other tests described above (Boehmer et al., 1991; Kolari & Pynnönen, 2010; MacKinlay, 1997).

In-line with other event studies, this study adopts a standardized cross-sectional (BMP) test as the primary significance test (Boehmer et al. 1991; Kolari and Pynnönen 2010). Standardized tests are preferential to traditional parametric tests because of their statistical power and wider applicability in instances of cross-sectional correlation and event-induced volatility. Standardized parametric tests are also preferential to non-parametric tests when abnormal returns are normalized and continuous. Furthermore, the cross-sectional BMP test can better account for cross-sectional and event-induced variance across a sample set (Kolari and Pynnönen 2010). This availability is important if the sample firms share common event days or a common industry. Finally, the adjusted BMP test depresses the test statistic when the general market correlates with industries, as in the case of the fossil fuel industry (Function 7).

$$(7)\ Z_{BMP,t} = \frac{1/n \sum_{i=1}^{n} SAR_{it}}{\sqrt{1/n(n-1) \sum_{i=1}^{n}(SAR_{it} - \sum_{i=1}^{n} SAR_{it}/N)^2}}$$

Robustness tests, such cross-sectional t-test, crude dependence test, Patell test, and sign test have been conducted as robustness checks, to test for conflicting results.

Results

The following section reports on the results of the study. First, we present the descriptive statistics of the sample set. Then we inform about the results of the statistical tests.

Descriptive Statistics

Overall, we analyzed 24 independent event announcements between 2012 and 2015 over a sample of 199 coal, oil, and gas firms. Of the 200 publicly traded companies listed by Carbon Underground 200, one stock ticker (coAL) was not accessible on the WRDS.

Table 1 presents the descriptive statistics of the entire sample and the benchmark during the entire period and the event windows. The mean and median returns are zero, the standard deviation is approximately 0.011, and the distribution of the sample is leptokurtic and slightly skewed to the left. The data suggests that the financial returns of the Carbon Underground 200 firms between 2012 and 2015 are similar to the benchmark. The data across 521 days (pre- and post-event windows) surrounding the event periods, however, suggests that the financial returns of Carbon Underground 200 firms are lower than the benchmark.

About here Table 1

Not all events underperformed relative to the market index. Six of the twenty-four events had a positive cumulative average abnormal return (CAAR) over the estimation period (-250, -11) relative to the market model. We conducted a t-test to compare whether events during a phase of increasing return over the estimation window had a statistically significant different return on the day of the event relative to events during a phase of decreasing returns (p = .3). This suggests that the industry did not underperform significantly over the estimation window for all events nor that the underperformance correlates with negative abnormal returns on the day of the event. Moreover, many events did not notice a statistically significant negative drop; eleven events outperformed the expected return on the event day (Figure 1).

About Here Figure 1

Figure 2 presents the average performance of fossil fuel shares, normalized across 24 independent event dates, relative to the MSCI market benchmark. The figure suggests that fossil fuel returns are depressed during the event and post-event window.

About here Figure 2

Aggregate Tests

The following aggregate and independent tests measure the statistical significance of the difference between abnormal returns surrounding divestment events and expected returns. The results suggest significant lower returns of fossil fuel shares compared to the benchmark.

The first set of tests aggregates the returns of all divestment events, around their respective event dates. A statistically significant abnormal return across an aggregate of events indicates that its influence is significant. The second set of tests will look at each event independently.

Abnormal returns are assessed up to 10 days before and after the event date, called day 0. Using the capital asset pricing model and standardized cross-sectional BMP tests, the results indicate an abnormal return of -0.127 percent on the event day 0. This result is statistically significant (p = .04, t = -1.76)**.** Table 2 presents the distribution of daily abnormal returns around divestment events. The negative excess return for multiple announcements indicates an effect across companies and events. Divestment announcements cause statistically significant negative excess returns on the event date. Furthermore, the results suggest a long-term 250 day effect ($p < .001$, $t = -11.79$). Furthermore, statistically significant abnormal returns occurred in the 1-, 2-, and 5- day intervals.

