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Do Divestment Announcements Affect Fossil Fuel Company Stock Returns?

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Abstract

In response to growing dissatisfaction from environmental activists, many large institutional investors have committed to divesting from fossil fuel related assets. Understanding the financial effects of these divestment movements is crucial to assessing their impact on climate change. Using a financial event study methodology with a sample of 50 divestment announcements from 2014 to 2022, this paper examines the effect that the announcement of these divestment decisions has on the stock returns of oil & gas and coal companies. I find the short term effect on stock prices following a divestment announcement to be insignificant, and I show that more than divestment announcements are required to find a significant effect. Ultimately, I conclude that the effect of divestment announcements may be less tied to the day of the announcement, and the true effects may be found in the longer term.

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1. Introduction

Over the past few years, what was once a political debate without immediate implications or much urgency has become a serious issue that scientists are calling a global crisis. In a report released on February 28, 2022 by the United Nations Intergovernmental Panel on Climate, scientists revealed that climate change is causing death and suffering around the world and some environmental effects from rising temperatures are irreversible (Tollefson 2022). Burning fossil fuels is a major contributor to the climate crisis (EPA). In an effort to limit the effects of these dirty energy sources, environmentalists have preached the importance of relying on renewable sources of energy. Activists have tried to accelerate a switch to renewables in many ways. One approach to catalyzing this transition is to divest from all assets tied to companies engaged in the extraction of fossil fuels. Divestment campaigns first became widespread in 2011 when many college students demanded for their colleges' endowments to divest from all fossil fuel-related businesses (Raji 2014). Since then, over 1500 institutions that manage a combined $40.51 trillion in assets, including schools, governments, pensions, and asset management companies have pledged to divest from fossil fuels (Global Fossil Fuel Divestment Commitments Database 2023). These divestments are either from specific fossil fuel types (coal only, oil & gas only, etc.) or all fossil fuels, most of which fall in the latter category.

While the overall goal of these divestment campaigns is to further the energy transition through a simultaneous shrinking of the fossil fuel industry and growing of the renewable energy industry, the mechanisms by which this goal is achieved via divestment are less clear. It is important to understand how the selling of fossil fuels assets should affect these businesses and how this compares to the goals of these activism campaigns and the actual effect once they

have happened. One opposing argument is that these divestment campaigns may not have a significant effect, since the divestment of an asset necessitates that someone else buys it. The new owner of the asset still sees some value in it since they decided to purchase it, and in many cases, they are able to continue to generate substantial profits from owning and operating fossil fuel businesses even after the divestment of the original owner is complete (The Economist). Critics are correct in positing that the financial impact of these divestments could be a wash, but advocates of the divestment strategy also hold the opinion that the effects may not be as direct as reducing the value of fossil fuel business. They reason that the negative attention that results from divestments can have negative financial consequences over a longer horizon (The Economist).

This leaves the basic question of what are the direct financial impacts of divestment unanswered. In theory, divestments should financially hurt fossil fuel companies. If fewer people are willing to invest in the company, then the price of owning a share of the equity in that company should be worth less. Following a simple supply and demand framework, divestments lead to a decrease in demand for the stock. This should increase the amount of that stock that is available in the market and ultimately decrease the price of the underlying security. Furthermore, this decrease in stock price should increase the cost of capital for the affected firms, making it more difficult for them to finance future investments and business operations. If investors view the stock as more risky, then the required return that they will demand on their capital is higher, and there will be less investors willing to contribute capital unless they think that the company can give them an appropriate return on their capital, given the risks that the company faces. However, as pointed out by skeptics, how this really plays out financially can differ greatly from the theoretical hypothesis.

Using an event study methodology, I find that in the short term periods following a large divestment announcement, fossil fuel companies' stock returns are not significantly affected. It is hypothesized that divestment announcements only affect fossil fuel companies via the public discourse and controversy that ensues in the days and weeks after a large announcement, which supports the belief that these events should negatively affect prices in the long term once investors have changed their outlook on fossil fuel businesses.

