

An Event Study Analysis of the
Fossil Fuel Divestment Movement

by

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AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

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ABSTRACT

In a relatively short time, the fossil-fuel divestment movement has emerged with global momentum, in light of the industry's influence on carbon induced anthropogenic climate change. Divestment is pursued by investors as a means to either mitigate against the risks of a tightening carbon budget and of stranding assets or as a means of activism to force change on the fossil fuel industry. Literature on the topic to date suggests that divestment may have a direct impact on share prices or indirect impact stigmatizing the fossil fuel industry. Conversely, skeptics argue that divestment may be too small to have a measurable impact. However, there is no empirical study that distinctly measures the impact of divestment and related events on the fossil fuel industry.

The objective of this thesis is to objectively measure the impact of divestment events and compare its efficacy relative to similar events. Thus, the purpose of this thesis is two-fold, asking whether divestment events impact the fossil fuel industry and whether divestment events are more impactful than events on the carbon budget and stranded assets. In line with existing literature from the anti-Apartheid divestment movement, this study adopts the event study methodology to measure the impact.

The findings indicate that announcements of fossil-fuel divestment, stranded assets, and the carbon budget do negatively impact the share price of fossil fuel firms equally, on and around the event date. These results infer that the financial market perceives divestment and related events to be a material threat to the performance of fossil fuel firms. This thesis contributes to existing literature on fossil-fuel divestment by strengthening the ethical case that divestment can not only 'do well' as a financial tool but 'do good' as an activism tool as well.

Keywords: Fossil Fuel Divestment, Carbon Budget, Stranded Assets, Event Study

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TABLE OF CONTENTS

LIST OF FIGURES	vii
LIST OF TABLES	viii
CHAPTER 1. INTRODUCTION	1
CHAPTER 2: DIVESTMENT.....	3
2.1 Defining Divestment.....	4
2.1.1 Divestment as a Socially Responsible Investment.....	5
2.1.2 Divestment as a Social Movement.....	5
2.2 The History of Divestment Campaigns.....	6
2.2.1 The anti-Apartheid Divestment Campaign	6
2.2.2 The Fossil-fuel divestment Campaign	7
2.2.3 Comparing the Divestment Campaigns	7
2.3 The Two Sides of Divestment.....	8
2.3.1 Investors as Shareholders.....	8
2.3.2 Investors as Stakeholders	10
2.4 Conclusion and Next Steps	12
CHAPTER 3: THE CARBON BUDGET AND STRANDED ASSETS	13
3.1 The Carbon Budget	14
3.1.1 Carbon Dioxide and Climate Change	14
3.1.2 Quantifying the Carbon Budget.....	14
3.1.3 Industry Response to the Carbon Budget.....	15
3.1.4 Investor Response to the Carbon Budget.....	16
3.2 Stranded Assets	17
3.2.1 Risks to Asset Stranding	17
3.2.2 Industry Response to Stranded Assets	19
3.2.3 Investor Response to Stranded Assets	20
3.3 Conclusion and Next Steps	21
CHAPTER 4: RESEARCH	22
AND THEORY.....	22
4.1 Literature Gap	23
4.2 Research Question	23
4.3 Theory and Hypothesis	24
4.3.1 Efficient Market Hypothesis	24
4.3.2 Stakeholder Theory.....	25
4.4 Limitations of the Study.....	27
4.5 Conclusion and Next Steps	28
CHAPTER 5: METHOD	29
5.1 The Event Study Method	30
5.1.1 Applications of Event Studies.....	30
5.1.2 Validity	32
5.2 The Model Design.....	33
5.2.1 Define the Event	33
5.2.2 Define the Event Windows	37
5.2.3 Define the Sample.....	39
5.3 The Statistical Design	41

5.3.1 Expected Returns	41
5.3.2 Abnormal Returns	43
5.3.3 Tests for Statistical Significance.....	44
5.4 Conclusion and Next Steps	46
CHAPTER 6: RESULTS	47
6.1 Hypothesis One.....	48
6.1.1 Aggregate Results of Divestment Events	48
6.1.2 Independent Results of Divestment Events	50
6.2 Hypothesis Two	55
6.2.1 Aggregate Results of Related Events.....	55
6.2.2 Independent Results of Related Events.....	58
6.2.3 Comparing Events.....	60
6.3 Conclusion and Next Steps	62
CHAPTER 7: DISCUSSION.....	63
7.1 Linking Results to Literature	63
7.2 Justifying the Results	64
7.3 Contribution of Research	65
7.4 Opportunities for Further Research	65
CITATIONS	66

LIST OF FIGURES

Figure 1: Aggregate Plot of Divestment Events	50
Figure 2: Plot of Independent Divestment Events	53
Figure 3: Grouping Samples and Events	54
Figure 4: Plot of Independent Stranded Asset and Carbon Budget Event	57
Figure 5: Plot of Independent Stranded Asset and Carbon Budget Events	60
Figure 6: Plotting the Impact of Divestment, Stranded Asset, and Carbon Budget Events ...	61

LIST OF TABLES

Table 1: Divestment Events	35
Table 2: Carbon Budget and Stranded Asset Events	36
Table 3: Aggregate Statistical Test of Divestment Events	49
Table 4: Independent Statistical Test of Divestment Events	51
Table 5: Aggregate Statistical Test of Stranded Asset and Carbon Budget Event	56
Table 6: Independent Statistical Tests of Stranded Asset and Carbon Budget Events	59
Table 7: Comparing Divestment Events to Stranded Asset and Carbon Budget Events	61

CHAPTER 1. INTRODUCTION

Fossil-fuel divestment has ballooned to become one of the largest divestment campaigns in a few short years. It is often cited as a tool to force change on the fossil fuel industry, by directly depressing share prices or indirectly stigmatizing the industry across salient political and economic stakeholders. However, the impact of fossil-fuel divestment to date is just postulation. This thesis aims to measure the impact of divestment and related events on the fossil fuel industry by measuring deviations in the share price of carbon-major corporations.

The motivation for this thesis is the need to understand whether the fossil-fuel divestment movement does in fact impact the fossil fuel industry as it is perceived to. Conflicting results on whether divestment had a measurable impact in the context of the anti-Apartheid campaign warrants further analysis in the context of the fossil-fuel divestment movement. To measure the impact of fossil-fuel divestment events on the share price of carbon major firms, this thesis adopts an event study method. The event study method measures how markets price new information that is perceived to be relevant to the expected returns of the fossil fuel industry. Notably, instead of measuring the real corporate response to divestment, this study infers how markets perceive the announcements and how their perception of the announcement is priced into the industry's share value.

The study adopts an intertemporal event study methodology, which measures the direction and magnitude of divestment related events on the stock performance of the fossil fuel industry. The event study analysis is a quantitative and empirical research method, which statistically measures cause-and-effect relationships between select events and fossil fuel securities. The study cites stakeholder theory, to explain why divestment related events influence the fossil fuel industry. Finally, the research adopts an epistemological and exploratory scientific perspective, and a post-positive and pragmatic world view. The following research framework will provide the high level perspective needed to further build the methodological framework required to address the gap in literature.

The results of this thesis asserts that announcements of divestment are perceived to be material to the industry, as average returns experience a statistically significant decline on the day of the event. The results also state that announcements related to stranded assets and the carbon

budget have comparably significant declines in share price around the event day. The results are therefore in favour of divestment as an effective means to directly impact the share price of the fossil fuel industry.

The results are most significant for advocates of fossil-fuel divestment, as a means to justify the impact of pursuing divestment for an investor. The study also advances event study literature on divestment and more broadly, corporate social responsibility by strengthening the argument that investors can influence corporate objectives through shareholder activism. Finally, the results are important for the fossil fuel industry, because it attests that fossil fuel divestment and related events all have a significant and continued negative impact on the share value of fossil fuel firms.

CHAPTER 2: DIVESTMENT

This chapter presents an introductory perspective of the divestment movement. Divestment as a social movement has been adopted in the past, most recognizably against the human rights violations of the Apartheid system. Fossil-fuel divestment has recently emerged as a means to raise discourse on the ‘carbon budget’ and ‘stranded assets’, which cites that the majority of proven carbon reserves must remain grounded and rendered worthless, if global temperatures are to be stabilized under the 2°C target. Divestment is thus most commonly pursued as means of shareholder activism to weaken the industry and limit carbon emissions, or as a means of risk management against the impacts of asset stranding. Thus, the duality of the divestment campaign as a means to ‘do well’ and ‘do good’ will be discussed below.

2.1 Defining Divestment

Divestment is defined as a socially motivated decision by private wealth owners or institutional investors to withhold capital from firms involved in a perceivably reprehensible activities (Ansar, Caldecott, & Tilbury, 2013; Kaempfer, Lehman, & Lowenberg, 1987). This definition makes a number of inferences that can be expanded upon.

Divestment is a socially motivated decision as opposed to a strictly financial or economically motivated action. In other words, divestment is often pursued to invoke a moral response, in addition to risk mitigation strategy. In fact, fossil-fuel divestment first gained prominence following Bill McKibben's Do the Math campaign, which encouraged investors to pursue divestment as a means of forcing change on fossil fuel companies (350.org, 2012).

Divestment is pursued by institutional investors who control the funds of university endowments, pension funds, or other large holdings and withhold capital by selling publicly listed shares of carbon-major corporations. As of December 2015, over 3.4 trillion dollars of assets under management (and over 5 billion dollars in funds) have been pledged to be withdrawn from the fossil fuel sector (Arabella Advisors, 2015; Fossil Free, 2015; Nussbaum, 2015). Investors can choose to divest from all fossil fuel stocks or to divest from selected firms by risk profile, subsectors, or worst offenders (Paum, 2015). Withheld capital can directly or indirectly affect a firm's decision.

Finally, in the context of fossil-fuel divestment, the reprehensible activity is defined as the production and development of environmentally unsustainable assets that are at risk of premature devaluation due to a tightening carbon budget. Briefly, the carbon budget explains that nearly 80 percent of proven reserves must remain grounded to limit global temperatures under the 2°C threshold (Meinshausen et al., 2009). If the carbon budget is to be met, the grounded reserves and related activities may suffer premature write-downs and effectively become worthless (Caldecott, Tilbury, & Carey, 2014). Stranded assets and the carbon budget will be discussed in greater detail in chapter 3 below.

2.1.1 Divestment as a Socially Responsible Investment

Divestment can be understood as a form of socially responsible investing (SRI) because it applies ethical screening criteria to select investment decisions (Renneboog, Ter Horst, & Zhang, 2008). These screening criteria can be driven by an ethical conviction to align personal values or societal concerns within investment decisions (Schueth, 2003; Shank, Manullang, & Hill, 2005; Statman, 2006), or as a prudent management tool to internalize environmental or social investment risks (Weber, 2010). In the context of divestment, ethical screening may also be coupled with positive selections which encourages reinvestment toward clean energy developments (Divest-Invest, 2015). Critics argue that socially responsible investments are a constraint to investors (Bello, 2005; Dorfleitner, Halbritter, & Nguyen, 2016) that is motivated by misplaced guilt (Johnsen, 2003) or that socially responsible investments have little influence on corporate behaviour when screened by their business type or industry (Knoll, 2002). In this respect, the purpose of divestment as a socially responsible investment is twofold; to ‘do well’ as a risk management tool and to ‘do good’ as a social activism tool.

2.1.2 Divestment as a Social Movement

Divestment can also be understood as a means of social activism. The movement illustrates how individual stakeholders can collectively mobilize to advocate for social justice (Grady-Benson & Sarathy, 2015). Together grassroots movements of activists have staged multi-day sit-ins, petitions, iconic ‘shantytown’ and ‘human oil spill’ protests, and boycotts where applicable (Pitterman & Markun, 1978; Soule, 1997). These initiatives are often complemented by high profile endorsements and mass campaigns by shareholders and stakeholders alike (Guay, Doh, & Sinclair, 2004; Ngeleza & Nieuwhof, 2005). Thus, the divestment movement is not simply about the pledge to withdraw, but a larger movement preceded by many small-scale dialogues across stakeholders and institutions, which together advocate for social justice.

2.2 The History of Divestment Campaigns

Divestment as a means of addressing a perceived injustice is not a new phenomenon and has been most famously in the context of the racial conflicts and human rights violations of the South African Apartheid (Arnold & Hammond, 1994; Grossman & Sharpe, 1986; Posnikoff, 1997; Rudd, 1979). In smaller part, divestment has been campaigned against the health impacts of tobacco industry (Cogan, 2000; Wander & Malone, 2004), the Darfur genocide (Bechky, 2009; Patey, 2009), Burmese militancy (Freeman, 1996), Israeli war crimes (Makdisi, 2003) and of other ‘sin stocks’ as well (Fabozzi, Ma, & Oliphant, 2008; Hong & Kacperczyk, 2009). The perceived successes of past campaigns are cited as demonstrable examples of why and how fossil-fuel divestment too can effectively influence the fossil fuel industry. The ‘fossil free’ initiative (2014, p. 1) for instance, explicitly states that as the anti-Apartheid divestment campaign “helped break the back of the Apartheid government... we hope that the fossil-fuel divestment movement can help break the hold that the fossil fuel industry has on our economy and our governments”. In this respect, a short comparative analysis of the anti-Apartheid divestment campaign and the fossil-fuel divestment campaign is presented in the following section.

2.2.1 The anti-Apartheid Divestment Campaign

The anti-Apartheid divestment campaign was pursued by European, American, and South African investors (Lansing & Kuruvilla, 1988), as a means to raise awareness of and combat the South African Apartheid legislature that viewed the coloured community as inferior (Ngeleza & Nieuwhof, 2005). The campaign primarily targeted 255 American companies (Coons, 1986) and banks (Gosiger, 1986) for their involvement in Apartheid South Africa. The intention of the divestment campaign was to limit new investments, deprive access to new financial capital, and in turn weaken and overthrow the apartheid regime (Hunt, Weber, & Dordi, 2016). While there is some evidence that investors that chose to divest from companies with South African operations may have suffered reduced earnings (Simon et al., 1985), there is little consensus on whether divestment had any direct or indirect impact on the eventual failure of the Apartheid (Gosiger, 1986; McWilliams & Siegel, 1997).

2.2.2 The Fossil-fuel divestment Campaign

The fossil-fuel divestment campaign is spearheaded by public organizations like universities, faith based groups, governments, and pension funds (Fossil Free, 2015) as a means to raise discourse on the carbon budget, stranded assets, and continued fossil fuel production. The campaign primarily targets 200 of the largest publicly listed fossil fuel firms (Alexeyev, Connolly, Di Rosa, Francis, & Palmier, 2015) based on the potential CO₂ emissions of their reported reserves. In contrast to the anti-Apartheid campaign, the intention of fossil-fuel divestment is to stigmatize the industry and delegitimize the industry's political, economic, and social licence to operate (Vaughan, 2014). Evidence to date suggests that portfolios that reduce their carbon exposure can outperform market indexes (FTSE, 2014; MSCI, 2016) which might predominantly be due to the recent decrease in oil prices. Nevertheless, there is no empirical evidence on the impacts of the fossil-fuel divestment campaign on the industry.

2.2.3 Comparing the Divestment Campaigns

Hunt, Weber, and Dordi (2016) compare the anti-Apartheid and fossil-fuel divestment campaign to assess whether the two campaigns share common strategies, intentions and outcomes. The study infers that while the purpose of the two divestment campaigns does differ (to abolish the Apartheid regime versus force change on the industry) the approaches taken do share some similarities. Most notably, both campaigns aim to coerce a political response by extending regulations against the injustice, limit access to financial capital by augmenting the company's cost of capital, and raise public awareness of the injustice in an effort to revoke the company's social license to operate. Moreover, both campaigns aim to benefit shareholders by ensuring financial returns are comparable and opportunities for reinvestment exist. Thus, while the pressures and motivations to divest are familiar, the intended impacts on violating firms do vary. Once again, there seems to be an emerging trend across divestment campaigns that there are two equally important sides to the divestment debate; one focusing on the financial incentive for investors as shareholders and the other on the moral imperative for investors as stakeholders.

2.3 The Two Sides of Divestment

The two sides of the divestment debate revolve around an investor's opportunity to do well as a shareholder and the investor's mandate to do good as a stakeholder. Grady-Benson and Sarathy (2015) attest that university campaigns are often rejected either because they are perceived to present significant transactional or risk induced costs or that divestment would have negligible influence in combatting carbon emissions. There is however, little consensus to strongly infer either side of each argument, with a large number of prestigious institutions on both sides, choosing to either divest or pursue other means of engagement. The following section looks to expand on both considerations, highlighting cases that support and dispute each argument.

2.3.1 Investors as Shareholders

Investors as shareholders are driven by value maximization. That implies that a rational investor would prefer to invest in the portfolio with the most favourable risk-return profile (Markowitz, 1991; Sharpe, 1994). Under an exclusively financial perspective, the pursuit of divestment must therefore offer competitive or better financial returns. A wide range of literature both supports and critiques that fossil-fuel divestment does, given recent trends, offer a superior risk-return profile.