About here Table 2

We note that the results used the capital asset pricing model for the estimation window and the BMP test as the statistical model. However, the analysis was also conducted using the mean returns and market OLS estimation models as well as the cross-sectional t-test, crude dependence test, Patell test, and sign test as statistical tests. In all, 15 robustness checks were conducted; we present the results of these checks in Table 3 below. The mean returns model is exposed to idiosyncrasies among fossil fuel shares and thus, depress the excess returns and result in false negative test results. The market model and CAPM yield similar results; however, the latter is slightly more sensitive as it accounts for market risks. Tests of standardized returns (including the crude dependence test, Patell test, and BMP test) are preferred for their ability to account for cross-sectional correlation and event-induced variance, which is important when the sample shares common event days or a common industry. The following section presents the impacts of the events individually.

About here Table 3

Independent Tests

Independent tests examine the abnormal returns of each event individually. Cumulative abnormal returns (CAR) are measured across one, two, five, and ten days around the event date, using the capital asset pricing model and standardized cross-sectional BMP tests. Table 4 indicates that many but not all divestment events have a significant effect on share prices.

About here Table 4

The first observation from the individual results is that some events are more influential than others are. Of the selected events, the most influential one fell around the third weekend of September 2014, which included the New York People's Climate March, the Rockefeller

Fund's divestment announcement, and the 2014 UN climate summit. In contrast, the least influential events include the Global Divestment Day campaign and the Guardian Media Group's divestment announcement. Figure 3 presents this distribution of impacts.

About here Figure 3

Furthermore, there is a tipping point at which divestment events have longer-term impacts on fossil fuel stocks. Events after September 19, 2014 (the Rockefeller Fund's divestment announcement) have longer-term negative abnormal returns spanning as far as ±10 days around the event day indicating a shift in the investors' long-term perceptions of divestment events over the last years.

Furthermore, the post-event window (11,260) assesses whether the influence of the divestment announcement persisted beyond the event window or experienced a rebound effect after the event. 17 of the 24 announcements resulted in a long-term negative impact on the fossil fuel industry's share price compared with the benchmark up to one year after the announcement (see Figure 3). Finally, the results suggest a significant long-term negative impact of all events compared to the estimation window (see Table 4).

Discussion and Conclusion

This study contributes to the knowledge on the impact of ethical investment behavior on share prices of the fossil fuel industry and consequently on their ability to explore and exploit fossil fuel resources. Hence, it addresses a gap that is neglected in conventional finance research (Diaz-Rainey et al. 2017). Our results suggest that divestment announcements by important stakeholders have a statistically significant negative impact on the price of fossil fuel shares and therefore can influence the financial performance of fossil fuel companies. Together with the findings by Ekwurzel et al. (2017) who trace nearly two-thirds of total industrial CO_2 and CH_4 emissions to 90 major industrial carbon producers, divestment has the potential to influence the emissions of the major climate change contributors.

Our results are in-line the studies by (Wright and Ferris 1997) and (Meznar et al. 1998) that announcements of divestment lead to negative returns. Hence, the findings of this study complement the results of significant negative returns in the short run but also suggests a long-term impact.

This study suggests that if powerful and legitimate stakeholders announce divestment because of an urgent matter, such as climate change, they can influence share prices of affected industries. Similar to announcements about environmental fines (Klassen and McLaughlin 1996), or about breaches of codes of conduct (Amer 2015), divestment announcements affect fossil fuel share prices.

Concerning the social movement theory, media influence may have also played a role in legitimizing secondary stakeholders. Social norms in financial market reinforce this effect (Liston 2016). Not only has the divestment movement communicated social norms with regard to financial risks of climate change (such as stranded assets) but so have financial market players, such as the governor of the Bank of England (Carney 2015) as well as the Task Force on Climate-Related Disclosures (2016) who have warned about climate-related financial risks. Consequently, divestors can contribute to a decline in fossil fuel production that is needed to achieve the climate goals (Erickson and Lazarus 2018).