This thesis introduces these findings in the order that follows. Section 2 discusses the relevant literature around the topic, explaining what has been studied thus far, what the findings of previous studies have concluded, and how this study adds to the existing literature. Section 3 gives an overview of the sources and structure of the data used in the study, in addition to providing relevant summary statistics and other information about the data. Section 4 details the event study methodology used to analyze the data, and outlines the statistical methods used to analyze the data and results of the event study. Section 5 reports the results of the event study analysis, the results of the split sample analyses, and analyzes the power of the results. Section 6 discusses the implications and interpretations of the empirical findings. Finally, section 7 recapitulates the overall finding of the study and their implications for the divestment movement and future research related to this topic.

2. Literature Review

Past literature studies the various effects of divestment campaigns, including the specific effect of large institutional investors' divestment announcements on stock prices of fossil fuel companies. First, it is important to understand what effects divestment decisions ought to have, and how this logic compares with empirical examples of divestments in the past. In Bergman's

(2018) general overview of the theoretical financial, political, and social impacts of divestments, a broad, qualitative review of existing literature, in addition to interviews with activists and financial actors gives insight into how divestment campaigns have and should affect fossil fuel companies in the short and long term after these announcements. Generally, he finds that the direct financial impacts of divestment—immediate decreases in fossil fuel companies' capital—are weaker and more difficult to measure than the indirect financial effects, which are the long term changes in capital raising ability and profitability of fossil fuel businesses. Since divestment campaigns are often initiated by smaller, less influential organizations and individuals, many early divestment announcements affected investor's outlook only indirectly via the larger press coverage of fossil fuel companies as a result of the divestment announcement. Direct financial impacts to fossil fuel companies are unclear. Only announcements from influential financial institutions had immediate negative effects on the financial performance of fossil fuel companies and more poignant changes in attitude from policy makers that directly affected their treatment of fossil fuel companies via regulations. Thus, the main indirect effect of early divestment announcements was their initiation of the change in public discourse that motivated larger institutions to follow suit. Consequently, Bergman's main analysis of the financial impacts is that they are indirectly caused by overall change in investor sentiment about fossil fuels companies, meaning that the immediate impact of the actual divestments is less significant and harder to accurately measure.

Other studies have focused on this acute financial impact and find mixed effects of these divestment announcements. As Bergman (2018) points out, one counterargument to divestment campaigns is that the investors choosing to divest from these assets could violate their fiduciary duty as asset managers to create the maximum possible returns for their clients while

minimizing the risks. However, the loose and evolving definition of "fiduciary duty" weakens this counterargument. Further rebutting the notion that divestment weakens an investor's ability to maximize returns and minimize risk, Halcoussis and Lowenberg's (2018) study on the effects of divestments on portfolio returns find that carbon-free portfolios tend to perform similarly, and in some cases slightly better, than the broader market. The authors compare fossil-fuel free portfolios to the S&P 500 over an 8 year period and find that low-carbon portfolios, akin to the investment portfolios of the companies that have announced divestments, earn slightly higher returns than the general market. Conversely, Plantinga and Scholtens (2020) report that the performance of portfolios excluding fossil fuel stocks does not differ significantly from unrestricted portfolios in terms of both returns and risk.

Some literature has also sought to analyze the effects of divestment not on the investors themselves, but on the fossil fuel companies from which they have divested. Dordi and Weber (2019) find that divestment announcements during January 2012 to December 2015 decreased the share prices of fossil fuel companies, when controlling for the general underperformance of these securities during the time period studied. Similarly, Zori el al. (2022) finds that divestment announcements have a negative effect on fossil fuel stocks, but with the qualification that the magnitude and significance of this effect varies based on the timing of the announcement and the size of the divesting investor.