2.3.1.1 In Favour of Shareholder Impact

Literature in favour of competitive performance is vast across academics and practitioners. There is evidence that the adoption of responsible investments and fossil fuel free portfolios both outperform traditional indexes.

Literature on responsible investments infer that it is favourable to account for environmental, social, and governance (ESG) and sustainability factors in investment decisions. In fact, a publication by UNEP-FI (2015) draws on the argument that the failure to consider for ESG indicators in investment decisions is a failure of an investor's fiduciary duty; integrating ESG considerations in contrast, enables investors to make prudent financial decisions and improve their financial performance. In a similar vein, Walker et al. (2014) propose that investors who account for sustainability criteria within the capital asset pricing model can effectively manage their portfolios to maintain direct returns today, while concurrently mitigating indirect long-

term risks. In contrast to the traditional perspective that responsible investments constrain diversification and thereby performance (Rudd, 1981), recent studies suggest that the performance of socially responsible funds may not differ significantly from conventional funds (Bello, 2005) and may even outperform the conventional investments (Weber, Mansfeld, & Schirrmann, 2012).

In regard to environmental risks from the fossil fuel industry, a number of studies compare the financial performance of prevalent market indices to fossil free counterparts. The MSCI ACWI ex fossil fuels index for instance, tends to comparably or out-perform the MSCI ACWI over a five year period (MSCI, 2016). Another complementary report by the FTSE finds that their counterpart ex fossil fuel index performs competitively with lower volatility than the traditional FTSE developed index (FTSE, 2014). Yet another study by Sustainable Insight Capital Management finds that of three fossil fuel free portfolios created, all outperformed the S&P 500 across 1, 3, and 5 year periods between 2008 and 2013 (Willis & Spence, 2015). Most recently, a study on the Canadian market also finds that fossil free portfolios outperform their associated benchmarks, with a superior risk-return trade-off than traditional portfolios (Hunt, 2016). These results are further attested across analyses conducted by organizations like the Carbon Disclosure Project (Fanelli, 2012) and Impax Asset Management (Simm, 2013), which suggest that by reducing carbon exposure in their portfolio, investors can achieve competitive if not greater returns. Again, economic factors like oil prices have played a predominant role in recent underperformance of the industry.

2.3.1.2 Against Shareholder Impact

In contrast, other studies propose that fossil fuel investment continues to be favourable and the decision to divest can suppress a portfolio's financial performance.

In the context of responsible investments in general, some studies warn that investment constraints may pose significant costs for investors (Geczy, Stambaugh, & Levin, 2005; Renneboog et al., 2008). Other studies postulate that investors may also face a cost of pursuing ethical or exclusionary screening, that may lead to increased risks or decreased returns (Richardson, 1987).

In the context of fossil fuel investments, one study by Bloomberg New Energy Finance proposes that fossil fuel investments remain favourable because they offer the scale, liquidity, growth, and yield that alternative investments cannot compete with (Bullard, 2014). The report further infers the market would require a massive scale-up of new investment vehicles to offer comparable opportunities for reinvestment.

On the topic of fossil-fuel divestment, three studies propose that the decision to divest could harm the financial performance of investors and endowments. The first study indicates that the financial returns from oil and natural gas stocks across the 2000s far out performed the overall performance of American college and university endowments (Shapiro & Pham, 2012). Another study suggests that the “costs to investors of fossil fuel divestiture are highly likely and substantial, while the potential benefits – to the extent there are any – are ill-defined and uncertain at best” (Fischel, 2015, p. 3). The last study calculates that divestment could cost millions in lost returns annually, as endowments exchange portfolio diversification for moral imperatives (Cornell, 2015). Costs to pursuing divestment can also arise from administering a reinvestment program (Ennis & Parkhill, 1986) and, if screening does prove to have a direct impact on the transgressing firm’s stock price, the cost of changes in stock performance as well (Knoll, 2002).

2.3.2 Investors as Stakeholders

Investors as stakeholders play an important role in guiding corporate responsiveness. Those investors who are most salient to the firm (R. K. Mitchell, Agle, & Wood, 1997) also have the most influence on corporate decisions. Under a stakeholder view, investor’s must be certain that their decision to divest does in fact influence the fossil fuel industry. A wide range of literature both supports and critiques this perspective.

2.3.2.1 In Favour of Stakeholder Impact

The influence of shareholder activism can be direct, by reducing the demand for shares in the market or indirect, by stigmatization of the industry. In detail, Paum (2015) proposes that if discourse on divestment is perceived to be a material threat to the valuation of the industry, the efficient market will directly depress share prices in the short term in fear of future consequences to growth projections. Depressed share prices will discount the industry’s projected cash flows, raise costs of capital financing, and weaken production capacity in the

long run. In contrast, Ansar et al. (2013) proposes that divestment will have little direct impact on share prices. The greatest impact would not come by directly influencing the firm's debt or equity, but rather through the indirect stigmatization of the industry. Negative stigma can undermine the industry's reputation with other salient stakeholders (i.e. policy makers and financiers), prompt increasingly restrictive legislation, and weaken investor confidence in the industry.

A report by the OECD highlights two examples whereby the stigmatization of divestment has already prompted corporate response (Baron & Fischer, 2015). Peabody cites divestment in its risk disclosures as a factor that may adversely affect demand for the company's products or securities and the Australian mining industry encourages companies to pursue diversification into renewables and low carbon technologies to strengthen investor confidence. The response therefore infers that divestment may do little in the way of directly affecting the fossil fuel industry's performance, but rather will be most effective in triggering a widespread stigmatization of the industry.

2.3.2.2 Against Stakeholder Impact

Conversely, other studies propose that divestment will do little in the way of influencing the fossil fuel industry and climate targets, due to the industry's size, influence and global entrenchment.

Most recognizably, the direct impact of divestment on equity is argued to be limited given that the small sum of funds being divested cannot significantly perturb stock prices (Ansar et al., 2013; Bullard, 2014). Moreover, the divested equity will simply be acquired by less scrupulous investors relatively quickly and at a discounted rate (Ansar et al., 2013). In this regard, it may be more beneficial to engage with the industry to pursue change.

Global entrenchment of fossil fuels further complicates the pursuit of divestment as a means to meet the carbon budget targets, not only from direct demand for energy but also through the indirect impacts of the industry across other industries. Ritchie and Dowlatabadi (2015) for instance, argue that divesting from all fossil fuel companies would only decrease the UBC endowment carbon exposure by around 3 percent, given the demand for carbon intensive products in other industries. Another study by Knoll (2002) argues that while the anti-

Apartheid campaign was successful because corporations could simply withdraw their business operations in South Africa, corporations involved with fossil fuel developments will not simply stop producing fossil fuels. In the same vein, divestment would not impact national or state owned corporations like NICO and Saudi Aramco, who own a large bulk of proven reserves (Paum, 2015). Finally, it is likely that the decline in stock prices in recent years are more sensitive to changes in price levels than to the reputational risks of divestment (Baron & Fischer, 2015).

2.4 Conclusion and Next Steps

The purpose of this chapter was to explain what divestment is, how divestment campaigns work, and how the fossil fuel campaign is pursued as a means to ‘do well’ and ‘do good’ for investors. To reiterate, fossil-fuel divestment has proliferated as a means for investors to financially disassociate from the fossil fuel industry for either financial or ethical reasons. However, the divestment movement is more than just a pledge to divest; it is a larger means of social activism whereby endorsements, campaigns, which together work to influence the fossil fuel industry. The intention is to raise discourse of the industry’s influence in climate change, through the carbon budget and risks of stranded assets. Finally, for divestment to be pursued the campaign must be perceived to both ‘do well’ and ‘do good’ for the investor.

CHAPTER 3: THE CARBON BUDGET AND STRANDED ASSETS

This chapter presents an in-depth analysis of current literature on the factors that have prompted the development of the divestment movement. The campaign was inaugurated by Bill McKibben's (2012) 'Do the Math' campaign, which stressed the importance of meeting the carbon budget to mitigate the worst of global temperature rise. Meeting this carbon budget however, will strand many of the existing reserves, rendering them unburnable. This chapter expands on the pressures at play to meet the carbon budget and exasperate asset stranding and the implications for investors.

3.1 The Carbon Budget

Carbon emissions must be restricted, to limit temperatures under 2°C warmer than pre-industrial levels. The carbon budget quantifies the limit of carbon emissions that can be safely emitted if global temperatures are to be limited to under 2°C.

3.1.1 Carbon Dioxide and Climate Change

The science of climate change is well understood; the increased production of long-lived greenhouse gases in the atmosphere have on average raised global temperatures by 0.8°C from the pre-industrial era (IPCC, 2014); nearly half of the globally accepted 2°C target that was agreed upon in the Copenhagen Accord (Accord, 2009). Increased concentrations of carbon dioxide (CO₂) emissions, most affiliated with increased fossil fuel use (Quéré et al., 2013), continue to accumulate in the atmosphere well above the safe level of 350 parts per million (ppm), effectively raising global temperatures toward the 2°C threshold (Hansen et al., 2008). For context, mean global emissions currently sit at over 404 ppm (Dlugokencky & Tans, 2016) outpacing the mid-Pliocene era, a time period where natural carbon levels were estimated to be between 360 to 400 ppm, mean global temperatures were two to three degrees warmer than pre-industrial times, northern latitudes (~60°N) were five to ten degrees warmer, and sea levels were at least 15 to 25 meters above modern levels (Stocker et al., 2014). Similar impacts in the global climate system have not been experienced to date, however, the accumulation of carbon through the human activity has been much faster than natural progression. An additional 2°C over preindustrial levels could be disastrous for global food and water systems, human health, ecosystems, and economic assets (IPCC, 2014), irreversibly transforming people and the ecosystems they depend on across an increasingly inhospitable anthropocene era. Thus, to mitigate the worst of catastrophic climate change, global temperatures must be limited to under the 2°C threshold and consequently, carbon emissions must be stabilized at a safe operating space for humanity.

3.1.2 Quantifying the Carbon Budget

A seminal study on carbon emission targets calculates that if global temperatures are to be limited to under 2°C (with 80 percent probability), carbon emissions must be limited to 886 billion tonnes (Gt) CO₂ between 2000 to 2050 (Meinshausen et al., 2009). This is the ‘carbon budget’; the total amount of emittable carbon below the 2°C threshold. To put Meinshausen et

al.'s (2009) carbon budget in context, proven fossil fuel reserves (those which have a 90 percent certainty of being extracted) amount to 2,795 Gt CO₂ (Campanale & Leggett, 2011), over three times as much as what can be safely emitted. As such, no more than one-third of existing reserves can be consumed prior to 2050 (IEA, 2012). To date, global carbon emissions are approximately 32 Gt CO₂ per year, a figure that has negated an additional 321 Gt CO₂ (over one-third) of the carbon budget between 2000 and 2009 alone (Friedlingstein et al., 2010). Simply put, the remaining carbon budget of 565 Gt CO₂ is one-fifth of total carbon potential across the vast majority of proven fossil fuel reserves. Any effort to limit global temperatures at the 2°C target will thus require nearly 80 percent of proven reserves remain grounded. This is the groundwork that inspired Bill McKibben's 'Do the Math' and resulting fossil-fuel divestment campaign, to raise a movement that will address the 'terrifying' new math of climate change (McKibben, 2012).

3.1.3 Industry Response to the Carbon Budget

Reserves of coal, oil, and gas are geographically widespread (BP, 2016). Oil reserves are most abundant in Venezuela, Saudi Arabia, and Canada, natural gas reserves are most abundant in Iran, Qatar, and the Russian Federation, and coal reserves are most abundant in America, Russia, and China. A study on the geographical distribution of fossil fuels suggest that the Middle East holds over half the unburnable oil and gas reserves and at least 90 percent of American and Russian coal must remain untouched in order to meet the carbon budget (McGlade & Ekins, 2015). Moreover, the study infers that unconventional and higher-priced reserves like that of Canadian and Venezuelan oil or of Arctic gas will be priced out of use. Carbon capture and storage (CCS) technologies does have the potential to extend the budget, by effectively preventing fossil fuel emissions from entering the atmosphere. However CCS would at most have a modest effect on overall levels of emissions, increasing the budget by 125 Gt CO₂ in an ideal scenario (Leaton, Ranger, Ward, Sussams, & Brown, 2013; McGlade & Ekins, 2015).

Potential emissions can also be split by ownership as a large majority of emissions is highly concentrated among few nationally owned and privately owned corporations. Heede (2014) calculates that 63 percent of global industrial emissions from 1751 to 2010 (914 gigatonne carbon dioxide equivalent) can be directly traced to 90 carbon major national and privately owned producers of oil, natural gas, coal, and cement. By extension, the top 200 publicly listed

fossil fuel companies (ranked by the carbon emission potential of their fossil fuel reserves) hold a total of 555 Gt CO₂, which is further concentrated among the top few listed corporations (Alexeyev et al., 2015; Campanale & Leggett, 2011). A pro-rata allocation of the global carbon budget would leave 115 Gt CO₂ to be distributed across listed companies from 2015 to 2050 (Leaton et al., 2013). Nevertheless, this has not curtailed continued exploration of new fossil fuel reserves to replace existing production; oil and gas reserves of the top 100 firms grew by 2.5 percent in the 2014 while coal reserves grew by 1.4 percent respectively (Alexeyev et al., 2015).

3.1.4 Investor Response to the Carbon Budget

Markets may be mispricing the risks of unburnable carbon held by listed companies, as valuation is in part calculated by the firm's long-term growth potential. It is estimated that over 50% of a firm's value is dependent on the expected cash-flows a decade into the future (Carbon Trust, 2008). One indicator of future production is the firm's reserve-replacement ratio, an indicator that measures whether a company is replacing more fossil fuels than is producing. Maintaining oil production and in turn firm valuation is therefore dependent on increased capital expenditures toward continually expanding proven, albeit increasingly marginal reserves (Leaton et al., 2013). The Carbon Tracker Initiative (2013) reports that the global 200 publicly listed companies invested upwards of \$674 billion in 2012 alone towards exploration, production, and refining expenditures. Increasingly these companies are investing in new reserves which are more expensive and technical marginal ventures, including bituminous sands, ultra-deepwater drilling, and shale gas production (Stockman, 2011). Moreover, as emissions, growth, and revenues remain concentrated among the largest companies (Alexeyev et al., 2015), smaller marginal producers are at risk of acquisition, as cost effective means for larger companies to expand their proven reserves.

Though it is due to shareholder pressures that firms invest in expanding reserves, investing in companies that continue to replenish proven reserves may be a risky decision. In a 2°C scenario, grounded reserves could put over \$28 trillion at risk; risks most concentrated on high-cost high-carbon sources of production (Lewis, Voisin, Hazra, Mary, & Walker, 2014). To materialize the potential implications of grounded reserves for the industry and its investors, an example in the Carbon underground report (2013) shows that Shell's valuation fell by over £3 billion in 2004 when the company contracted its proven reserves by about 20 percent - a

decision that depressed stock prices by 10 percent within the span of a week (Campanale & Leggett, 2011). Moreover, unburnable carbon poses knock-on effects that not only affect investors, but lenders, pension funds, and indeed individual savers as well. Bank lending exposures may face significant haircuts to the value of their loan books, pension funds may risk funding shortfalls to their pension entitlements as fossil fuel investments falter, and savers may face uncertainties akin to financial bubbles as their investments track carbon intensive markets (Campanale & Leggett, 2011). Financiers must therefore recognize that investing in companies that continue to allocate ever increasing capital expenditures toward replenishing assets that may never be used, may prove to be a risky decision. Notably, in light of these risks, financial institutions are beginning to examine their carbon exposure and developing solutions to reduce their risk (Alexeyev et al., 2015).

3.2 Stranded Assets

In a 2°C scenario, investments in high-carbon developments could be wasted if carbon reserves are to remain grounded. For instance, capital expenditures on the exploration of new reserves would be worthless and infrastructure developments may be mothballed or entirely abandoned before their economic life. In other words, investments in high-carbon developments that cannot be used could effectively become “stranded assets”. Stranded assets are defined as assets that suffer from unanticipated or premature write-downs, devaluations, or conversions to liabilities (Caldecott et al., 2014). The stranding of carbon assets in the case of fossil fuels can be caused by a number of environment-related risk factors that are poorly understood and regularly mispriced (Caldecott et al., 2014).

3.2.1 Risks to Asset Stranding

A scenario analysis of stranded assets by Caldecott et al. (2014) provides an encompassing framework of the most pressing environment related risks that could lead to the stranding of assets. The report infers that government regulations, environmental challenges, changing resource landscapes, technology innovations, evolving social norms, and litigations may be some common risks to asset stranding.