Of course, the most common criticisms would stand that the lower share prices, might simply be caused by market forces or declining oil prices. However, this study has several robustness checks in place to isolate the impact of events. Moreover, we compare the performance of the industry to the market index over an estimation, event, and post-event window. The results show that while expected return across the period for the fossil fuel portfolio and the market index are aligned, there is a decoupling between both around the event window. This result carries through the post-event window, where the market index and fossil fuel portfolio continue to run in parallel, albeit at a lower price.

In-line with Harris and Gurel (1986), we conclude that ethical divestors can create a demand shift for fossil fuel shares through increasing the cost for financial capital and decreasing the solvency of fossil fuel firms. Both, capital cost and solvency are important impacts on the ability of fossil fuel companies to explore and exploit their resources. The question, however, whether the decrease in share price influences the business strategy of affected companies is still open and should be addressed in future research. Though lower share prices increase the costs for financial capital (Modigliani and Miller 1958), the effect on the exploration of new fossil fuel resources (Jaccard et al. 2018) is still unclear. Furthermore, the impact of divestment on fossil fuel extraction in different parts of the world should be analyzed to address equity considerations regarding fossil fuel extraction (Kartha et al. 2018).

To shareholders, divestment does have a place in the ethical investors' toolbox, as a means to influence the corporate objectives of the fossil fuel industry. However, not all pledges to divest will be equally impactful. For instance, the Guardian Media Group divested its one-billion-dollar fund with little influence whereas the University of Oxford pledged to divest an endowment which held no shares much greater impact.

To the advocates of divestment, the results suggest that divestment does have an impact on the industry, but does not infer that divestment will have an impact on corporate objectives. To the fossil fuel industry, the fossil-fuel divestment campaign has affected the industry's share price, as markets perceive these threats as credible to the industry's expected returns. Hence, it is in the industry's best interest to engage with shareholders and stakeholders alike, to address their concerns. To stakeholders, these results encourage continued discourse on the topics of stranded assets and the carbon budget, as equally influential to the divestment movement.

As a strategy, shareholders can pressure the fossil fuel industry by announcing divestment if other strategies, such as shareholder engagement, do not lead to a change in the addressed fossil-fuel firms. Further, to increase the influence of a fossil-fuel divestment announcement, a socially responsible shareholder might establish shareholder associations that announce divestment instead of announcing it individually.

Stakeholders can also pressure the financial industry to offer more fossil-free products, such as mutual funds, to provide fossil-free divestment opportunities. Furthermore, stakeholders might inform conventional investors about the financial risks of being invested in fossil fuels to achieve change.

Generally, it seems that strategies that create awareness of financial market participants are most helpful. Instead of 'preaching to the converted' (environmentalists, SRI investors), divestment announcements should address financial market participants.

Regarding the divestment literature, this thesis provides the empirical basis against theoretical literature and provides the groundwork for more detailed empirical analysis in future studies. To reiterate, however, this study cannot make any inference to the long-term effect of divestment. As such, the results do not confirm that divestment can 'force change' on the industry but that divestment has contributed to depressing share prices of fossil fuel firms

Numerous opportunities for further research on the topic of divestment can be pursued. First, this thesis can be extended to more succinctly measure the impact of different events, by further categorizing and comparing between events and subsamples. Moreover, we concede that further analysis of more recent events that were not under a period of downturn should be a priority in this research agenda. Third, the impact of divestment can be compared to the impact of other climate change strategies, such as engagement initiatives. Fourth, even if divestment announcements influence stock prices, this study does not guarantee to meet the climate goals or that the industry has faced financial pressures to reduce emissions.