Both Dordi and Weber (2019) and Zori et al. (2022) employ an event study framework to their econometric analysis to determine the effects of these announcements on the stock prices of fossil fuel companies, yet the structure of their models differs slightly. Most notably they differ in the number of observations they use for both divestment announcements and fossil fuel companies, as well as the time period over which they analyze the returns of these

businesses. Dordi and Weber (2019) analyzed 119 unique events, which they narrowed down using a screening process from an original sample of over 1500 events. Interestingly, one check the authors used was google search data for the word “divestment” around the event timing to confirm the relevance of the event in media discourse during which the event happened. Zori et al. (2022) used 116 divestment announcements, including announcements from small, medium, and large investors to analyze the effects of differently sized investors. Dordi and Weber (2019) analyzed stock prices of 200 companies, utilizing the companies from the Carbon Underground, which includes the top 100 oil and gas and top 100 coal companies worldwide in terms of carbon emissions created. Zori et al. used the NGO FossilFreeIndexes to find the 51 companies they used in their study, only including companies from this list that were listed in the U.S. Dordi and Weber combine the use of a single day event window and multi-day event windows of 10 days around the event to study abnormal returns. Their estimation window for normal returns is 250 trading days. Zordi et al. used 8 different event windows, the first four of which had an equal number of time before and after the event date (0 days +/-, 2 days +/-, 5 days +/-, and 10 days +/-). Due to their hypothesis that the incorporation of the information of the announcement would affect long term growth outlooks and valuations of fossil fuel companies, they also studied event windows where 10, 30, 60 and 90 days after the announcement were included.

These examples serve to show the robustness of the event study as a way of analyzing this question. The general framework for constructing such a study is laid out in greater detail in MacKinlay (1997). MacKinlay outlines the main steps to building an event study to analyze stock prices, which are choosing an event window and date and calculating abnormal returns. Choosing an event window for divestments depends on the hypothesis of how divestment

affects stock prices. If it is assumed that these divestments should have a direct effect on the prices of fossil fuels securities, then a one day event window is ideal. If it is theorized that there could be long term effects on the price of the stock, similar to the hypothesis of Zori et al., then a post event window should be included as well. Next, calculating abnormal returns is done by subtracting actual returns from expected normal returns. Expected normal returns can be estimated in many ways, and the method used depends on the type of event being studied as well as the length of the event window. For shorter event windows, expected normal returns will be very small, so the method used is less significant. For longer event windows, it is important to estimate normal returns carefully as to not include effects of the event in normal returns, or include normal returns in abnormal returns. The market model is a popular method of estimating these normal returns, which both Dordi and Weber and Zori et al. employ. This method is especially useful for studying fossil fuels companies, since many other macroeconomic conditions affect the price of these stocks during the time that divestment announcements happened. This methodology is described in greater detail in Section 4.

While the event study methodology employed in this paper, as explained in MacKinlay (1997), follows a similar technique and statistical analysis to prior literature focused on this same relationship, this study finds no significant difference in stock returns of fossil fuel companies in the days following a large divestment announcement. Although the power analysis determines that more data are needed to find significant results, this indicative of the notion that divestment announcements affect stock returns of fossil fuel companies over a longer time horizon than is suggested by past research and general event study methodology guidance. It could also suggest the possibility that the event date itself is not a significant driver of stock price swings.

3. Data

3.a. Divestment Announcements Data

The divestment announcements data come from www.divestmentdatabase.org, a website that posts and tracks asset managers and institutions that have made announcements that they are divesting from some or all fossil fuel related assets. Divestmentsdatabase.org is managed by Stand.earth, a not-for-profit organization that studies climate change and our earth. The data also include the date that the announcement was made and reported by the press, which will be used as the event date in the event study. The divestments fall in one of five categories: Full, Fossil Free, Partial, Coal and Tar Sands, and Coal only. Full divestments mean that the institution or corporation made a commitment to divest from all fossil fuel company investments, including direct ownership, shares, commingles mutual funds containing shares, corporate bonds, or any other asset classes, within a set timeline and avoid these types of investments in the future. Fossil Free means that the institution or corporation did not own any investments in fossil fuels at the time of the announcement, and in their announcement they committed to abstaining from any investments of this type in the future. Partial divestment mean that the institution or corporation committed to either divest from all asset classes in some fossil fuel types (e.g. coal and oil, but not natural gas) or divest from all fossil fuels investments in some but not all asset classes (e.g. all equities, but not corporate debt). Coal and Tar Sands divestments mean that the institution made a commitment to divest from all assets tied to any thermal coal and tar sands companies. Coal only divestments are ones in which the institution or corporation made a binding commitment to divest from all assets from any thermal coal companies only. Overall, the divestments database lists over 1500 divestment announcements