The emergence of stringent government regulations in favour of climate change mitigation, energy efficiency, renewable developments, and human health pose significant risks to continued carbon intensive production. Policies such as carbon pricing and cap and trade are

enforced across national and regional governments, as direct measures to address climate change challenges (Kossoy & Guigon, 2012). Coal faces the greatest regulatory risk, with policy developments like the EU Plant Combustion Directive and the US Clean Air Act that directly target coal-fired power (Paum, 2015). Policies targeting air and water pollution can also place increased pressure on carbon intensive assets without directly restricting carbon emissions. China's thirteenth five-year plan, for instance, aims to aggressively limit factory emissions and water intensity among other initiatives as early as 2021 (Qin, 2016). Policies targeting renewable developments are making alternative sources of energy more widespread in place of conventional fuels. In the US for instance, the Renewable Portfolio Standards (RPS) requires that electricity providers generate or acquire a certain portion of their power from renewable sources, such as wind, solar, geothermal or biomass (Rabe, 2006). Finally, speculation of impending policies encourages markets to react ahead of anticipated regulatory changes. One notable example is the intended national determined contributions (INDCs) that lay the groundwork for global emission reduction legislations over the coming years.

Fossil fuel assets also face stranding from a changing resource landscape. North America's expansion into liquid natural gas (Leaton, 2015) for example significantly disrupted oil demand across OPEC nations (Smith, 2015). In recent years, the fall in oil prices has also emerged as one of the most significant stranding risk to carbon major industries. Globally, the market value of oil and gas companies has dropped by over \$580 billion in just a few months after the decline of the oil price (Paum, 2015). If these trends continue, the market may face a strictly economically-driven decarbonisation.

New innovations in alternative energy may add to the risk of asset stranding. Advancements in energy storage are critical for the transition to renewable power, in the conversion of intermittent outputs to reliable power (Cookson, 2015). Moreover, rapid adoption of electric vehicles and energy efficient engines could further decrease demand for conventional energy sources in transport and infrastructure (Parkin, 2016).

Recent developments in declining demand for conventional fuels may be a larger indication of changing social norms, away from what was once perceived to be a formidable and necessary evil (Whitley, 2015). Reputational damage from initiatives like the divestment movement may have long-term consequences for the industry, revoking the industry's social licence to operate

across a range of stakeholders including investors to customers and employees (Maclean, 2014).

Environmental challenges from increasingly erratic weather systems can also lead to the stranding of assets. The Fort McMurray Wildfire for example, destroyed more than 3,000 structures, stalled oil production for two weeks, and cost insurers nearly 9 billion CAD (Moudrak, 2016).

Litigation may also become a more prominent risk for fossil fuel companies as communities take legal action in favour of the protection of the environment, health and livelihoods (UNEP, 2012). One notable example include opposition to oil exploration in Nigeria, that has adversely affected agricultural land and biodiversity in the region (Frynas, 1999).

3.2.2 Industry Response to Stranded Assets

The impacts of more stringent regulations, economic drivers, innovation, and evolving social norms are already recognizable among fossil fuel sectors, many of which are struggling to remain competitive.

Global coal demand is slowing. Declines are driven by global measures to reduce consumption, increasing pressures to improve efficiency, greater competition from alternative energy sources, and slower economic growth in China (Alexeyev et al., 2015; Maclean, 2014). Additionally, China - representing 50% of global coal consumption (Maclean, 2014) - continues to reduce its reliance on coal-fired power, due to concerns over poor air-quality and its associated health impacts. Oversupply in turn has caused coal prices to fall, most directly affecting new export driven mines to operate at a loss (Alexeyev et al., 2015). Efforts to open new mines in the recently approved Galilee Basin, the largest coal deposit in the world, have struggled to secure financing (Taylor, 2014) given its implications on global coal supply, coal prices, and potential for stranded assets.

The oil sector is facing historically low prices, yet reserves continue to grow. The share of high-cost proven reserves will need to be redefined as probable or possible as a large majority will no longer be economically viable to produce. Major fossil fuel producers have faced credit rating downgrades in the midst of low oil price and rising debt, making it increasingly more

difficult to acquire financing for new developments (Ailworth & Hufford, 2016; Armental, 2016).

3.2.3 Investor Response to Stranded Assets

Investors can take a range of measures to protect their investments from exposure to stranded assets. Strategies vary from holding and engaging with industries to encourage best practices or divesting away from the industry.

Investors who choose to hold fossil fuel stocks can take active steps to diversify away from stranded asset risks by reducing exposure to assets with high risks of stranding or hedging upside potential with opportunities that thrive in a low carbon economy. In some instances, this practice can enhance the value of an investor's portfolio (UNEP, 2014).

Investors who choose to hold can also engage with vulnerable companies, as key stakeholders, to influence corporate strategy in favour of the low-carbon transition. Investors can engage with companies to ensure 1) capital expenditures, acquisitions, and valuations are justified, 2) low-carbon projects are pursued, 3) stranding risks are internalized in equity and debt valuations, 4) executive resolutions account for environmental risks, 5) stakeholders are adequately engaged, and 6) carbon footprints are publically disclosed (Paum, 2015). One recent example of shareholder influence involves pushing the industry to pursue share buybacks, inferring that the company does not have a better plan for the capital other than to return it to the shareholders (Leaton, 2015). Investors can also choose to engage with these companies through collaboration with initiatives like the Investor Group on Climate Change (IGCC), Institutional Investors Group on Climate Change (IIGCC) and the Investor Network on Climate Risk (INCR) that work together to influence public policy and corporate behaviour (Towers Watson, 2015). Investors can otherwise look to organizations like the Sustainability Accounting Standards Board, the Carbon Disclosure Project, and the Asset Owners Disclosure Project, who engage with fossil fuel industries to disclose carbon risks (Generation Foundation, 2013).

Finally, investors can choose to divest from carbon risks by screening out perceivably risky investments as a means to reduce exposure risk or reinvest towards the transition to a low carbon economy.

3.3 Conclusion and Next Steps

The purpose of this chapter was to explicate the importance of the carbon budget and stranded assets, as motivating factors for the fossil-fuel divestment movement. The analysis expands on some key pressures at play - the mounting evidence to limit carbon emissions with a carbon budget and the rising risks of stranded assets - and how these factors have already begun affecting the industry its shareholders. The necessity to restrict emissions to the carbon budget drives the investor's ethical conviction to limit carbon emissions, whereas the risks of stranded assets drive the investor's financial mandate for competitive returns. Discourse on stranded assets or the carbon budget should thus be looked on comparably to fossil-fuel divestment initiatives.

The first two chapters detail the relevance of the carbon budget, stranded assets, and the fossil-fuel divestment movement, as one set of tools to address the issue of carbon induced global warming. The topics once again allude to the financial incentive for investors as shareholders and the ethical conviction for investors as stakeholders, however the results remain unclear.

CHAPTER 4: RESEARCH AND THEORY

This chapter builds on the literature on divestment, stranded assets, and the carbon budget, to present the theoretical framework adopted in this thesis. First, the gap in literature is introduced as a lack of empirical evidence to support that announcements of fossil-fuel divestment, stranded assets and the carbon budget has an impact on the fossil fuel industry. The research question thus asks if instances of announcements of divestment, stranded assets, and carbon budgets have an impact on the share price of fossil fuel companies.

This question is answered in the context of the efficient market hypothesis and stakeholder theory. The efficient market hypothesis explains why announcements of divestment, stranded assets, and the carbon budget will be priced into share valuations if the market believes that divestment will have an impact on the fossil fuel sector. The stakeholder theory explains why announcements of divestment may be more impactful than announcements of stranded assets and the carbon budget.

4.1 Literature Gap

The literature so far suggests that divestment must be perceived as both financially favourable and ethically impactful to be pursued - attesting Grady-Benson and Sarathy's (2015) assertion that fossil-fuel divestment is often rejected for one of those two reasons. Yet the argument for both is conflicting. This thesis will focus on the latter, to measure the impact of divestment and related discourse on the fossil fuel industry. Discourse on divestment and by extension, discourse on stranded assets and carbon budgets may directly (through reduced demand for shares) or indirectly (through stigmatization) influence the industry's long term growth projections (Ansar et al., 2013; Paum, 2015). Critics cite that divestment cannot impact the fossil fuel industry and climate targets due to the influence and entrenchment of the industry. While there is ample postulation on the means by which divestment might or might not impact the fossil fuel industry, there is currently no empirical study to assess whether discourse of these topics have an impact on the fossil fuel industry.

4.2 Research Question

The study seeks to understand whether divestment announcements affect the share price of fossil fuel corporations. Divestment announcements are defined as instances of discourse, such as pledges to divest, endorsements, or campaigns, that present the topic of fossil-fuel divestment to the market. Comparably, announcements on stranded assets and carbon budgets also raise discourse on the topic through regulatory and economic pressures of industry stakeholders. Thus, the impact of divestment and related events on the fossil fuel industry's share price can be studied across two related research questions.

1. Do fossil-fuel divestment announcements have a measureable impact on the security valuation of prominent fossil fuel corporations?
2. Are fossil-fuel divestment announcements more impactful than announcements relating to the carbon budget or stranded assets, in impacting the security valuation of prominent fossil fuel corporations?

4.3 Theory and Hypothesis

To understand why a divestment announcement could impact the share price of fossil fuel firms, this thesis first turns to efficient market hypothesis, a subset of modern portfolio theory, that aptly explains how markets are efficient at immediately reflecting all available information into the price of a security (Fama, 1970). The impact of new information by shareholders of a firm can be estimated by its immediate effect on stock price, much before the corporate response to the new information (McWilliams, Siegel, & Teoh, 1999). In the context of fossil-fuel divestment, the efficient market hypothesis explains why the very discourse to divest funds even before the funds are withdrawn, can immediately influence the stock price of firms in the fossil fuel sector.

In contrast, to understand why announcements related to stranded assets and the carbon budget may be less impactful than announcements related to divestment, this thesis turns to the stakeholder theory (Freeman, 1984). Stakeholder theory explains why actions by stakeholders can influence corporate objectives. Similarly, the impact of new information by stakeholders can be estimated by its immediate effect on stock price, before corporations respond to the new information (McWilliams et al., 1999). In the context of stranded assets and the carbon budget, the stakeholder theory explains why discourse on the topic by regulatory and economic stakeholders can provoke a corporate response, while the efficient market hypothesis explains why the anticipated corporate response by the market can immediately influence the stock price of firms in the fossil fuel sector.

4.3.1 Efficient Market Hypothesis

The efficient market hypothesis explains how all available and relevant information is incorporated into the share price of a firm as soon as the information is publically announced (Fama, 1970). Thus, the efficient market hypothesis can measure the market's response to an announcement well before the 'real' macroeconomic response. Fama (1970) further explains that depending on how information is absorbed, the efficient market hypothesis can take three forms – weak, semi-strong, and strong. This thesis assumes that markets have semi-strong efficiency, such that market prices reflect all compounded historical data and all publicly available information, but not private information. Fama et al. (1969) empirically apply the semi-strong market efficiency hypothesis, to test examine the process by which share prices respond to certain kinds of new information. The study finds that market anticipation (or

speculation) of adjustments in expected returns plays an important role in the pricing of shares. Jensen (1978) expands on Fama's (1969) research to suggest that markets only perceive information as relevant till the point where the marginal benefit of acting on the information does not exceed the marginal cost. Together, Fama's research on the semi-strong-form efficient market hypothesis lays the groundwork for why the impact of new information on a firm can influence the share price of the firm and how to measure this impact using the event study methodology (Fama, 1991).

In the context of announcements related to divestment, stranded assets, or the carbon budget, the efficient market hypothesis explains that if markets perceive new information to be material to the fossil fuel industry's expected returns, the share price will adjust to reflect the new information. Thus, in the context of the first research question, if divestment will impact the fossil fuel industry, the hypothesis stands;

H₀: Announcements will not have a measurable impact on fossil fuel stocks.

H₁: Announcements will have a measurable negative impact on fossil fuel stocks.

The null hypothesis of no measurable response, infers that the market does not value the information as material to the fossil fuel industry. However, under the alternative hypothesis that divestment announcements do lead to a significant negative response, the efficient market hypothesis explains that the market perceives the information as material to the expected returns of fossil fuel firms. It would suggest that markets believe divestment can have a measurable impact on the industry, whether directly through reduced demand for shares or indirectly through the wider stigmatization of the industry. The efficient market hypothesis can be extended to explain the impacts of announcements related to stranded assets and the carbon budget on the fossil fuel industry as well.

4.3.2 Stakeholder Theory

The stakeholder theory explains why firms not only respond to pressures from its shareholders, but from stakeholders as well. It can be applied to understanding whether discourse on stranded assets and the carbon budget can impact a firm's share value, even though these pressures arise from industry stakeholders as opposed to the pressures of divestment by the industry's shareholders. Literature on stakeholder theory is predicated around identifying who a firm's

stakeholders are (Mitchell et al., 1997), what types of influences they exert (Donaldson & Preston, 1995; Rowley, 1997), and how organizations respond to stakeholder influences (Jensen, 2001; Kolk & Pinkse, 2007). In line with the efficient market hypothesis above, if the market perceives stakeholder pressures as relevant to the industry, the share price will reflect the impact of the information.

Stakeholders are most generally defined as a “group or individual who can affect or is affected by the achievement of a firm’s objectives” (Freeman, 1984, p. 46). Examples of stakeholders include governments, communities, employees, customers, suppliers, political groups, trade associations, and indeed, investors as well (Donaldson & Preston, 1995). The theory explains that stakeholders can “explain and guide the structure and operations of the established corporation” (Donaldson & Preston, 1995, p. 70), in much the same way shareholders can influence corporate objectives of a firm. Consequently, stakeholder pressures can also impact the share price of a firm, in line with the efficient market hypothesis. However, not all stakeholder pressures are equally influential in impacting corporate objectives. Mitchell et al. (1997) further categorize the various stakeholders by their power to influence the firm, the legitimacy of the stakeholder’s relationship with the firm, and the urgency of the stakeholder’s claim. Stakeholders that possess more attributes are more influential. For instance, divestment advocates may hold an urgent and legitimate claim but also lack the power to enforce their will on the industry. Governments often hold a dominant role in influencing corporations, though fall short on the urgency or demand to influence corporate action. Comparably, financiers may have the power and legitimacy as dominant shareholders but continue to undermine the urgency of climate change by financing continued fossil fuel production. Finally, shareholders are dominant stakeholders, given their power, legitimacy and urgency to influence corporate action. These actions however are not independent to each other; the theory further explains how stakeholders can in aggregate influence corporate action through the interdependent relationships between multiple stakeholders (Rowley, 1997). The simplest view of the relationship between stakeholders and the firm is defined in Donaldson and Preston’s (1995, p. 69) model, where stakeholders surround and exert influence on a focal organization. It is likely however, that stakeholders also influence each other, influencing not only organization but other stakeholder behaviours as well (Rowley, 1997, p. 891). Thus, divestment is a complex interconnected relationship between the divesting institutions, the fossil fuel industry, and the larger economic sphere. For instance, the New York Peoples Climate March in conjunction with the UN climate summit, preceded one of the most influential dates across the fossil-fuel

divestment movement, which included over 700 independent divestment pledges, including that of the Rockefeller fund, in the span of one day (Divest-Invest, 2014). Thus the stakeholder theory can adequately explain how discourse on stranded assets and the carbon budget, though have no direct influence on fossil fuel shares, can still influence corporate strategies and in turn the share price of fossil fuel companies.

In the context of comparing announcements of divestment to stranded assets and the carbon budget, the stakeholder theory explains why the impact of divestment pursued by dominant stakeholders may be more influential than the impact of discourse on stranded assets and carbon budgets often pursued by indirect stakeholders. Thus, in the context of the second research question, if divestment announcements are more impactful than events of stranded assets and the carbon budget, the hypothesis stands;

H₀: All announcements have an equal impact on fossil fuel stocks.

H₁: Announcements of divestment have a greater negative impact on fossil fuel stocks than announcements of stranded assets or the carbon budget.

The null hypothesis of equal response infers that the market views information related to stranded assets and the carbon budget equally to information related to divestment. In the context of stakeholder theory, this would explain that markets view pressures of indirect stakeholders comparably to the direct pressures of shareholders. Under the alternative hypothesis that divestment announcements do have a greater impact on fossil fuel shares, the stakeholder theory explains that the market perceives shareholders to be more influential than stakeholders in impacting corporate objectives.

4.4 Limitations of the Study

The study is limited in the scope of application and depth of analysis. These limitations however, offer opportunities for further study in the future. First, the scope of research is limited in application. It does not include an analysis of whether divestment is the right move for shareholders, but rather, simply focuses on whether such events have any impact on the security valuation of fossil fuel corporations. Moreover, even if divestment announcements do in fact influence stock price, this study does not affirm that the carbon budget will be met. This is because the study is limited to publicly listed corporations, which hold only a fraction of

proven reserves. Additionally, while regulatory and financial limitations may successfully strand some marginal reserves, global entrenchment of fossil fuel demand will continue to drive production for the foreseeable future. The study also does not directly isolate the simultaneous impacts of declining oil prices in recent years.