Similarly, it does not include an analysis of whether divestment is the right move for shareholders. Divestment can also be studied through the lens of the divesting intuition, applying signaling theory to understand why divesting institutions pledge to divest from fossil fuels, even if the action may not be in the divesting firm’s favour. Finally, studies could analyze the role of investment and divestment for other climate-related fields, such as land use (Forsell et al. 2016), low carbon feed source alternatives (Walsh et al. 2015), and nutrient availability (Fernández-Martínez et al. 2014).

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Figures and Tables

Table 1: Descriptive statistics of sample and benchmark between 2012 and 2015, and during the event periods

Descriptive Statistics	"Carbon Underground" between 2012 and 2015	MSCI ACWI Benchmark between 2012 and 2015	"Carbon Underground" around events	MSCI ACWI Benchmark around events
Average Daily Return of Security	0.000	0.000	-0.011	0.017
Cumulative Return Over Time	-0.534	0.035	-0.293	0.461
Median	0.000	0.000	-0.005	0.019
Standard Deviation	0.012	0.005	0.062	0.051
Skewness	-0.234	-0.986	-0.183	-0.326
Kurtosis	9.765	9.695	-0.643	-0.238

Table 2: Abnormal returns (AR) and cumulative abnormal returns (CAR) by day and by multi day intervals around events

Event Day / Interval	AR	CAR	BMP Test	P-Value
-260	-0.02	-0.02		
-10	0.07	0.04	0.54	0.70
-9	0.04	0.09	0.96	0.83
-8	0.04	0.13	0.24	0.59
-7	-0.04	0.09	-0.43	0.33
-6	-0.11	-0.02	-1.08	0.14
-5	-0.04	-0.06	-0.37	0.35
-4	0.04	-0.02	0.77	0.78
-3	-0.02	-0.04	-1.08	0.14
-2	-0.10	-0.13	-0.24	0.40
-1	-0.05	-0.19	-1.25	0.11
0	-0.13	-0.31	-1.76	0.04
1	-0.15	-0.46	-1.22	0.11
2	-0.03	-0.49	0.09	0.54
3	0.00	-0.49	0.32	0.63
4	-0.18	-0.67	-0.46	0.32
5	-0.10	-0.77	-0.32	0.37
6	0.03	-0.74	0.61	0.73
7	-0.01	-0.75	0.13	0.55
8	-0.08	-0.84	-1.16	0.12
9	0.03	-0.81	0.61	0.73
10	-0.01	-0.81	-0.20	0.42
260	-0.09	-0.90	-11.79	<.001
(-1,1)		-0.23	-1.95	0.03
(-2,2)		-0.26	-1.76	0.04
(-5,5)		-0.39	-1.83	0.03
(-10,10)		-0.11	-1.29	0.10

Table 3: Robustness tests by expected return models and statistical models on the day of the announcement aggregated across all events

Expected Returns Models	Statistical Test	P-value
Mean Model	CSect	-0.18
	CDA	-0.47
	PatellZ	-0.13
	BMPZ	0.06
	Sign	0.585
Market OLS	CSect	-1.11
	CDA	-4.58**
	PatellZ	-1.65*
	BMPZ	-1.51
	Sign	-0.55
Capital Asset Pricing Model	CSect	-1.43
	CDA	-5.73**
	PatellZ	-1.88*
	BMPZ	-1.76*
	Sign	-1.476