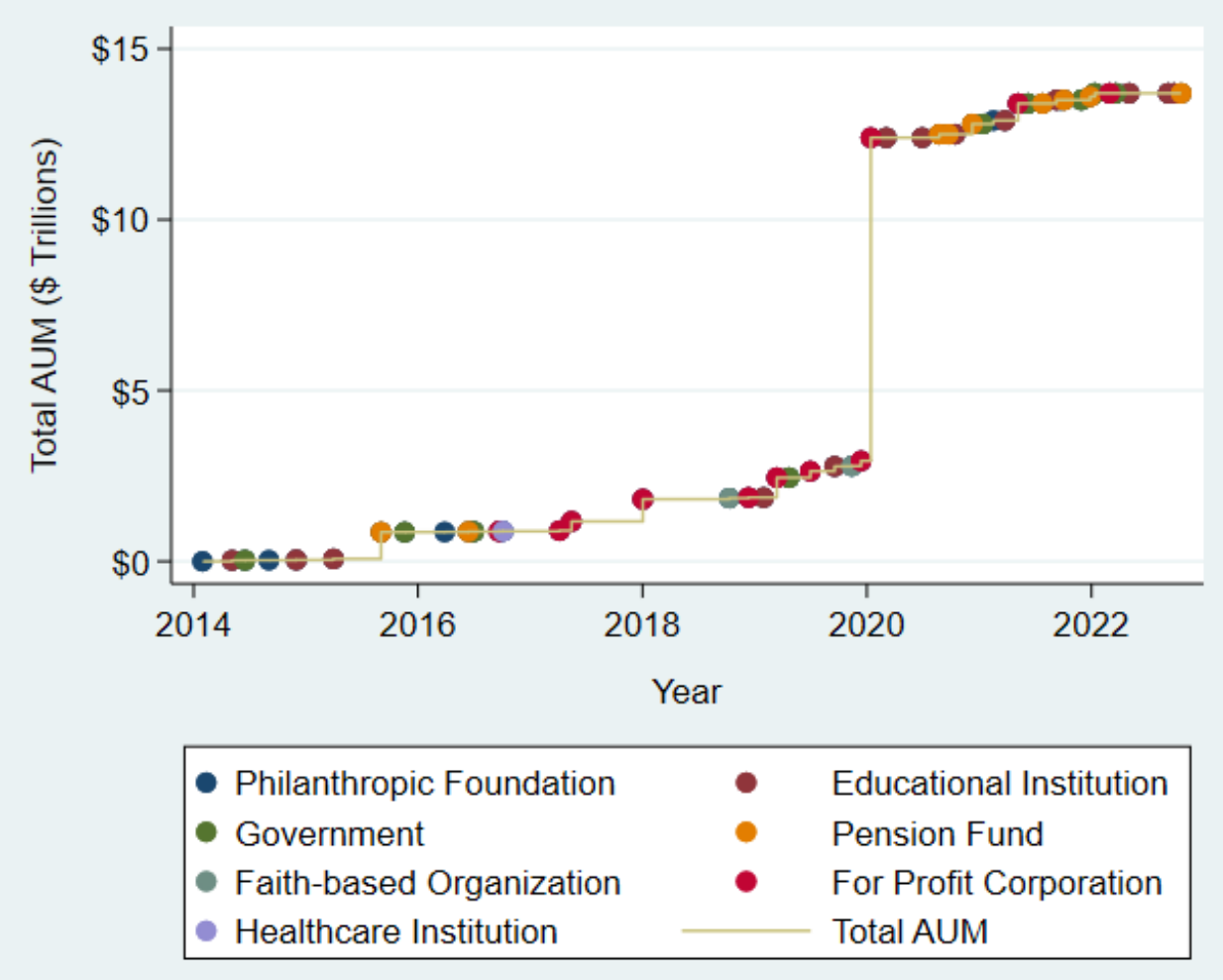
from institutions all over the world that manage a combined total of over $40 trillion of assets. The largest type of institution represented in the database is faith-based organizations, making up 35.2% of all divestment announcements. Educational institutions make up 15.8%, followed by philanthropic foundations comprising 12.1%, pension funds making up 11.9%, and governments making up 11.2%. For profit corporations represent 8.6% of all divestment announcements reported.