Finally, it is also important to recognize that event studies have no predictive ability and thus, cannot infer that continued divestment in the future will have the same impact as past campaigns. Second, the study is limited in its depth of analysis. The study does not differentiate between the impacts of divestment announcements on 1) oil, gas, and coal sectors, 2) country level discrepancies, 3) divestment pledges, campaigns, and events, 4) early versus late divestment announcements. There is evidence that these factors play an important role in influencing stock prices and as such, future event studies on the fossil-fuel divestment movement can more succinctly measure the impact of divestment and related events on fossil fuel security valuations.

4.5 Conclusion and Next Steps

The purpose of this chapter was to theoretically explain why divestment and related announcements may impact the share price of fossil fuel firms. Literature to date postulates why divestment may directly or indirectly influence the industry, but the results are conflicting. Moreover, there is no empirical literature conducted to measure this effect. Thus, the thesis asks if divestment events affect the security valuation of fossil fuel firms and whether divestment events are more impactful than stranded asset or carbon budget related events. The efficient market hypothesis is applied to understanding why divestment and related announcements may have an impact on the fossil fuel industry, if the market perceives the announcement as relevant to the industry. The stakeholder theory is applied to understand why divestment events may be a more impactful than stranded asset and carbon budget events. The next chapter introduces the method used to test whether divestment and related announcements influence the share price of fossil fuel firms.

CHAPTER 5: METHOD

This chapter presents the methodology applied to conduct an event study analysis of divestment announcements on the stock performance of publicly traded fossil fuel companies. Specifically, the event study analysis aims to examine whether the divestment movement influences the firm's stock value, to infer whether shareholders perceive divestment announcements as relevant to the fossil fuel industry. The purpose of this methodology chapter is to explicitly map the steps taken to achieve the study's final results, in a manner that is objective and replicable.

5.1 The Event Study Method

The event study model is an intertemporal statistical tool most commonly applied in accounting, economic, and financial literature as a means to measure the impact of new information on a select firm's share price (McWilliams & Siegel, 2001). The event study is a powerful tool to measure the impact of an event on a firm, because the effect can be observed over a relatively short time period through shifts in stock prices, rather than over a much longer period through direct productivity related outcomes (MacKinlay, 1997). This is because the event study is a test of the efficient market hypothesis, which infers that stock prices adjust to reflect all newly available information that is relevant to the value of the firm (Fama, 1991; Fama, Fisher, Jensen, & Roll, 1969). An event study analysis can thus measure the short run impact of a specific event on the value of a firm, given the assumption that all relevant information is immediately reflected in security prices (MacKinlay, 1997). However, not all information is relevant to shareholders; abnormal shifts are observed only when the profits to be made by acting on the new information exceeds the marginal costs (Jensen, 1978). Thus, negative abnormal returns from divestment announcements may infer that shareholders do perceive fossil-fuel divestment to be a material threat to the value of the industry. This thesis adopts the stepwise procedure from MacKinlay's (1997) seminal paper on event studies in economics and finance.

In its most basic form, an event study simply compares a stock return on a specific event day to its anticipated return subject to a predetermined control period (Corrado, 2011). More specifically, the event study identifies a set of comparable exogenous events and endogenous stock samples, calculates expected returns across an estimation window, and measures the statistical significance of the actual returns to what was expected. Variations along the research design procedure however, can lead to conflicting results, which undermine the external validity of the outcome (McWilliams et al., 1999). The event study literature on anti-Apartheid divestment for example, all post conflicting findings, stemming from variability in the selection of samples and events, length of analysis, and the management of extraneous industry events.

5.1.1 Applications of Event Studies

The breadth of literature that applies the event study methodology is well developed; Kothari and Warner (2004) estimate that five leading journals (the Journal of Business, Journal of Finance, Journal of Financial Economics, Journal of Financial and Quantitative Analysis, and

the Review of Financial Studies) alone encompass a total 565 studies between 1974 to 2000. Event studies are most successfully applied in the area of corporate finance (MacKinlay, 1997), across studies on mergers and acquisitions (Eckbo, 1983; Jarrell, Brickley, & Netter, 1988; Jarrell & Poulsen, 1989; M. C. Jensen & Ruback, 1983), financing decisions by corporations (Asquith & Mullins, 1986; Mikkelson & Partch, 1986; Myers & Majluf, 1984), post-earnings-announcements (Ball & Bartov, 1996; Ball & Brown, 1968; Bernard & Thomas, 1989; Foster, Olsen, & Shevlin, 1984), CEO successions (Beatty & Zajac, 1987; Davidson, Worrell, & Dutia, 1993; Friedman & Singh, 1989; Lubatkin, Chung, Rogers, & Owers, 1989), and a range of other financial considerations (Kothari, 2001; MacKinlay, 1997; C. W. Smith, 1986). Moreover, event studies are also used in law, to measure the effect of regulations (Schwert, 1981) and in cases of insider trading or fraud (Mitchell & Netter, 1994). Some unique but notable cases include event studies on celebrity endorsements (Agrawal & Kamakura, 1995) and strategic investment decisions (Woolridge & Snow, 1990). Equally vast is the scope of literature on event study methodology (Boehmer, Masumeci, & Poulsen, 1991; Brown & Warner, 1980; Campbell, Lo, & MacKinlay, 1997; Cowan, 1992; Lyon, Barber, & Tsai, 1999; MacKinlay, 1997; McWilliams & Siegel, 1997).

A number of event studies also look to topics related to sustainability management, such as the impact of inclusion or exclusion from Dow Jones Sustainability World Index (Cheung, 2010), or organizational environmental performance (Klassen & McLaughlin, 1996). McWilliams and Siegel (1997) further highlight instances of event studies in the field of corporate social responsibility, such as instances of affirmative action programs (Wright, Ferris, Hiller, & Kroll, 1995), plant closings (Clinebell & Clinebell, 1994), and product recall announcements (Davidson & Worrel, 1988). Notably, McWilliams and Siegel (1997) highlights that the studies on corporate social responsibility cite stakeholder theory to justify the event's impacts on stock prices, which may explain why researchers often use event studies to test theories of corporate responsibility.

In much the same way, anti-Apartheid divestment literature also apply the event study model to measure the impact of divestment announcements (McWilliams & Siegel, 1997; Meznar, Nigh, & Kwok, 1994, 1998; Posnikoff, 1997; Teoh, Welch, & Wazzan, 1999; Wright & Ferris, 1997). While all studies attempt to answer if a firm's decision to divest influenced their share price, nuances in the design framework as highlighted in McWilliams et al. (1999) has led to conflicting results. Of the six studies conducted, three infer that divestment has no impact on

share prices (McWilliams & Siegel, 1997; Meznar et al., 1994; Teoh et al., 1999), two studies infer a negative impact on share prices (Meznar et al., 1998; Wright & Ferris, 1997), and one study infers that divestment announcements have a positive impact on share prices (Posnikoff, 1997). These conflicting results also warrant further application of event studies in the context of the fossil-fuel divestment movement. Three of the six studies explicate the theories applied to explain their results. Wright and Ferris (1997) cite agency theory to propose that negative excess returns are a manifestation of the agency problem, finding that private and political forces rather than value maximization often drive corporate strategies. In contrast, Meznar et al. (Meznar et al., 1994) cites that the negative returns realized supports the stakeholder theory that managers include the interests of multiple stakeholders when deciding to divest from South Africa. Notably, while Posnikoff (1997) does cite the general economic theory, the report simply explains that the theory fails to explain why divesting institutions outperformed. The methods chapter below delves further into the frameworks that builds this study.

5.1.2 Validity

The econometric assumptions applied to the model's design is crucial in shaping the outcome of the study (Kothari & Warner, 2004). While the simplicity of the event study methodology has led to a vast collection of empirical research on corporate strategy and management, studies on the same phenomenon often lead to conflicting results subject to the model's design (McWilliams & Siegel, 1997). The validity of any study is thus, only as credible as the assumptions outlined in the methodology.

Event studies are sensitive to variations in research design. McWilliams et al. (1999) exemplify how such variations resulted in five conflicting reports on the impact of the anti-Apartheid divestment movement, both in the direction and magnitude of abnormal stock price returns. These conflicting results are most commonly due to the selection of events, event windows, and samples. In addition to the model framework, Brown and Warner (1980, 1985) establish that the application and results of event studies depend on strong empirical assumptions to ensure statistical validity. Thus, a number of statistical tools have also been used to correct statistical or measurement assumptions. The selection of expected return models, abnormal returns, and significance tests employed can further mitigate issues such as non-normalization, parameter estimations and non synchronous trading, and variance estimations (Brown & Warner, 1985). The following section explores how variations in the research design resulted

in conflicting findings across event study literature on anti-Apartheid divestment, as groundwork to detail the research design for this study.

5.2 The Model Design

The study's model design includes explicitly defining and selecting relevant events, event windows, and the sample set, in a manner that is unbiased and replicable. In directing this study's design framework, the methods adopted across the anti-Apartheid divestment literature will be highlighted.

5.2.1 Define the Event

The first step to conducting an event studies analysis is to explicitly define the event being studied. McWilliams et al. (1999) deduce that unlike traditional applications of event studies like mergers and acquisitions or earnings announcements, the interpretation of divestment announcements and other announcements of corporate social responsibility can lead to inconsistencies across design. A detailed description of the event includes the defining characteristics of the event being studied, including a scope of inclusionary and exclusionary criteria, date range, and source of event announcement.

5.2.1.1 Defining the Event in anti-Apartheid Divestment Studies

All six anti-Apartheid divestment studies examined the same issue; the impact of a divestment related announcement on a select institution's stock price. However, the selection of events across studies differed due to the inclusionary and exclusionary criteria applied. Some studies applied inclusionary criteria, only including events where divestment was voluntary (Teoh et al., 1999; Wright & Ferris, 1997) or only including events where the sample firm had complete data on financial returns (Posnikoff, 1997). Other studies adopted exclusionary criteria, like eliminating firms that do not trade on an American stock exchange (Meznar et al., 1994, 1998) or eliminating firms that did not subsequently divest (Teoh et al., 1999).

The selection of events also differed with respect to the range of years accounted and the sources of information. Dates in some studies range nearly 20 years from the early 1970s to 1991 (Meznar et al., 1994, 1998), while other studies are as short as six years, ranging from the early to late 1980s (Posnikoff, 1997; Teoh et al., 1999). Date ranges were also divided between

earlier and later events, to differentiate performance among early adopters and later announcements (Meznar et al., 1994, 1998). Equally important is the source of announcement. Notably, all six papers used the Wall Street Journal as one, if not the main source for information. McWilliams and Siegel (1997) explain that the Wall Street Journal is an important source as a record for financially relevant events, citing events that are perceived to be noteworthy to the financial community. Other sources of event announcements include newspapers like the New York Times (Meznar et al., 1994; Wright & Ferris, 1997), divestment publications like the Unified List (Posnikoff, 1997), and news and publication databases like the Dow Jones News Retrieval service and the Investor Responsibility Research Center (Teoh et al., 1999).

5.2.1.2 Defining the Event for the Fossil-fuel Divestment Study

In the context of this study, events can be defined as announcements related to the fossil-fuel divestment movement. The inclusionary criteria for divestment announcements are events of institutional pledges to divest any part or whole of their holdings of fossil fuel stock, events of endorsements in favour of or encouraging divestment, and events related to divestment campaigns that further discourse on the divestment movement. As of June 2016, the Fossil-Free organization lists 538 pledges, 23 high profile endorsements, and nearly 1000 national and local divestment campaigns.

Studying the expanse of these events is out of scope for this study, but can be specified by a date and source of event. The date range spanned from 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) and as recent as the symbolic four-year anniversary of the fossil fuel campaign (Crooks, 2015). To scope the most relevant events, a three-step process is adopted. First, the study limited events to announcements published in the Wall Street Journal or the Financial Times, for their financial relevance and frequent application across event study literature (Dyckman, Philbrick, & Stephan, 1984). The publications were extracted from the LexisNexis Database. Second the study turns to identify publications by groups like Oxford University's Stranded Assets Program, as key drivers in stimulating discourse on fossil-fuel divestment. Finally, the study looks to the Google Trends Database, which can be used to chart instances of dates (and their relevant announcements) where public discourse surged. This process of scoping the event date and source shrunk the list to 119 unique events.

To further scope the events, four steps of exclusionary screening are applied to exclude irrelevant events. First, publications of general reference (i.e. fossil-fuel divestment is...) or publications that do not include new information are excluded. Second, duplicate publications referencing a common event (i.e. Wall Street Journal's 'Rockefeller Fund Seeks to Shed Fossil-Fuel Investments' and the Financial Times' 'Rockefellers join anti-fossil fuel drive' duplication) are excluded, except for the first and earliest publication. Third, announcements of piecemeal developments or calls to action (i.e. 'Fossil-fuel divestment discussion moves toward Board' or 'Swedish pensions urged to dump fossil fuels') are excluded. Finally, rejections (i.e. Financial Times' 'Edinburgh University angers fossil-fuel divestment campaigners' publication) are excluded.

Table 1: Divestment Events

Divestment Pledges	
2013-05-14	Kissel, M. (2013). <i>Opinion: Swarthmore Under Student Siege</i> . Wall Street Journal.
2014-05-06	Crooks, E. (2014). <i>Stanford endowment votes to sell coal mining shares</i> . Financial Times.
2014-07-11	Vaughan, A. (2014) <i>World Council of Churches rules out fossil fuel investments</i> . The Guardian.
2014-06-25	Medact. (2014). <i>UK Doctors Vote to End Investments in the Fossil Fuel Industry</i> .
2014-09-22	Calia, M. (2014). <i>Rockefeller Fund Seeks to Shed Fossil-Fuel Investments</i> . Wall Street Journal.
2014-10-07	Smyth, J. (2014). <i>Australian pension fund LGS drops coal assets</i> . Financial Times.
2014-10-08	Brooks, L. (2014) <i>Glasgow becomes first university in Europe to divest from fossil fuels</i> . The Guardian.
2014-11-23	Marriage, M. (2014) <i>Norway's largest pension fund vows to drop coal mine holdings</i> . Financial Times.
2015-04-01	Mance, H & Clark, P. (2015). <i>Guardian Media Group to sell shares linked to fossil fuels</i> . Financial Times.
2015-04-30	Clark, P. (2015). <i>Church of England blacklists coal and tar sands investments</i> . Financial Times.
2015-05-18	Clark, P. (2015). <i>University of Oxford to spurn coal and tar sands investments</i> . Financial Times.
2015-06-23	Lutheran World Federation. (2015). <i>LWF announces decision not to invest in fossil fuels</i> . LWF.
2015-10-20	Carrington, D. (2015). <i>Oslo divests from coal companies</i> . The Guardian.
Divestment Endorsements	
2013-05-01	Klein, N. (2013). <i>Naomi Klein: Time for Big Green to Go Fossil Free</i> . The Nation.
2014-04-10	Tutu, D. (2014). <i>Desmond Tutu: We need an apartheid-style boycott to save the planet</i> . The Guardian.
2014-08-06	Gore, A & Blood, D. (2014). <i>Strong economic case for coal divestment</i> . Financial Times.
2014-11-04	Ki-moon, B. (2014) <i>Ban Ki Moon Endorses Fossil Fuel Divestment</i> . UNFCCC.
2015-03-15	Carrington, D. (2015). <i>Climate change: UN backs fossil fuel divestment campaign</i> . The Guardian.
Divestment Campaigns	
2012-09-19	350.org (2012). <i>Do the Math: We're jumpstarting a new movement, and we need your help</i> . 350.org.
2013-10-07	Ansar, A., Caldecott, B., & Tilbury, J. (2013). <i>Stranded assets and the fossil-fuel divestment campaign: what does divestment mean for the valuation of fossil fuel assets</i> . Stranded Asset Program, SSEE, University of Oxford.

2014-08-25	Bullard, N. (2014). <i>Fossil-fuel divestment: a \$5 trillion challenge</i> . Bloomberg New Energy Finance.
2014-09-19	Foderaro, LW. (2014). <i>New York Climate March: Taking a Call for Climate Change to the Streets</i> . New York Times.
2015-02-12	Mathiesen, K; Howard, E; & Shabbir, N. (2015). <i>Global Divestment Day: 'We are ready for urgent action on climate change'</i> . The Guardian.
2015-09-22	Crooks, E. (2015). <i>Funds worth \$2.6tn pledge to dump coal</i> . Financial Times.

In much the same process of identifying divestment announcements, the study also identifies a set of events related to stranded assets and the carbon budget, as a means to compare the impact of divestment announcements to related developments. Events selected are instances of increased public discourse on the environmental risks of fossil fuel companies, in regard to the topics of stranded assets or the carbon budget. The selection of events are as follows.