Table 4: Effect of Divestment Events on Fossil Fuel Share Price, by Event

Date	**Announcement**	**Intevals**							
		1		**2**		**5**		**10**	
9/19/2012	Do the Math Campaign	-7.54	0.00 **	-7.88	0.00 **	-3.18	0.00 **	6.73	1.00
5/1/2013	Naomi Klein Endorsement	-2.91	0.00 **	2.91	1.00	8.84	1.00	2.66	1.00
5/14/2013	Swarthmore College Divests	-3.37	0.00 **	-0.19	0.42	4.67	1.00	1.90	0.97
10/7/2013	SAP Publication Campaign	-2.59	0.00 **	-0.96	0.17	-0.87	0.19	-0.81	0.21
4/10/2014	Desmond Tutu Endorsement	0.31	0.62	-0.52	0.30	0.20	0.58	2.66	1.00
5/6/2014	Stanford University Divests	0.61	0.73	-0.05	0.48	2.81	1.00	-1.33	0.09
7/11/2014	World Council of Churches Divests	-1.67	0.05 *	-0.71	0.24	-4.42	0.00 **	-0.85	0.20
6/25/2014	British Medical Association Divests	-2.15	0.02 *	-0.59	0.28	3.02	1.00	-0.42	0.34
8/6/2014	Al Gore Endorsement	-2.42	0.01 *	2.30	0.99	-3.18	0.00 **	1.62	0.95
8/8/2014	Glasgow University Divests	1.68	0.95	0.14	0.55	-1.23	0.11	-1.10	0.14
8/25/2014	BNEF Publication Campaign	-1.19	0.12	-2.52	0.01 *	2.92	1.00	0.92	0.82
9/19/2014	New York Climate March Campaign	-5.99	0.00 **	-4.35	0.00 **	-5.66	0.00 **	-8.47	0.00 **
9/22/2014	Rockefeller Fund Divests	-6.34	0.00 **	-6.63	0.00 **	-6.20	0.00 **	-9.57	0.00 **
10/7/2014	Australian Pension Fund Divests	-4.95	0.00 **	-8.50	0.00 **	-9.81	0.00 **	-11.66	0.00 **
11/3/2014	Ban Ki-moon Endorsement	-0.62	0.27	0.34	0.63	3.41	1.00	0.50	0.69
11/24/2014	Norway Pension Fund Divests	0.67	0.75	-0.74	0.23	-7.57	0.00 **	-8.22	0.00 **
2/12/2015	Global Divestment Day Campaign	7.81	1.00	0.55	0.71	1.27	0.90	4.27	1.00
3/16/2015	Nick Nuttall Endorsement	-3.29	0.00 **	-0.96	0.17	-4.75	0.00 **	-7.38	0.00 **
4/1/2015	Guardian Media Group Divests	1.56	0.94	5.64	1.00	4.05	1.00	9.29	1.00
4/30/2015	Church of England Divests	1.79	0.96	1.90	0.97	-1.74	0.04 *	-2.54	0.01 *
5/18/2015	University of Oxford Divests	-3.57	0.00 **	-2.62	0.00 **	-2.73	0.00 **	-5.07	0.00 **
6/23/2015	Lutheran World Federation Divests	2.95	1.00	-4.81	0.00 **	-7.39	0.00 **	-8.82	0.00 **
9/22/2015	Four year anniversary Campaign	-8.56	0.00 **	-9.77	0.00 **	-9.34	0.00 **	1.03	0.85
10/20/2015	Oslo, Norway Divests	-7.02	0.00 **	-4.28	0.00 **	-7.09	0.00 **	3.65	1.00