3.b. Announcement Selection Criteria

To filter through this dense list of divestment announcements, some criteria were laid out to filter through insignificant announcements. First, only announcements by institutions or corporations managing at least $1 billion dollars in assets were considered. Next, only divestment announcements by institutions in the United States, or institutions that had operations or are publicly traded on a major US stock exchange (NYSE, NASDAQ) were kept. Due to the fact that the stock return data being used only includes companies traded on major US stock exchanges, announcements from international corporations outside of the United States, except for those tied to US equity markets via North American operating segments or use of united states public equity capital markets, were ignored, since they have an insignificant effect on US public equity markets. After these filters were applied, 85 individual divestment announcements remained. These 85 divestment announcements range from January 2014 to October 2022. Next, in order to analyze the aggregate effect of the events, it is necessary that no announcement occurs within the event window of another announcement. The event window is explained in more detail in section 4. The largest event window considered is 10 days, so if an announcement occurs within 10 days of another announcement, one must be removed from the sample. In these situations, the announcement that corresponds to a larger institution in terms of

assets under management was kept. After this final filtration process, a sample of 50 events remained. These 50 events will be analyzed individually and conjointly. The list of all 50 events and information about the divesting entity, including its type of divestment and assets under management, is reported in Table 1 in the Appendix. Figure 1, shown below, plots the divestment announcements over time, showing the cumulative assets under management of divesting institutions:

Figure 1 - Cumulative AUM of Divested Institutions



Source: divestmentdatabase.org

Note: This figure shows the cumulative assets under management of firms or organizations that committed to divesting from fossil fuel using the 50 announcements in the sample. On January 14, 2020, BlackRock, the world's largest asset management firm managing over $9 trillion in capital, committed to divesting from Coal, which is shown in the large jump in early 2020 in the figure.

The 50 announcements included in the study represent almost $15 trillion of capital divested from all fossil fuel investments. This does not mean that $15 trillion was divested from fossil fuel assets; rather, this $15 trillion corresponds to the total amount of capital managed by the divesting institutions. Divestment announcements are categorized by the type of institution. According to the sample of announcements, for profit corporations did not commit to divesting from fossil fuels until 2017, with more divestment announcements occurring in 2020, 2021, and 2022 than any of the years before 2020.

3.c. Stock Return Data

The stock return data come from two places. Industry specific returns data for oil and gas and coal industries are compiled by Ken R. French, Roth Family Distinguished Professor of Finance at the Tuck School of Business at Dartmouth University. Professor French calculates daily returns for industry portfolios. He defines the coal industry as businesses in bituminous coal production. He defines oil and gas companies as those involved in any part of petroleum or natural gas production, including upstream, midstream, downstream, and other oil and gas services companies. Included also are daily stock return data for the S&P 500 stock index, which was obtained from the S&P Capital IQ data service. Daily returns data for the dates that span the dates of the divestment announcements are included.