Table 2: Carbon Budget and Stranded Asset Events

Carbon Budget Events	
2012-07-19	McKibben, B. (2012). <i>Global Warming's Terrifying New Math</i> . Rolling Stone.
2012-10-30	Leggett, J. (2012). <i>Carbon bubble is a real risk for markets</i> . Financial Times.
2013-06-25	White House, The. <i>Obama's Remarks on Climate Change</i> . The White House.
2013-10-29	Gore, A & Blood, D. (2013). <i>The Coming Carbon Asset Bubble</i> . Wall Street Journal.
2014-04-24	Lewis, MC. (2014). <i>Stranded Assets, Fossilised Revenues</i> . Kepler Cheuvreux.
2014-09-29	Ritter, B. (2014). <i>Let's Act Before the Oil Bubble Bursts</i> . Wall Street Journal.
2015-01-12	Meyer, N & Brinker L. (2015). <i>The Myth of the Carbon Investment 'Bubble'</i> . Wall Street Journal.
2015-01-19	Kirk, S & Bansal, R. (2015). <i>Peak carbon before peak oil</i> . Deutsche Bank.
2015-03-12	Clark P. (2015). <i>Global carbon emissions stall in 2014</i> . Financial Times.
2015-05-25	Pope Francis. (2015). <i>Encyclical Letter, Laudato Si' of the Holy Father Francis on Care for our Common Home</i> . The Holy See.
Stranded Asset Events	
2012-05-07	Scott, M. (2012). <i>Focus falls on asset owners' climate risks</i> . Financial Times.
2012-11-12	Birol, F, et al. (2012). <i>IEA World Energy Outlook 2012</i> . International Energy Agency.
2013-04-18	Leaton, J., Ranger, N., Ward, B., Sussams, L., & Brown, M. (2013). <i>Unburnable Carbon 2013: Wasted capital and stranded assets</i> . Carbon Tracker Initiative.
2013-08-30	IPCC. (2014). <i>Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change</i> . IPCC.
2014-09-22	United Nations. (2014). <i>UN Climate Summit 2014: At Climate Summit, UN is practicing what it preaches</i> . United Nations.
2014-11-27	Faucon, B; Said, S; & Kent, S. (2014) <i>Oil Prices Plunge After OPEC Stays Put</i> . Wall Street Journal.
2015-04-16	Paum, A. (2015). <i>Stranded assets: what next?</i> HSBC Global Research.
2015-04-27	Poulter, J. (2015). <i>World's Largest Investors Continue to Gamble on Climate Risk: Asset Owners Disclosure Project</i> .
2015-05-06	Denning, L. (2015). <i>Big Oil's Disruptive Climate Change</i> . Wall Street Journal.
2015-09-29	Carney, M. (2015). <i>Breaking the Tragedy of the Horizon</i> . Bank of England.
2015-12-16	UNFCCC. (2015). <i>Paris Pledge for Action Boosts Paris Climate Agreement</i> . UNFCCC.

5.2.2 Define the Event Windows

Announcements must be tested for event date accuracy and managed for confounding and clustering effects. Event date accuracy refers to the process of identifying the earliest instance of disclosure of new information. Generally, the event study method assumes that new information is unanticipated, however the earliest instance of disclosure may be difficult to identify for divestment announcements where decisions are achieved after lengthy public debate. The decision to divest from South Africa could often be anticipated, coming “at the end of lengthy debates within firms and between firms and particular stakeholder groups... Thus, information that a firm was considering pulling out of South Africa may often have been available well ahead of the announcement itself” (Meznar et al., 1994, p. 1640). In such cases, a long event window that captures price effects prior to and after the announcement date or statistical tests that control for contemporaneous market returns can isolate the event response (MacKinlay, 1997). Long event windows however, can be influenced by extraneous confounding and clustering events. This section attempts to evaluate the preference for long event windows while controlling for other relevant events.

5.2.2.1 Defining the Event Window in anti-Apartheid Divestment Studies

Adopting a long event window is one solution to internalize the impacts of information leakage and speculation. Posnikoff (1997) adopted the shortest event window, spanning one day prior to and one day after the event. Meznar et al. (1994) comparably adopted the longest event window, over 41 days. Wright and Ferris (1997) adopted single day event windows for up to ten days prior to and up to ten days after the divestment announcement. However, while long event windows are useful when announcements may be anticipated prior to the announcement date, the longer the event window the greater the probability that actual returns may be affected by other significant events.

External firm specific or industry wide events weaken the validity that abnormal returns are strictly in response to the event being studied (McWilliams et al., 1999). Confounding events influence select firms, from announcements related to dividends, mergers, new products, or unexpected earnings (McWilliams & Siegel, 1997) or from non-sample spillovers from competing firms (McWilliams et al., 1999). Brown and Warner (1985) infer that confounding events are most problematic for studies with small sample sizes and long event windows, however a long event window can be appropriate if the sample size is large. Three of the six

studies on anti-Apartheid divestment address confounding events (McWilliams & Siegel, 1997; Meznar et al., 1998; Wright & Ferris, 1997), however, the short three day event windows adopted by Wright and Ferris (1997) and McWilliams and Siegel (1997) do not raise concerns of confounding effects. The study by Meznar et al. (1998) on the other hand does raise significant concerns, because the study only addresses confounding events for days -1 and 0 across its 41 day long event window and relatively small sample size.

Clustering events of industry wide announcements may impact multiple firms in a related industry. Thus, sample sets that share a common industry may be more sensitive to extraneous events as errors in excess returns are correlated among a large set of clustered firms (McWilliams et al., 1999). This makes it challenging to isolate the impact of the pertinent event, when stock price changes can be introduced from external market or industry factors. Much like confounding events, Brown and Warner (1985) infer that a large sample size and short event window can adequately control for industry effects, however for an industry specific sample set as in the case of fossil-fuel divestment, industry effects must be controlled. Two of the six anti-Apartheid divestment studies address clustering events (Posnikoff, 1997; Teoh et al., 1999). Posnikoff (1997) highlights that statistical tools like the ordinary cross sectional t-test can be adopted where event date clustering may exist (Boehmer et al., 1991). Conversely, Teoh et al. (1999) incorporates an industry factor into a custom market-model type regression to isolate clustering impacts.

5.2.2.2 Defining the Event Windows for the Fossil-fuel Divestment Study

This study reviews the events highlighted above to ensure that the dates cited are the earliest instances when information about the event reaches the market. However, even if the exact date can be isolated, speculation prior to or lagging outcomes post event can lead to inaccuracies (MacKinlay, 1997). Longer event windows can capture the effects of speculation or lagging response however expose the study to extraneous influences.

Confounding effects that impact sample firms individually can be masked with a large sample size. Clustering effects however, are more problematic for this study, because the sample firms share a common industry. Clustering effects can be mitigated by excluding events with industry events within the event window or 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 & Dent, 1984), however since the purpose of the study is to test the impact of divestment on the industry as a whole, the inclusion of an industry variable may depress the excess returns and lead to a false negative type II error.

The event window adopted is a combination of short one-day and long multi-day event windows. Single day windows, as structured by Wright and Ferris (1997) present greater statistical power than multi-day windows. This study will thus adopt a single day event window for up to ten days prior to and up to ten days after the event date. This will be complemented by a series of longer multi-day event windows, to internalize instances of speculation and to measure the longer term influence of the divestment event (MacKinlay, 1997). The study adopts four windows, spanning 1, 2, 5, and 10 days around the event.

5.2.3 Define the Sample

After defining the exogenous events and associated windows, the design framework turns to the endogenous sample. Sample sets are collected for the firm selections and control factors. Sample selection and size are important considerations for design and statistical validity; differences in sample selection and sample size among the anti-Apartheid divestment event studies led to inconsistent results (McWilliams et al., 1999).

5.2.3.1 Defining the Sample in anti-Apartheid Divestment Studies

The literature on event studies examined, highlights the steps taken to identify the sample set of firms, control variables, and their associated financial data. First, of an initial population of 207 firms that had divested from South African operations (Meznar et al., 1994), sample sets ranged from as large as 46 firms (Teoh et al., 1999), to as little as seven (Meznar et al., 1998) or even zero, in the case of a 41 day long event windows with no confounding events (McWilliams & Siegel, 1997). Results from a small sample is problematic however, not only because small samples exacerbate the influence of outliers and statistical issues around normality, but also because small samples cannot be extrapolated to infer trends across the larger population.

Once the sample of firms is identified, the researcher turns to collecting the stock price returns, which are used as endogenous variables in the study. While there has been considerable

discourse on the use of daily versus monthly returns (Brown & Warner, 1980, 1985; Dyckman et al., 1984; Morse, 1984), the use of daily returns data has become more prevalent for its more precise measurements (Kothari & Warner, 2004). The event studies conducted for the anti-Apartheid divestment movement all collected daily adjusted returns for each of the firms assessed. Three of the studies explicitly state that daily observed returns are collected from the Center for Research in Security (CRSP) database (Posnikoff, 1997; Teoh et al., 1999; Wright & Ferris, 1997). The study by Teoh et al. (1999) further explicates that the CSRP can also provide financial data for the market and industry factors for expected return models. Risk free rates like the one-year treasury bills adopted by Teoh et al. (1999) are obtained from the Federal Reserve Historical Business Day Database.

5.2.3.2 Defining the Sample for the Fossil-fuel Divestment Study

The sample set of selected firms is a representative fraction of the larger population. First, the larger population is most broadly defined as publicly listed coal, oil, and gas companies; nationally owned corporations are out of scope for this study. The sample of publicly listed companies studied are adopted from the Carbon Underground 200 (Alexeyev et al., 2015); an initiative by Fossil Free Indexes that ranks the top 100 coal and top 100 oil and gas companies by the potential carbon emissions content of their reported reserves. This selection of sample firms is justified as an adequate representation of the larger population, as the largest corporations account for the largest share of potential production and emissions (Heede, 2014). Moreover, the Carbon Underground 200 sample of corporations envelop 98 percent of coal reserves, 98 percent of gas reserves, and 97 percent of oil reserves held by listed companies (Alexeyev et al., 2015). The sample size of 200 firms is sufficiently large enough to suppress idiosyncratic influence of individual firms and strengthen the power of statistical tests. Subsamples can be further narrowed by industry classification or geographical location; however, these discrepancies will be out of scope for this study. Finally, this study adopts the MSCI all-country world index as the exogenous proxy for expected returns and the US 1-year treasury rate as the risk free rate of return.

Stock returns are collected from the Wharton Research Data Services (WRDS) platform, which hosts the Center for Research in Security Prices (CRSP) database of daily stock prices. End of day returns are adjusted for the effects of stock splits, mergers, and dividends. Valued weighted indexes are collected for the MSCI market index, as it most accurately reflect market

performance (Ohlson & Rosenberg, 1982). Raw financial returns cannot be easily compared given different market sizes and currencies, thus, all outputs are normalized as continuously compounded returns, to best conform to normality assumptions (Fama, 1976).

5.3 The Statistical Design

The statistical design introduced in this section complements the model design as highlighted above. Much in the same way anti-Apartheid divestment event studies share a common goal but differing design frameworks, nuances in the statistical frameworks can also lead to conflicting outcomes (McWilliams et al., 1999). These differences come from the choice of expected return models, the abnormal return aggregations, and the statistical tests applied. The following section first looks to literature to understand when different statistical frameworks may be more appropriate than others.

The expected returns commonly adopted are the mean returns approach (Meznar et al., 1998; Posnikoff, 1997; Teoh et al., 1999), the ordinary least squares approach (Posnikoff, 1997), custom multi-factor frameworks of the traditional market model (Teoh et al., 1999), and the capital asset pricing model (Wright & Ferris, 1997). Cable and Holland (1999) describe how these models of expected returns compare. The abnormal returns are most simply calculated as the difference between expected and actual returns, but can be specified for factors like normalization (standardized abnormal returns), temporal averages over specified event windows (cumulative abnormal returns) and cross-sectional averages across the sample set (average abnormal returns) (McWilliams et al., 1999). Finally, the significance tests applied span from the most simple t-test (Teoh et al., 1999; Wright & Ferris, 1997), to more complex tools like cross-sectional tests (Posnikoff, 1997), and non-parametric binomial Z-scores (Meznar et al., 1994, 1998; Wright & Ferris, 1997). In directing this study's statistical framework, issues that arise from the design of expected and abnormal returns and statistical tests will be addressed and mitigated.

5.3.1 Expected Returns

A number of simplistic and more complex approaches are available to calculate the expected return of a given security; this subsection highlights some of the most commonly applied tools. Event studies generally adopted a 200 to 250-day estimation period for all expected return

models. The choice of method applied is dependent on the design approach and its ability to effectively isolate the abnormal returns of an event.

5.3.1.1 Expected in anti-Apartheid Divestment Studies

The first and simplest method to calculate expected returns is the mean return model. This method simply calculates the average rate of return for a specific security, over a predetermined estimation period. This method is applied by studies by Posnikoff (1997), Meznar et al. (1998), and Teoh et al. (1999) in the context of anti-Apartheid divestment. Brown and Warner (1980, 1985) demonstrate that this relatively simplistic model often yields results similar to those of more sophisticated models, however their results are under the assumption that the study adopts short event windows.

The market model calculates expected returns from an external market index, rather than the specific security. Proponents of the market model attest that isolating variations in market returns can more effectively separate the effects of events studied (MacKinlay, 1997). Market proxies can be broad like the S&P 500 index (McWilliams & Siegel, 1997), or a sample-specific like the Johannesburg Stock Exchange (JSE) industrial index as a proxy for the South African Market (Teoh et al., 1999). Variations on the market model, such as the market adjusted returns model (Cable & Holland, 1999) and the market and risk adjusted models (Brown & Warner, 1980) are respectively applied in instances where estimation windows are not feasible or where risk induced variance is high. Brown and Warner (1985) 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). Custom market models such as that adopted by Teoh et al. (1999) for example can control for market, industry, and risk factors together.

Economic models are generally more complex multi-factor models to more precisely calculate expected normal returns. One prevalent macroeconomic multifactor model in event studies is the capital asset pricing model (CAPM), which extends the market model to price securities by both the market and market risk (MacKinlay, 1997).

5.3.1.2 Expected Returns for the Fossil-fuel Divestment Study

This study applied CAPM as the primary expected returns model. It will adopt the MSCI all-country world index and 1 year US treasury price over an estimation window of 250 trading days prior to the event window. The expected returns model will mitigate instances of non-normality by adopting the logarithmic continuous compounding returns. Finally, the market OLS model will be cross referenced to the CAPM as a robustness check for instances of serial correlation and nonsynchronous trading (Lo & MacKinlay, 1990). The capital asset pricing model can be calculated as;

$$E(R_{i,t}) = R_{f,t} + \beta_i [R_{m,t} - R_{f,t}]$$

Where the expected return of security i on day t “E(R_{i,t})” is dependent on risk premium rate of return, calculated as the difference between the market index “R_{m,t}” and a risk free index “R_{f,t}”.

5.3.2 Abnormal Returns

The abnormal return (AR) is simply defined as the difference between the expected and actual return of a given firm on the event day. Three modifications to the AR include standardization, time series aggregation, and cross sectional aggregation.

5.3.2.1 Abnormal Returns in anti-Apartheid Divestment Studies

The simple abnormal return calculates the difference between expected and realized returns, but only calculates abnormal returns for one security at a time, only accounts for a one trading day, and does not address distributional errors. Cross-sectional aggregation can combine abnormal returns of multiple firms in a sample to one average abnormal return (AAR). Time series aggregation can extend the event window by combining abnormal returns of a firm over many days, to one cumulative abnormal return (CAR). Together, abnormal returns can be aggregated to a cumulative average abnormal return (CAAR). Furthermore, a standardized abnormal return (SAR) divides the residuals by its standard error, to normalize the data (Dodd and Warner, 1983). With the exception of Wright and Ferris (1997), anti-Apartheid event studies literature most commonly compute standardized abnormal returns.

5.3.2.2 Abnormal Returns for the Fossil-fuel Divestment Study

This study applied the standardized abnormal return (SAR) as the primary calculation for abnormal returns. The standardized abnormal returns are however also compounded across firms (standardized average abnormal return) and over time (standardized cumulative abnormal returns), as required by the choice of statistical tests applied. The standardized abnormal return normalizes the abnormal returns by dividing the abnormal return by its standard error, calculated as follows;

$$SAR_{i,E} = \frac{AR_{i,E}}{\hat{S}_i \sqrt{1 + \frac{1}{T_i} + \frac{(R_{m,E} - \overline{R}_m)^2}{\sum_{t=1}^{T_i} (R_{m,t} - \overline{R}_m)^2}}}$$

Where, “SAR_{i,E}” is the standardized abnormal return of one security ‘i’ on event day ‘E’, calculated by the abnormal return (AR_{i,E}) divided by the standard deviation of the abnormal return adjusted for forecast errors.

5.3.3 Tests for Statistical Significance

The standardized abnormal returns calculated above must be vetted to be statistically significant. To do so, several test statistics can be applied, depending on choice of aggregation and the assumptions of probability distributions. This section first examines the differences in test statistics between independent, standardized, time aggregated, and cross sectional tests. While these tests depend on distributional assumptions, nonparametric tests can be applied in instances where these assumptions are not defined.

5.3.3.1 Significance Tests in anti-Apartheid Divestment Studies

The first and most simple test statistic is the t-test as applied by Wright and Ferris (1997). The t-test is simply the ratio of the mean excess return for one firm on the event day to its estimated standard deviation, but raises concerns of cross-sectional correlation among firms on the event

day and of event induced volatility over multiple days. Both errors understate the standard deviation, overstate the t-statistic, and lead to a type I incorrectly rejecting the null hypothesis. In turn, the simple t-test has relatively low statistical power.