Notes:
**p<0.05, **p<0.01*

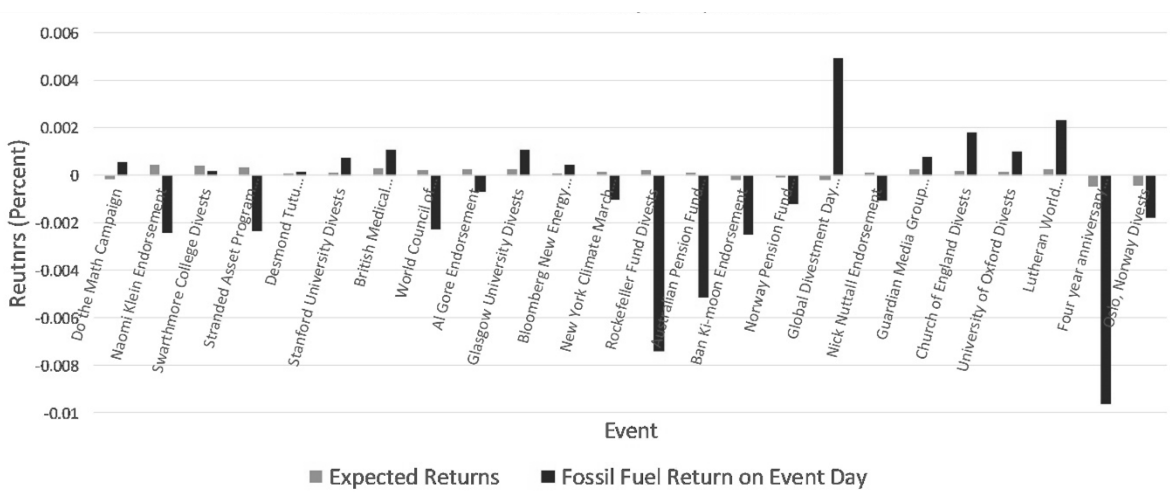

Figure 1: Fossil fuel returns on event day relative to expected returns for each independent event

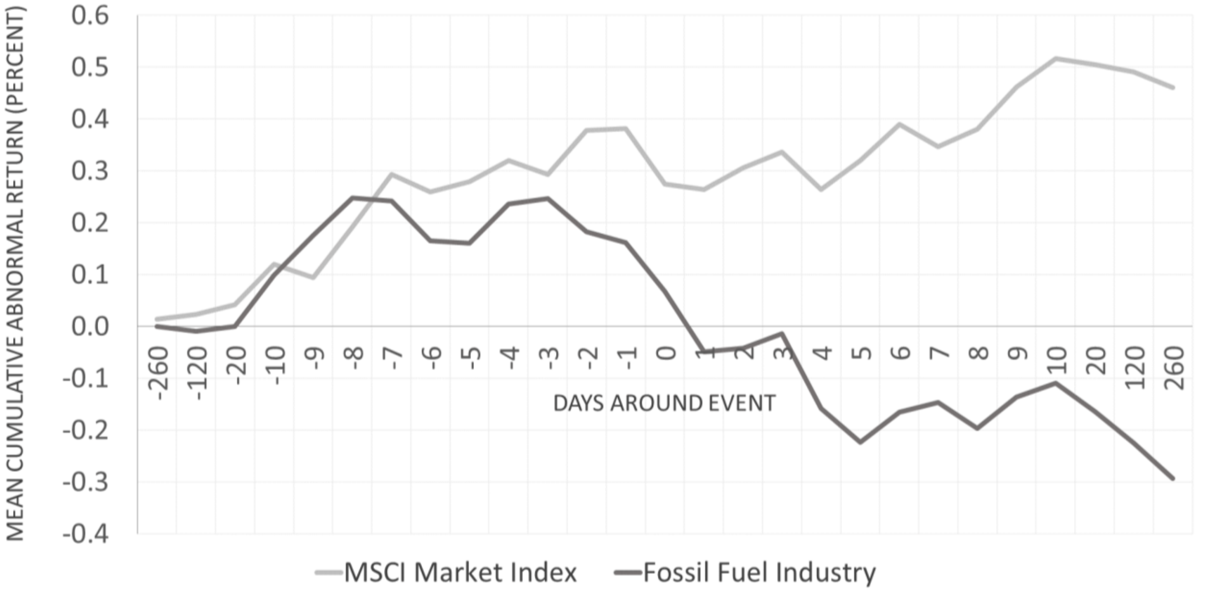

Figure 2: Aggregate fossil fuel returns around event day relative to market index