3.d. Summary Statistics

Of the 50 divestment announcements to be included in the event study, the largest investor based on assets under management is Black Rock, which manages over $9 trillion USD. The median amount of AUM by all announcers is about $9 billion. The average is over $274 billion. 66% of the 50 announcements considered were "Full" announcements, as defined by divestmentdatabase.org. 26% were Coal only, and 4% or less were Coal and Tar Sands Only, Partial, or Fossil Free. As for the types of institutions divesting, 26% were educational institutions. 22% were for profit corporations, followed by Governments and Pension funds each representing 18% of all announcements in the sample. Philanthropic Foundations accounted for 10% and Faith-based organizations and Healthcare institutions represented 4% and 2%, respectively. Tables 2 and 3 show the breakdown of divestmenting entity type and divestment type, respectively.

Table 2 - Type of Divesting Institution

Categories	Count	Percentage
Pension Fund	9	18%
For Profit Corporation	11	22%
Government	9	18%
Educational Institution	13	26%
Philanthropic Foundation	5	10%
Faith-based Organization	2	4%
Healthcare Institution	1	2%

Source: divestmentdatabase.org

Table 3 - Type of Divestment

Categories	Count	Percentage
Full	33	66%
Coal Only	13	26%
Coal and Tar Sands Only	1	2%
Fossil Free	1	2%

Source: divestmentdatabase.org

The average daily return for the years 2013 to 2022 in Oil companies was 0.01%. This is compared to an average daily return of 0.04% in the coal industry, and 0.06% in the S&P 500 Index, which serves as a good proxy for "normal" returns during the period. In the Oil & Gas and Coal industries, the standard deviations of the returns were 3.2 and 1.9 respectively, while the S&P 500 had a slightly less volatile expected return, with a standard deviation of 1.1. The maximum daily loss for Oil & Gas companies was -18.44% and Coal companies maximum loss was -19.88%. Meanwhile, the S&P 500's worst trading day posted a -11.98% loss. The S&P maximum daily gain for the period was 9.38%, while Coal companies had a maximum return on a single day of 16.14% and Oil & Gas had 19.91%.

4. Methodology

The methodology for this financial event study is based on previous research, with MacKinlay (1997) serving as the main roadmap. I highlight important parts for this study and explain how they apply to these data.

The first step in conducting an event study is to define an event. In general, an event is the date during which something happens that affects the value of a security or asset. This broad definition can be applied to any event that could have a material effect on the value of a security or asset. Some popular examples, which are the subject of many event studies, are quarterly or annual earnings releases, dividend increases, or merger or acquisition announcements. The event date is that calendar day during which the event of interest occurs. In this case, the event is the date of announcement of divestment from fossil fuels by a large institution. This should have an impact on the value of many securities, specifically the public equity prices of fossil fuel companies that are being sold off in these divestments.

Next, the event window is set. The event window is defined as the period of time around the event during which the security prices of interest are examined. It is common practice to set the event window to be larger than the specific period of interest, especially when the specific date of the event is uncertain or there is reason to believe that information of the event's occurrence leaked before the official event date. The smallest event window used in practice includes the day of the event and the day after the event, accounting for all price changes occurring after market close on the day of the event. The after-hours trades that affect the price of the stock are omitted if the event window is set to solely the event date. If information about the event leaked before the event date, the days leading up to the event should be included in the event window. Although the event window ought to match the researcher's hypothesis about the effect that the event has on the security, in practice, many event windows are considered. For this study, the hypothesis is that any event, or divestment announcement, will negatively affect fossil fuel security prices not only on the event day, but for many days after the event, as the public attention resulting from a large announcement will circulate through the press for many days, leading to increased discussion about the divestment which will to gradually change investors' perceptions of fossil fuel companies and ultimately hurt their value. In order to test this hypothesis, multiple event windows were considered to study the effects of divestments as thoroughly as possible. In relative event time, with the day of the event being time 0, the days after the event being days 1, 2, 3, etc. and the days leading up to the event being -3, -2, -1, etc., the event window can be written as $[\tau_1, \tau_2]$, where τ_1 is the first day of the event window in event time and τ_2 is the last day. The event windows considered in this study are [0,1], [-2,2], [0,5], [0,10], [-5,5].