A cross-sectional adjusted t-test, as adopted by Posnikoff (1997), is used to calculate the significance of average abnormal returns across a portfolio by dividing the average residual by a cross-sectional standard deviation. The test however, implicitly assumes that abnormal returns are uncorrelated and event-induced volatility is insignificant (Brown & Warner, 1985).

In the event that announcements are correlated, because they share the same calendar date or are from the same industry, standardized returns can be used (Armitage, 1995). Tests of standardized returns are commonly used in anti-Apartheid literature (Meznar et al., 1994, 1998; Wright & Ferris, 1997), for their greater statistical power (Boehmer et al., 1991; Kolari & Pynnönen, 2010; MacKinlay, 1997). The standardized Patell (1976) adjusted test for instance controls for heteroscedastic effects between estimation and event windows to adjust for cross-correlation, however the model assumes that event induced variance is insignificant. Boehmer et al.'s (1991) standardized cross-sectional (BMP) test, builds on Patell's adjusted test, to incorporate variance from both the estimation and the event periods into abnormal returns. More recently, Kolari and Pynnönen (2010) introduce an adjusted standardized residual test and adjusted BMP test to adjust for cross-correlation between the market and securities.

Nonparametric tests are free of assumptions regarding the distribution of returns and are as such, perceived to be more powerful tests where distributional assumptions can not be made (Dutta, 2014). The most common nonparametric tests adopted in event studies are the sign test and the rank test (MacKinlay, 1997). The general sign test, as introduced by Cowan (1992), measures the proportion of the sample with positive or negative performance greater than or less than 50 percent, and can be applied in instances where the cumulative abnormal return could be either positive or negative (MacKinlay, 1997). The sign test is useful to address for skewness in returns (Dutta, 2014). The rank test, as introduced by Corrado (1989) transforms the distribution of abnormal returns to a uniform ranked distribution, which mitigates issues of asymmetry in the initial distribution. Typically, nonparametric and parametric tests are best applied together; nonparametric tests can check for robustness in the conclusions of parametric tests (MacKinlay, 1997).

5.3.3.2 Significance Tests for the Fossil-fuel Divestment Study

This study adopts the standardized cross-sectional (BMP) test as the primary significance test. Standardized tests are preferential to traditional parametric tests for 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 the abnormal returns are normalized and continuous. The cross-sectional BMP test is preferential to Patell's (1976) standardized residual test for its ability to better account for cross-sectional and event-induced variance across a sample set, which is important when the sample shares common event days or a common industry. Finally, Kolari and Pynnönen's (2010) adjusted BMP test can depress the test statistic in instances where the market and security are correlated, as in the case of the fossil fuel industry. Nevertheless, other tests including the cross-sectional t-test, crude dependence test, Patell test, and sign test will also be conducted as robustness checks, to test for conflicting results. Thus, the standardized cross-sectional BMP test will be the primary significance test and will be formulated as;

$$Z_{BMP,t} = \frac{\frac{1}{N} \sum_{i=1}^N SAR_{i,E}}{\sqrt{\frac{1}{N(N-1)} \sum_{i=1}^N \left(SAR_{i,E} - \sum_{i=1}^N \frac{SAR_{i,E}}{N} \right)^2}}$$

5.4 Conclusion and Next Steps

The purpose of this chapter was to detail the piecewise process adopted to conduct this study. The event study method is commonly used for its simplicity and applicability; however, the validity of results heavily relies on the assumptions made. Most notably, the researcher's methodology dictates their choice of events to be studied, the range of event windows, and the endogenous sample set utilized. The calculations for the expected returns model, the abnormal returns, and the statistical tests utilized also play an important role in ensuring the results are valid. Thus, this chapter lays the groundwork for this study in a manner that is both valid and replicable. The next chapter presents the results of the study.

CHAPTER 6: RESULTS

This chapter presents the event study results, to assess the impact of divestment and related events on the stock performance of listed fossil fuel companies. The results indicate that divestment events have a statistically significant negative abnormal return on the event day. This suggests that the market perceives divestment events as material to the fossil fuel industry's share valuation. The results also indicate that events related to stranded assets or the carbon budget do have a statistically significant negative abnormal return, however there is no evidence to suggest that divestment events have a greater negative impact on the industry. This suggests that the market perceives all stakeholder pressures on divestment, stranded assets, and the carbon budget equally influential to the fossil fuel industry.

6.1 Hypothesis One

The first research question asks, do divestment events impact the share price of listed fossil fuel companies? The null hypothesis stands that there will be no abnormal stock price reaction because the market does not perceive divestment events to have measurable valuation consequences. The alternate hypothesis infers that divestment events negatively influence the share price of fossil fuel stocks. This is justified by the efficient market hypothesis, that markets perceive new information about divestment as a relevant threat to the industry and adjust prices accordingly.

6.1.1 Aggregate Results of Divestment Events

The first test examines the aggregate stock returns of 22 overlapping event announcements between 2012 and 2015. The average abnormal returns (AAR) span over a ± 10 -day event window and across a sample size of 199 firms. The cumulative average abnormal returns (CAAR) span over one, two, five, and ten days surrounding the event date. The capital asset pricing model is adopted to calculate expected returns and the standardized cross-sectional BMP test is used to test for statistical significance. The fundamental statistics show that 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.

6.1.1.1 Testing Aggregate Results of Divestment Events

The evidence from table one indicates that on average, fossil fuel shares did have a statistically significant negative response on the event day. There is also some indication that shares began to respond to divestment up to 3 days prior to the event, which may be indicative of speculative behaviour, however these results are not statistically significant. Moreover, there is some indication that shares continued to decline for a majority of days after the event, however these results are not statistically significant either. In contrast, the cumulative abnormal returns indicate that together, there is a statistically significant negative response for the one-day, two-day, and five-day event windows, suggesting that the impacts of divestment span wider than the event day itself. According to the efficient markets hypothesis, the negative response explains that markets do perceive divestment events to be a material risk to the performance of the fossil fuel industry. Cumulative abnormal returns can be plotted to better visualize the performance of fossil fuel stocks during instances of a divestment event.

Table 3: Aggregate Statistical Test of Divestment Events

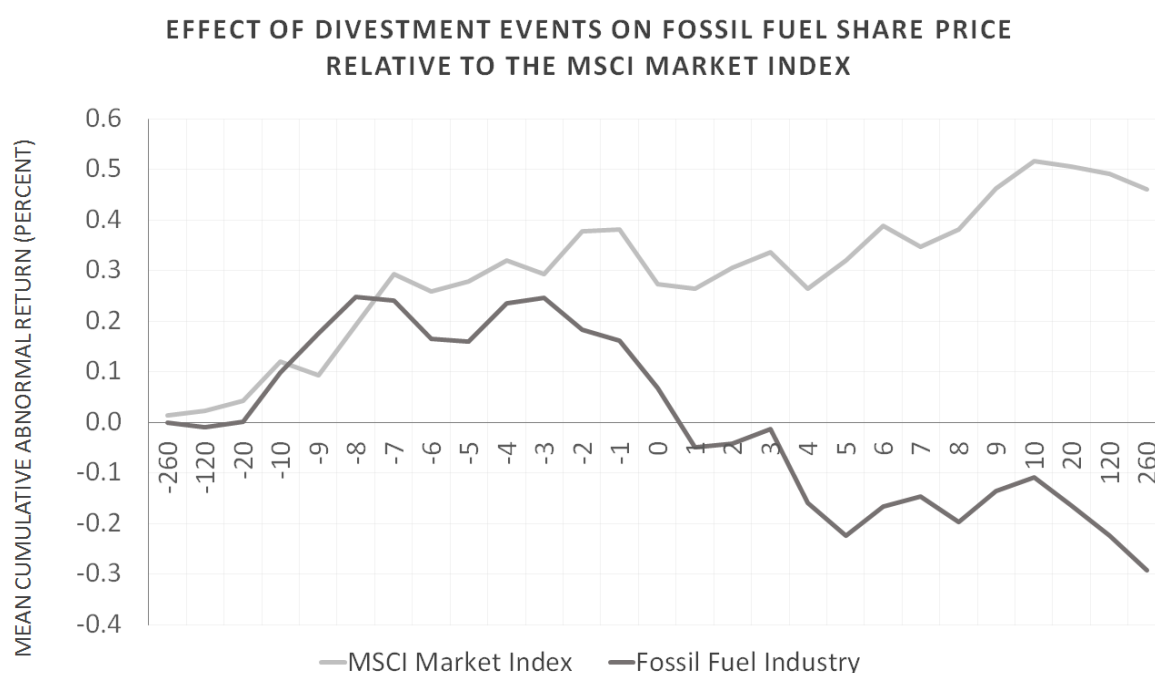
EFFECT OF DIVESTMENT EVENTS ON SHARE PRICE			
Fundamentals			
	Mean	0.000	
	Median	0.000	
	Standard Deviation	0.010	
	Skewness	-0.089	
	Kurtosis	4.937	
	Number of Events	24	
	Average Sample Size	199	
Single Day Event Windows			
Event Day	Daily Percentage of Abnormal Returns	Cumulative Percentage of Abnormal Returns	Standardized Cross-Sectional BMP Test
-260	-0.025	-0.025	
-10	0.066	0.041	0.537
-9	0.045	0.086	0.959
-8	0.039	0.126	0.239
-7	-0.038	0.087	-0.427
-6	-0.109	-0.021	-1.084
-5	-0.037	-0.059	-0.373
-4	0.043	-0.016	0.774
-3	-0.022	-0.038	-1.085
-2	-0.095	-0.133	-0.244
-1	-0.054	-0.187	-1.253
0	-0.127	-0.314	-1.758 *
1	-0.148	-0.462	-1.221
2	-0.026	-0.488	0.091
3	-0.004	-0.492	0.324
4	-0.177	-0.669	-0.462
5	-0.098	-0.767	-0.325
6	0.026	-0.741	0.609
7	-0.013	-0.755	0.127
8	-0.083	-0.837	-1.163
9	0.029	-0.808	0.609
10	-0.006	-0.814	-0.196
260	-0.089	-0.903	
Multi-Day Event Windows			
Intervals	Cumulative Percentage of Abnormal Returns	Standardized Cross-Sectional BMP Test	
(-1,1)	-0.230	-1.950 *	
(-2,2)	-0.258	-1.763 *	
(-5,5)	-0.389	-1.832 *	
(-10,10)	-0.114	-1.293	

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

6.1.1.2 Plotting Aggregate Returns

The evidence below highlights the decoupling of fossil fuel shares away from the MSCI market index. The figure draws the relationship of the industry and market across the estimation window (-260,-11), the event window (-10,10), and the post event window (11,260). Figure one attests to the results above, that fossil fuel shares begin their decline as early as three days prior to the event and continues its decline across the one-year post-event window as well. This suggests that divestment events may have long term consequences for fossil fuel stocks.

Figure 1: Aggregate Plot of Divestment Events



6.1.2 Independent Results of Divestment Events

The next test examines the individual stock returns of each event announcement. The cumulative average abnormal returns (CAAR) for one, two, five, and ten days surrounding the event date, the capital asset pricing model is adopted to infer expected returns, and the standardized cross-sectional BMP test is used to test for statistical significance. The fundamental statistics show that the mean and median returns are zero, the standard deviation deviates between 0.009 and 0.015, the skewness between -0.22 and 0.07 and the kurtosis between 2.86 and 6.66. The sample size spans from 197 to 199.

6.1.2.1 Testing Independent Results

The evidence from table two indicates that many but not all divestment events are influential. Two main findings can be extrapolated, first that some events prove to be more influential than others and second that there is a tipping point at which divestment events seem to have longer term impacts on fossil fuel stocks.

Table 4: Independent Statistical Test of Divestment Events

EFFECT OF DIVESTMENT EVENTS ON FOSSIL FUEL SHAPRE PRICE, BY EVENT									
Event Day	Multi-Day Event Windows								
	(1,1)		(2,2)		(5,5)		(10,10)		
	CAAR	BMP	CAAR	BMP	CAAR	BMP	CAAR	BMP	
12.09.19	Do the Math Campaign	-0.008	-7.540 **	-0.013	-7.884 **	-0.006	-3.180 **	0.017	6.727
13.05.01	Naomi Klein Endorsement	-0.003	-2.908 **	0.005	2.908	0.019	8.844	0.008	2.656
13.05.14	Swarthmore College Divests	-0.005	-3.369 **	0.000	-0.195	0.011	4.666	0.006	1.904
13.10.07	SAP Publication Campaign	-0.003	-2.588 **	-0.002	-0.957	-0.002	-0.866	-0.002	-0.815
14.04.10	Desmond Tutu Endorsement	0.000	0.307	-0.001	-0.517	0.001	0.202	0.009	2.661
14.05.06	Stanford University Divests	0.001	0.610	0.000	-0.046	0.007	2.807	-0.005	-1.330
14.07.11	World Council of Churches Divests	-0.002	-1.674 *	-0.001	-0.711	-0.010	-4.422 **	-0.003	-0.853
14.06.25	British Medical Association Divests	-0.002	-2.146 *	-0.001	-0.591	0.005	3.022	-0.001	-0.421
14.08.06	Al Gore Endorsement	-0.005	-2.418 *	0.004	2.300	-0.007	-3.180 **	0.005	1.616
14.08.08	Glasgow University Divests	0.002	1.675	0.000	0.137	-0.003	-1.232	-0.003	-1.095
14.08.25	BNEF Publication Campaign	-0.001	-1.188	-0.004	-2.524 *	0.007	2.915	0.004	0.919
14.09.19	New York Climate March Campaign	-0.010	-5.991 **	-0.012	-4.348 **	-0.020	-5.656 **	-0.042	-8.468 **
14.09.22	Rockefeller Fund Divests	-0.011	-6.336 **	-0.018	-6.631 **	-0.020	-6.200 **	-0.046	-9.574 **
14.10.07	Australian Pension Fund Divests	-0.005	-4.948 **	-0.023	-8.497 **	-0.041	-9.808 **	-0.043	-11.664 **
14.11.03	Ban Ki-moon Endorsement	-0.001	-0.617	0.001	0.338	0.011	3.409	0.002	0.500
14.11.24	Norway Pension Fund Divests	0.001	0.671	-0.002	-0.743	-0.033	-7.567 **	-0.057	-8.224 **
15.02.12	Global Divestment Day Campaign	0.009	7.812	0.003	0.553	0.006	1.274	0.025	4.268
15.03.16	Nick Nuttall Endorsement	-0.006	-3.286 **	-0.002	-0.956	-0.012	-4.750 **	-0.025	-7.380 **
15.04.01	Guardian Media Group Divests	0.003	1.559	0.012	5.635	0.012	4.051	0.036	9.287
15.04.30	Church of England Divests	0.003	1.790	0.004	1.905	-0.006	-1.738 *	-0.011	-2.540 *
15.05.18	University of Oxford Divests	-0.006	-3.573 **	-0.005	-2.622 **	-0.007	-2.730 **	-0.022	-5.066 **
15.06.23	Lutheran World Federation Divests	0.005	2.948	-0.012	-4.810 **	-0.023	-7.395 **	-0.059	-8.817 **
15.09.22	Four year anniversary Campaign	-0.019	-8.564 **	-0.029	-9.768 **	-0.034	-9.338 **	0.004	1.031
15.10.20	Oslo, Norway Divests	-0.015	-7.025 **	-0.012	-4.283 **	-0.032	-7.089 **	0.015	3.654

Notes:
 *p<0.05, **p<0.01
 a. CAAR: Cumulative Average Abnormal Returns.
 b. BMP: Standardized Cross-Sectional BMP Test

Of the selected events, the most influential events fell around the third weekend of September 2014, which not only included the New York People’s Climate March, the Rockefeller Fund’s divestment announcement, and over 700 independent pledges to divest from fossil fuels (Divest-Invest, 2014), but also 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, which posted positive abnormal returns across all cumulative windows. Other less influential events include social rights activist Desmond Tutu’s endorsement, Stanford University’s divestment pledge, Glasgow University’s divestment pledge, and UN secretary general Ban Ki-Moon’s endorsement. Other Notable cases include social activist Naomi Klein’s endorsement, and Swarthmore College’s divestment pledge, which noted a statistically significant negative response across the ±1-day event window before rising back up thereafter. The second major finding is that events after September 19, 2014