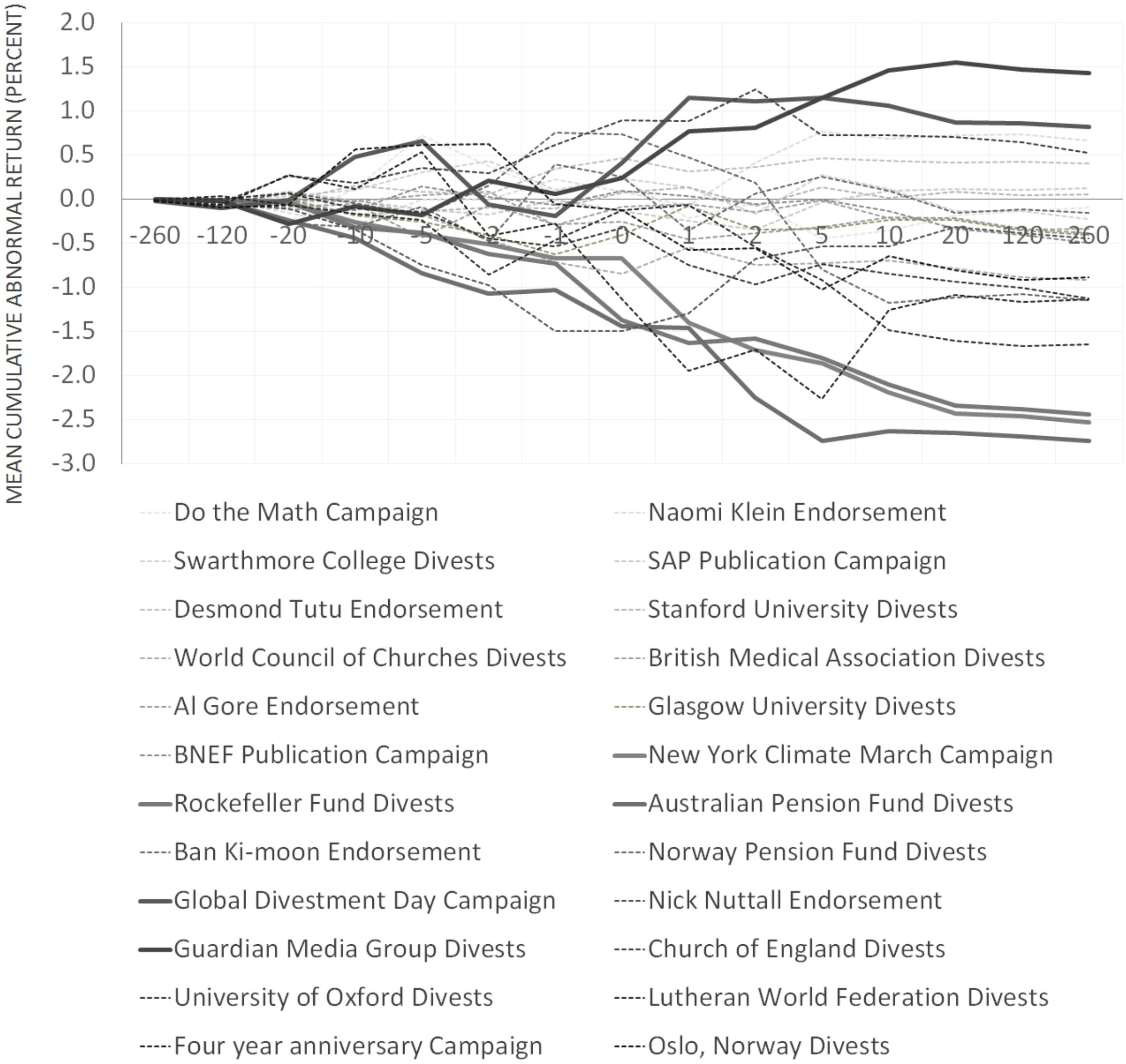

Figure 3: Effect of independent divestment events on share price relative to the Market Index