After defining the event and event window, one must determine the securities to be analyzed over the event window after each event. In this case, the securities of interest are Oil & Gas and Coal companies. Two portfolios of daily returns, one for Oil & Gas and one for Coal companies, will be considered. Each portfolio will be treated as a single asset in the event study methodology. Since they are in the same industry, returns of fossil fuel companies are correlated and have a large covariance. It would violate the independence assumption to study separate Oil and Gas or Coal companies as individual securities in the study. To eliminate the covariance of fossil fuel company returns, a portfolio of returns for all companies of these types are used.

Once the events, event window, and securities have been decided, the next step is to calculate abnormal returns. Abnormal returns can be defined as the actual return for a security on a given day less the normal or expected return for the asset on that same day. For security i on event date t, the abnormal return can be calculated as $AR_{it} = R_{it} - E(R_{it}|X_t)$, where AR_{it} is the abnormal return, R_{it} is the actual return, and $E(R_{it}|X_t)$ is the normal return. There are multiple models for calculating the normal return. This study will use the market model, which is a popular choice among researchers. The market model assumes a linear relationship between security i and the market's average daily return. The daily return of the S&P 500 is commonly used for the market portfolio, as it is in this study. Using an OLS regression, the coefficient of this linear relationship is calculated over an estimation period, and the results of that model are used to predict the normal returns during the event window, which are finally used to calculate the abnormal returns as defined above. The linear specifications of the market model are as follows:

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

$$E(\varepsilon_{it} - 0) \qquad var(\varepsilon_{it}) = \sigma^2_{\varepsilon_{it}}$$

where R_{it} is the return of security *i* on day *t,* and R_{mt} is the return of the market on day *t*. The β of the OLS regression as defined in equation (1) will be used to prejudice the normal returns of security *i* on a certain day during the event window, based on the market return on that same day,

In order to use the market model to produce normal returns, one must define the estimation window, which is the time during which one regresses the security's returns on the market return. Generally the estimation window does not coincide with the event window, as to not capture the effects of the event in the estimation period. A common choice is to use the 110 days prior to 10 days before the event to estimate the market model. With this information, the abnormal returns can be calculated for the event window and then analyzed and tested for significance.

In order to analyze the returns over the event window, one must first aggregate the abnormal returns for each day in the event window. This can be done simply by adding the abnormal return from each day in the event window to get the $CAR_i(t_1,t_2)$, where t_1 and t_2 are the bounds of the event window. These CARs can then be averaged for all of the securities in consideration to get the average aggregate return during the event window. In this case, this step is unnecessary since the study only considers a single portfolio of returns. Next, one can aggregate the CARs for each event through time using a similar method. As noted by MacKinlay 1997, the order of these two aggregations does not change the analysis or results.

Under the assumption that returns are normally distributed, the variance of the returns can be calculated as

$$var(\overline{AR_t}) = \frac{1}{N^2}\sum_{i=1}^{N} \sigma^2_{\varepsilon_i} \quad (2)$$

This calculation can then be aggregated over each day to find the variance for any event period:

$$var(\overline{CAR}(\tau_1, \tau_2)) = \sum_{t=t_1}^{t_2} var(\overline{AR_t}) \quad (3)$$

Again, this aggregation can be done first security by security and then across time, or vice versa. Using these estimates allows for the analysis of statistical hypotheses for any event period. To analyze the statistical significance of the aggregated CARs, one can test the null hypothesis, which is that the abnormal returns over the event window are not statistically different from 0, using this calculation:

$$\theta_1 = \frac{\overline{CAR}(\tau_1,\tau_2)}{var(\overline{CAR}(\tau_1,\tau_2))^{\frac{1}{2}}} \quad (4)$$

These calculations under the assumption of normal distribution of returns allow for the parametric analysis of CARs for each event individually, and for the aggregation of all events using the statistic defined in the above equation. In this study, the significance of the abnormal returns of specific choice events and the aggregated return averaged over all events will be considered and analyzed.