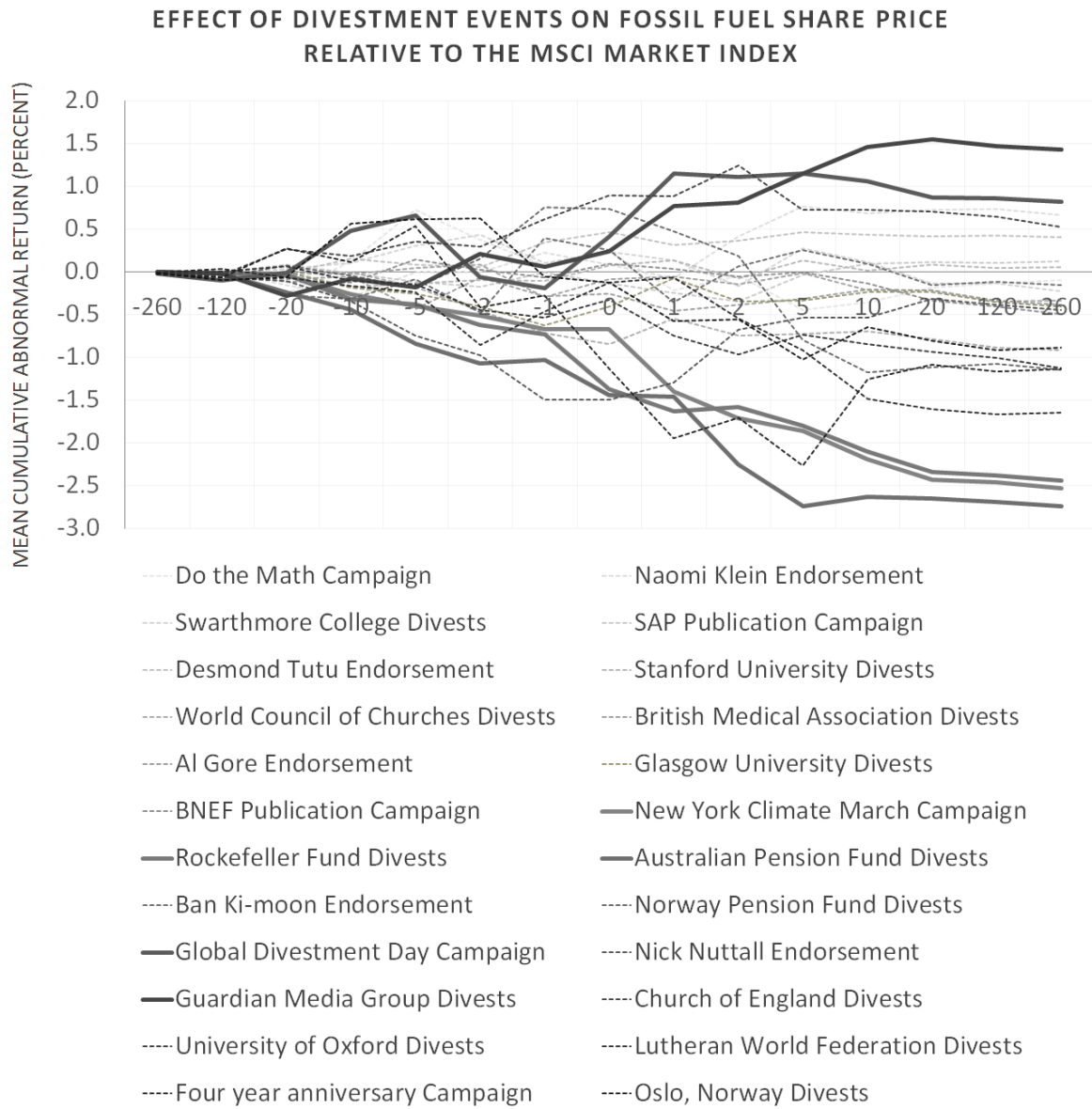
seemed to not only be more influential but also had longer term implications spanning as far as ± 10 days around the event day, which might indicate a shift in the investors' perception of divestment events.

6.1.2.2 Plotting Independent Returns

The evidence below attests that not all divestment events have been influential. The figure draws the relationship of each independent event on the industry relative to the MSCI market index, across the estimation window (-260,-11), the event window (-10,10), and the post event window (11,260). The independent results are shaded in gradient to differentiate between early events (lighter) and later events (darker) and notable events are thickened to visualize the range of variation.

First, figure two shows that while many events had a negative response on the day of or surrounding the event date, other events had little to no response all together. Events such as the Global Divestment Day campaign or Guardian Media Group for example seem to outperform the market on the days of and leading up to the event. Recognizably, this does not mean that events which saw an outperformance in the market index saw positive returns on that day as well, since the trend lines are held relative to the MSCI average. Secondly, the figure attests to the notion that early divestment events generally seem to be less influential than later divestment events. Finally, the figure shows that the majority of events weakened the share price beyond the event window and into the post-event window as well.

Figure 2: Plot of Independent Divestment Events

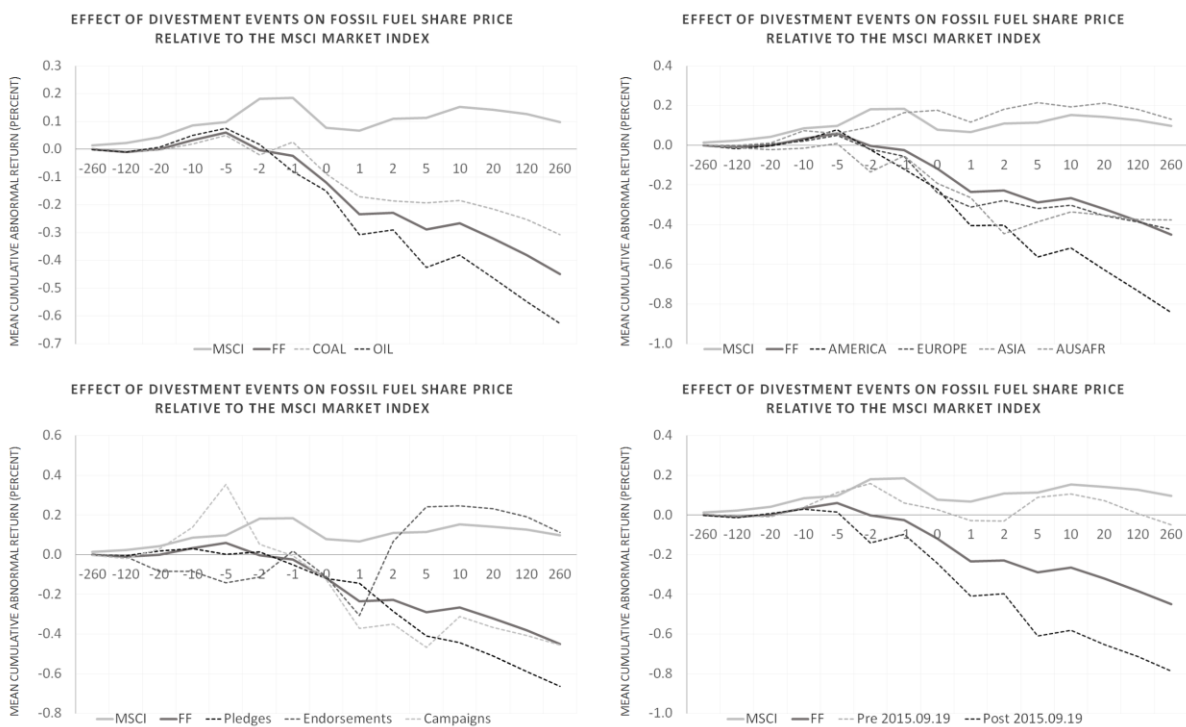


Concluding Remarks

The aggregate results infer that there is a statistically significant negative response on the event day. The results also infer that the impacts of a divestment event carry beyond the event date, resulting in sustained underperformance of the industry through the post-event window. Finally, the independent results infer that later events may have been more influential than earlier ones in impacting firms across a longer event window.

Divestment related events do have a statistically significant response on the event date. Thus, the null hypothesis that divestment has no impact on fossil fuel shares can be rejected. However, outcomes may differ when samples are subcategorized and events are grouped. For instance, figure three shows that sub-samples of coal stocks underperform relative to oil and gas stocks, and sub-samples of firms on Asian markets outperform while firms in the Americas underperform. Moreover, events of pledges and campaigns are more influential than endorsements in the long run and later events tend to underperform relative to early events. While the statistical analysis of these variations is not in scope for this study, the visual representations do indicate the discrepancies and pose opportunities for future research.

Figure 3: Grouping Samples and Events



6.2 Hypothesis Two

The second research question asks, are divestment events more influential than events related to the carbon budget and stranded assets? The null hypothesis stands that there is no difference between divestment events or events of stranded assets or carbon budgets, on fossil fuel share prices. This is because the market perceives similar events to have relatively equal valuation consequences. The alternate hypothesis infers that events related to stranded assets or the carbon budget will have a lesser effect on share prices. This is because under the perspective of stakeholder theory, divestment pursued by more salient shareholders have a greater direct impact than discourse on stranded assets and the carbon budget, which is pursued by stakeholders who do not have a direct impact on share price.

6.2.1 Aggregate Results of Related Events

The first test examines the aggregate stock returns of 21 overlapping event announcements on stranded assets or the carbon budget between 2012 and 2015. The average abnormal returns (AAR) span over a ± 10 -day event window and across a sample size of 198 firms. The cumulative average abnormal returns (CAAR) span over one, two, five, and ten days surrounding the event date. The capital asset pricing model is adopted to infer expected returns and the standardized cross-sectional BMP test is used to test for statistical significance. The fundamental statistics show that 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.

6.2.1.1 Testing Aggregate Results

The evidence from table three indicates that on average, fossil fuel shares did have a statistically significant negative response across one day prior, after, and the day of the event. There is also some indication that shares began to respond to events as early as 10 days prior to the event, which may be indicative of speculative behaviour, however these results are not statistically significant. Comparably, the cumulative abnormal returns indicate a statistically significant negative response for the one-day, two-day, and five-day, and 10-day event windows, suggesting that the impacts of discourse on stranded assets and carbon budgets also span beyond the event day. According to the stakeholder theory, the negative response justifies that markets perceive discourse among stakeholders to be a material risk to the performance of the

fossil fuel industry, even if the stakeholders have no direct influence on share price as in the case of divestment events. Cumulative abnormal returns can be plotted to better visualize the performance of fossil fuel stocks during instances of a divestment event.

Table 5: Aggregate Statistical Test of Stranded Asset and Carbon Budget Event

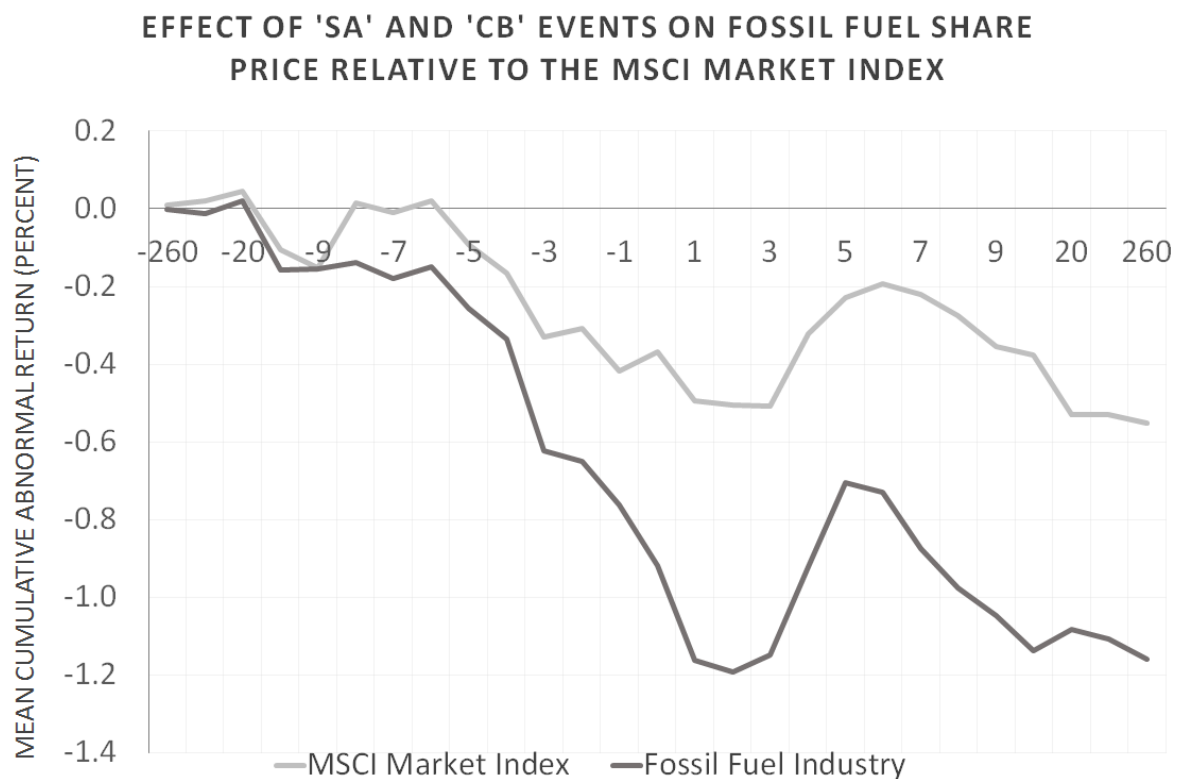
EFFECT OF 'SA' AND 'CB' EVENTS ON SHARE PRICE			
FUNDAMENTALS			
Mean		0.000	
Median		0.000	
Standard Deviation		0.011	
Skewness		-0.079	
Kurtosis		4.796	
Number of Events		21	
Average Sample Size		198	
SINGLE DAY EVENT WINDOWS			
Event Day	Daily Percentage of Abnormal Returns	Cumulative Percentage of Abnormal Returns	Standardized Cross-Sectional BMP Test
-260	-0.033	-0.033	
-10	-0.218	-0.251	-2.723 **
-9	-0.039	-0.290	-0.719
-8	-0.024	-0.314	-0.389
-7	-0.084	-0.398	-0.172
-6	-0.012	-0.410	0.268
-5	-0.147	-0.558	-1.642
-4	-0.121	-0.679	-1.106
-3	-0.328	-1.006	-3.656 **
-2	-0.069	-1.076	-1.020
-1	-0.154	-1.229	-1.943 *
0	-0.198	-1.427	-1.854 *
1	-0.284	-1.711	-2.718 **
2	-0.070	-1.781	-1.191
3	0.000	-1.781	-0.171
4	0.188	-1.593	2.255
5	0.172	-1.421	1.626
6	-0.064	-1.485	-0.771
7	-0.188	-1.673	-1.247
8	-0.141	-1.814	-1.509
9	-0.113	-1.927	-1.280
10	-0.132	-2.058	-2.147 *
260	-0.059	-2.118	
MULTI DAY EVENT WINDOWS			
Intervals	Cumulative Percentage of Abnormal Returns		Standardized Cross-Sectional BMP Test
(-1,1)	-0.633		-3.390 **
(-2,2)	-0.771		-3.434 **
(-5,5)	-1.006		-3.625 **
(-10,10)	-2.015		-4.646 **

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

6.2.1.2 Plotting Aggregate Returns

The evidence highlights the underperformance of fossil fuel shares in the presence of select stranded assets and carbon budget events across the estimation window, the event window, and the post event window. Figure four indicates that while share prices began a steep decline as early as six days prior to the event date, the decline closely follows the market index, which also fell during the days preceding the event. Notably however, the decline among fossil fuel shares is steeper for days surrounding the event. Finally, the figure indicates that the fossil fuel shares rise over the days after the event, suggesting a market correction as shares are repurchased at a lower price. Nevertheless, the impact of stranded asset and carbon budget events seem to lead to sustained underperformance of the industry well into the post-event window. Thus, the results suggest that events related to stranded assets and the carbon budget do depress fossil fuel shares across both the event and post-event window.

Figure 4: Plot of Independent Stranded Asset and Carbon Budget Event



6.2.2 Independent Results of Related Events

The next test examines the individual stock returns of each event announcement included above. The cumulative average abnormal returns (CAAR) for one, two, five, and ten days surrounding the event date, the capital asset pricing model is adopted to infer expected returns, and the standardized cross-sectional BMP test is used to test for statistical significance. The fundamental statistics show that the mean and median returns are zero, the standard deviation deviates between 0.009 and 0.016, the skewness between -0.31 and 0.19 and the kurtosis between 2.54 and 6.38. The sample size spans from 196 to 199.

6.2.2.1 Testing Independent Results

The evidence from Table four indicates that the majority of selected events are influential in depressing fossil fuel share prices. Ten of the 21 events have statistically significant negative returns across all four sets of event windows. Perhaps unsurprisingly, the most influential events include OPEC's announcement to maintain oil production levels which consequently led to a fall in oil prices and the 2014 UN climate summit which complemented the New York Climate march and the Rockefeller Fund's divestment pledge. Curiously, the introduction of the Asset Owners Disclosure Project (AODP), Barack Obama's remarks on climate change, the IEA World Energy Outlook publication are also highly influential events. In contrast the least influential events were the AODP 2015 Global Climate publication, the HSBC 'Stranded Assets: What's Next' publication, and the IPCC Fifth Assessment publication, all of which were insignificant across all cumulative ranges. Some surprisingly weaker events include Mark Carney's Tragedy of the Horizon speech and the UNFCCC COP21 event.

Table 6: Independent Statistical Tests of Stranded Asset and Carbon Budget Events

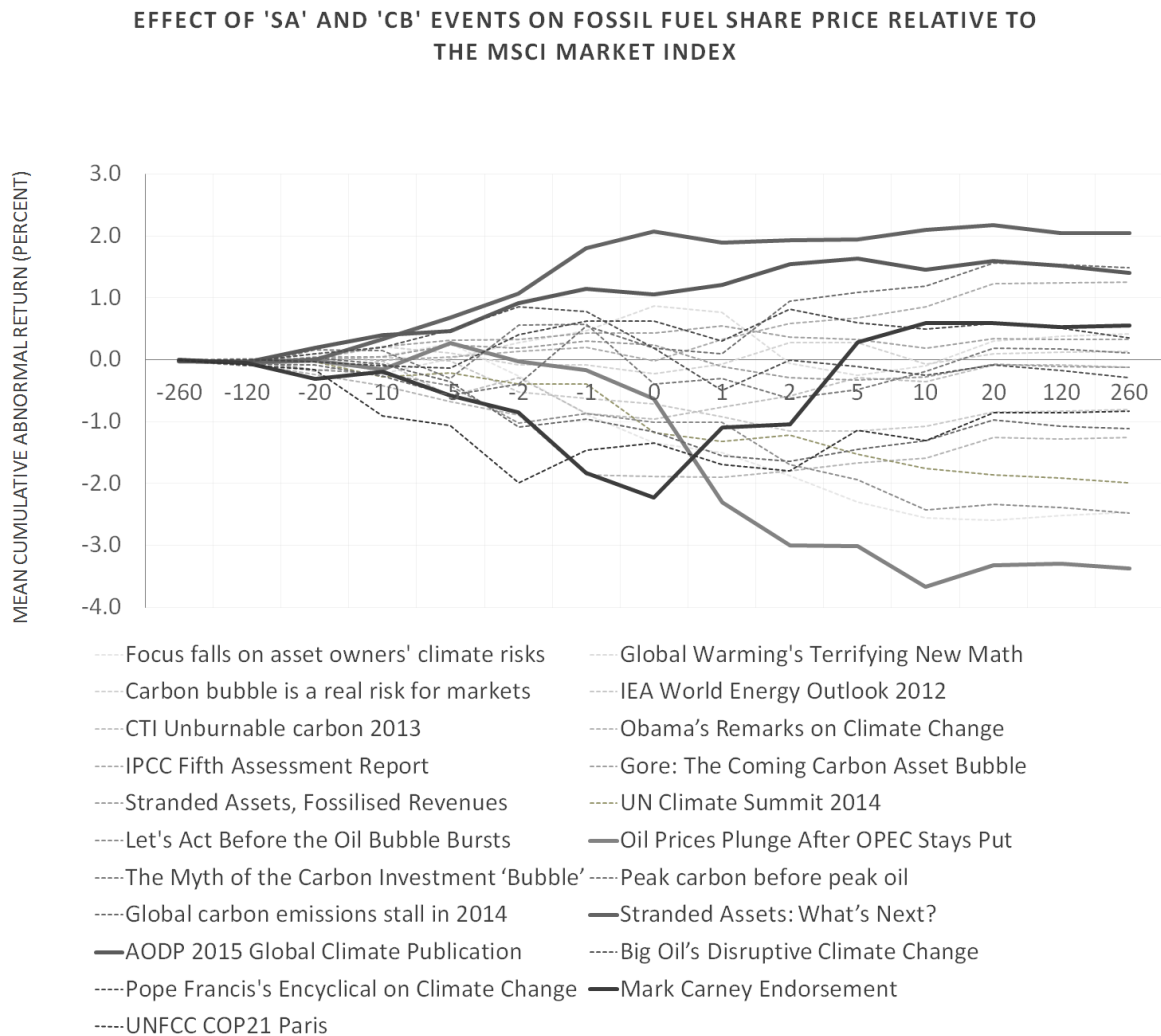
EFFECT OF DIVESTMENT EVENTS ON FOSSIL FUEL SHAPRE PRICE, BY EVENT											
Event Day		MULTI-DAY EVENT WINDOWS									
		(1,1)		(2,2)		(5,5)		(10,10)			
		CAAR	BMP	CAAR	BMP	CAAR	BMP	CAAR	BMP		
12.05.07	Focus falls on asset owners' climate risks	-0.015	-12.048 **	-0.023	-12.086 **	-0.034	-14.910 **	-0.047	-13.277 **		
12.07.19	Global Warming's Terrifying New Math	0.002	1.735	-0.011	-7.417 **	-0.007	-2.908 **	-0.021	-7.736 **		
12.10.30	Carbon bubble is a real risk for markets	-0.003	-2.396 *	-0.002	-1.474	-0.008	-4.496 **	-0.021	-7.332 **		
12.11.12	IEA World Energy Outlook 2012	-0.007	-3.900 **	-0.018	-8.799 **	-0.020	-8.314 **	-0.019	-7.476 **		
13.04.18	CTI Unburnable carbon 2013	-0.008	-4.244 **	-0.004	-2.048 *	-0.014	-5.578 **	-0.014	-4.148 **		
13.06.25	Obama's Remarks on Climate Change	-0.013	-6.157 **	-0.013	-5.850 **	-0.023	-8.092 **	-0.034	-9.485 **		
13.08.30	IPCC Fifth Assessment Report	-0.001	-0.655	0.003	1.624	0.004	1.829	0.006	2.932		
13.10.29	Gore: The Coming Carbon Asset Bubble	-0.001	-0.397	-0.004	-2.374 *	-0.003	-1.529	-0.006	-2.157 *		
14.04.24	Stranded Assets, Fossilised Revenues	-0.005	-5.633 **	-0.005	-3.551 **	-0.005	-2.447 *	-0.006	-2.384 *		
14.09.22	UN Climate Summit 2014	-0.011	-6.336 **	-0.018	-6.631 **	-0.020	-6.200 **	-0.046	-9.578 **		
14.09.29	Let's Act Before the Oil Bubble Bursts	-0.002	-1.602	-0.020	-11.117 **	-0.031	-11.965 **	-0.062	-12.122 **		
14.11.27	Oil Prices Plunge After OPEC Stays Put	-0.026	-8.495 **	-0.035	-7.931 **	-0.026	-4.986 **	-0.071	-10.477 **		
15.01.12	The Myth of the Carbon Investment 'Bubble'	-0.012	-8.080 **	-0.006	-2.273 *	-0.020	-5.155 **	-0.012	-3.033 **		
15.01.19	Peak carbon before peak oil	0.001	0.707	0.016	5.790	0.002	0.594	-0.008	-1.844 *		
15.03.12	Global carbon emissions stall in 2014	-0.008	-3.366 **	-0.015	-7.388 **	-0.023	-7.728 **	-0.027	-7.155 **		
15.04.16	Stranded Assets: What's Next?	0.005	3.191	0.006	2.462	0.014	4.354	0.031	7.615		
15.04.27	AODP 2015 Global Climate Publication	0.000	-0.184	0.008	3.399	0.008	2.912	0.002	0.508		
15.05.06	Big Oil's Disruptive Climate Change	-0.017	-6.915 **	-0.010	-3.831 **	-0.008	-2.639 **	-0.015	-3.704 **		
15.05.25	Pope Francis's Encyclical on Climate Change	-0.005	-2.291 *	0.000	-0.040	-0.007	-1.890 *	-0.022	-3.326 **		
15.09.29	Mark Carney Endorsement	-0.007	-3.908 **	0.000	0.073	0.012	3.400	0.023	5.474		
15.12.16	UNFCC COP21 Paris	-0.001	-0.222	-0.012	-2.643 **	-0.002	-0.376	-0.054	-8.856 **		

Notes:
 *p<0.05, **p<0.01
 a. CAAR: Cumulative Average Abnormal Returns.
 b. BMP: Standardized Cross-Sectional BMP Test

6.2.2.2 Plotting Independent Returns

The evidence across independent events once again attests that not all stranded asset or carbon budget events are equally influential. Results are mapped relative to the MSCI market index and graded in chronological order (from lighter to darker) across the estimation window, the event window, and the post event window. Figure 5 indicates that while the majority of events experienced a negative response on the day of or surrounding the event, ten of the 21 events rallied up to a level where fossil fuel returns outperformed the MSCI market index over the post-event window. As attested to above, the most influential event was the OPEC announcement, while the least influential events were the HSBC stranded assets publication and the AODP global climate publication announcements. One notable case is Mark Carney's 'Tragedy of the Horizon' speech, which declined prior to the event day but adjusted upward to outperform the market over the post-event window.

Figure 5: Plot of Independent Stranded Asset and Carbon Budget Events



6.2.3 Comparing Events

Finally, in order to answer whether divestment events are in fact more influential than stranded asset or carbon budget events, the two types of events are compared. The results suggest that while divestment events may be less influential over the days surrounding the event, there is no statistically significant deviation between the two datasets. Independent t-tests highlighted in table five over one, two, five, ten, and 260 day intervals do not highlight any statistically significant discrepancy. Figure six plots the cumulative returns for events related to divestment versus events related to stranded assets and the carbon budget, relative to the MSCI market index. The figure confirms that both types of events lead to underperformance among fossil fuel shares. Visually, while stranded asset and carbon budget events seem to have a more significant decline around the event day, the difference is not statistically significant.

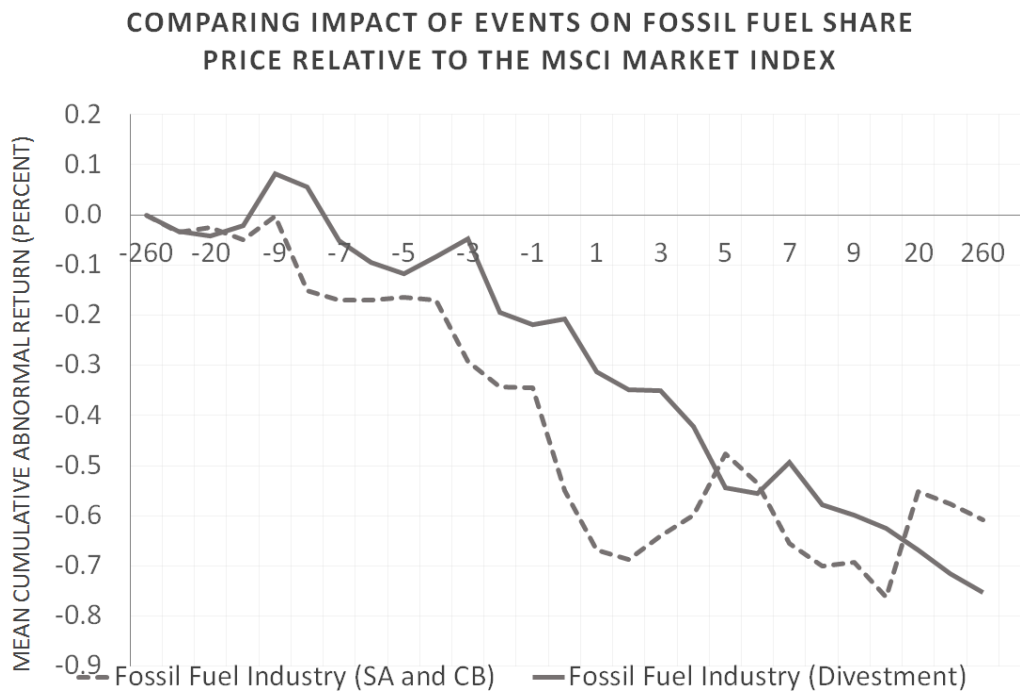
Moreover, while stranded asset and carbon budget events rebound upwards toward the post event window, shares seem to maintain their downward trajectory after divestment events.

Table 7: Comparing Divestment Events to Stranded Asset and Carbon Budget Events

COMPARING THE EFFECT OF EVENTS ON SHARE PRICE		
MULTI-DAY EVENT WINDOWS		
Independent T-Test		
Intervals	Divestment and the Carbon Budget	Divestment and Stranded Assets
(-1,1)	0.031	0.032
(-2,2)	0.008	0.008
(-5,5)	0.004	0.004
(-10,10)	0.013	0.012
(-260,260)	0.006	0.006

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

Figure 6: Plotting the Impact of Divestment, Stranded Asset, and Carbon Budget Events



Concluding Remarks

Divestment related events do not have a greater negative response relative to events related to stranded assets or the carbon budget. Thus, the null hypothesis that divestment events are more influential than stranded asset and carbon budget events cannot be rejected. This could suggest that all stakeholders are equally impactful, or conversely, that stakeholder theory does not apply in this case.

6.3 Conclusion and Next Steps

The purpose of this chapter was to answer the research questions; whether divestment and related events have an impact on the share price of fossil fuel firms. The first null hypothesis, that divestment events have no measurable impact on the fossil fuel industry can be rejected. However, this result does not represent all divestment events equally. There is an opportunity to extend the study further, to adjust for discrepancies between fossil fuel type, geographical location, type of divestment announcement, and across the timeline of divestment announcements. The second null hypothesis, that divestment events are not more influential than events of stranded assets and the carbon budget can not be rejected. The independent results confirm that not all events are comparably impactful. There is an opportunity to extend this result in the context of the saliency of key stakeholders and the means by which they can influence the fossil fuel industry.

CHAPTER 7: DISCUSSION

The results complement the notion that discourse on divestment, stranded assets, and the carbon budget are all impactful in influencing the fossil fuel industry. This chapter briefly outlines the value of the research conducted.

7.1 Linking Results to Literature

Literature on fossil-fuel divestment explains that the campaign is pursued by institutional investors as a means of social advocacy against the fossil fuel industry. The fossil fuel industry is a major contributor to anthropogenic climate change and if climate targets are to be met, the majority of existing reserves must be rendered unburnable. There is no empirical evidence however, to measure whether announcements of divestment, stranded assets, or the carbon budget have any impact on the sector's corporate objectives. In the context of the efficient market hypothesis, this thesis tested the impact of such topics using the event study methodology. The results suggest that markets are in fact responding to pressures of divestment, stranded assets, and the carbon budget. Moreover, in the context of stakeholder theory, this thesis compared shareholder driven divestment events to stakeholder driven events of stranded assets and the carbon budget. The results suggest that markets perceive the pressures of shareholders and stakeholders equally. The findings contribute back to the literature on whether divestment has an impact on the fossil fuel sector, with a resounding yes.

Notably, this is not the first study conducted that measures the impact of divestment events. In fact, six of its kind relate to the anti-Apartheid divestment campaign. This is the first of its kind in the context of the fossil-fuel divestment campaign. The results attest to the studies by Wright and Ferris (1997) and Meznar et al. (1994, 1998) that announcements of divestment lead to statistically significant negative returns. The findings of this thesis thus complement the results of significant negative returns in the short run, but also expands the findings to suggest that there may be a long term impact as well.

7.2 Justifying the Results

Of course, the most common criticisms would stand that the lower prices are simply due to market forces or declining oil prices. While both concerns are relevant, this study has a number of robustness checks in place to ensure the impact of events are isolated.

First, in order to justify that price impacts are not simply due to market forces, the study compares the performance of the industry to the market index over an estimation, event, and post-event window. The results show that while the trend across the estimation window for the fossil fuel portfolio and the market index are aligned, there is a decoupling between the two 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.

Second, in order to justify that the price impacts are simply not in response to falling oil prices, the study points to two examples of independent results - one before and one after OPEC's announcement to maintain oil production levels. The first example relates to the third weekend of September 2014, which arguably proved to be the most impactful instance across the divestment movement. The pressures of the UN climate summit, the people's climate march, the Rockefeller Fund pledge, and over 700 other independent pledges in conjunction, depressed fossil fuel share prices by over 3 percent over the event window and sustained at that level over the following year. The second example relates to Mark Carney's speech on the Tragedy of the Horizon, an event that occurred after the OPEC announcement. Fossil fuel share prices experienced a notable decline relative to the market index as early as 10 days prior to the event, indicative of prior knowledge and speculation around this event. However, fossil fuel share prices quickly rose after the event, outperforming the market index in as little as five days. If in fact these prices were strictly driven by oil prices, it would stand to reason that shares would not have seen the correction in prices directly after the event day. These two examples point to the fact that while stocks undoubtedly respond to falling oil prices, the results are indicative that these isolated events are also impacting share prices.

7.3 Contribution of Research

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. This does not suggest that all pledges to divest, will be equally impactful; 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 to begin with 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. It is thus in the industry's best interest to engage with shareholders and stakeholder alike, to address their concerns. To stakeholders, this thesis encourages continued discourse on the topics of stranded assets and the carbon budget, as equally influential to the divestment movement.

To the literature on divestment, 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; rather that divestment has to date, had an impact in depressing share prices of fossil fuel firms.

7.4 Opportunities for Further Research

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. Second, the impact of divestment can be compared to the impact of other climate change strategies, such as engagement initiatives. Finally, divestment can be studied in the context 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.

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