5. Results

5.a. Aggregated Event Sample Results

After aggregating all of the abnormal returns across each event window and then aggregating across all 50 events, parametric tests were performed to test the significance of the results. The results are categorized into 10 different values. There are 5 results for the average

CAR during each event window for the Oil & Gas portfolio, and similarly, there are 5 values for the CAR for the Coal portfolio during each of the event windows. The aggregated returns for each event window, defined as or CAR, are listed in Table 4 along with tests of their significance.

Table 4 - Full Event Sample Results

Event Window	Portfolio	CAAR	St. dev.	t statistic	Corresponding p value
[0,1]	Coal	0.51%	1.96%	1.82	0.076
[0,1]	Oil	1.00%	4.35%	1.63	0.109
[-2,2]	Coal	0.16%	3.35%	0.34	0.734
[-2,2]	Oil	0.09%	7.91%	0.09	0.932
[0,10]	Coal	-0.33%	7.46%	-0.31	0.759
[0,10]	Oil	0.40%	8.99%	0.31	0.753
[0,5]	Coal	0.24%	4.89%	0.35	0.726
[0,5]	Oil	-0.16%	7.25%	-0.15	0.875
[-5,5]	Coal	0.85%	6.84%	0.88	0.381
[-5,5]	Oil	-0.75%	10.25%	0.51	0.611

For the smallest event window, [0,1], which represents a window including the day of the announcement and the day after the announcement occurs, the CAR for the coal and oil portfolios are 0.51% and 1.00%, respectively. The standard deviation of these returns over the 2-day period following the divestment announcement are 1.96% for the coal portfolio and 4.35% for the oil and gas portfolio. The t-statistic from the parametric significance test is 1.82 for the coal portfolio for the [0,1] event window and 1.63 for the oil and gas portfolio with their corresponding p-values being 0.076 and 0.109 respectively. The null hypothesis against which significance is tested is that the CAR over the event period is 0.00%. With this in mind, I reject

the null hypothesis with the 90% confidence interval for the coal portfolio returns, and fail to reject the null hypothesis for the oil and gas portfolio over the same period. In all other event windows, for both the Coal and Oil and gas portfolios, we fail to reject the null hypothesis. As the length of the event window increases, so does the standard deviation of the returns and the corresponding p value, representing the increased variance and decreased statistical significance of the results. In order to further investigate the relationship between the returns and these events, the CARs were recalculated with multiple subsets of the events.

5.b. Split Sample Results

The CARs were recalculated for the same event windows using a subset of the events. The subset of 25 events was formed by taking the median of the assets under management of the divesting entity and taking all events above the median for that statistic. The median of the assets under management of institutions making divestment announcements was slightly larger than $9 billion. Next, the CAR was recalculated the same way as it was with the full sample, but only including the 25 announcement events corresponding to institutions with assets under management value above the median. The results and significance were calculated identically and are reported in Table 5.

Table 5 - Split Sample Results: AUM

Event Window	Portfolio	CAAR	St. dev.	t statistic	Corresponding p value
[0,1]	Coal	0.54%	2.03%	1.33	0.198
[0,1]	Oil	1.76%	4.47%	1.96	0.061
[-2,2]	Coal	0.01%	2.77%	0.02	0.983
[-2,2]	Oil	0.17%	6.72%	0.13	0.898
[0,10]	Coal	0.23%	6.96%	0.21	0.838
[0,10]	Oil	-0.23%	8.69%	-0.13	0.897
[0,5]	Coal	0.59%	4.26%	0.695	0.493
[0,5]	Oil	0.54%	7.25%	0.37	0.712
[-5,5]	Coal	1.55%	5.42%	1.43	0.165
[-5,5]	Oil	2.37%	8.93%	1.33	0.196

For the [0,1] event window, I fail to reject the null hypothesis at p = 0.1 for the coal portfolio, but I reject the null hypothesis for the oil portfolio, at a 10% significance level. The cumulative aggregated abnormal returns for oil portfolios over the [0,1] event window are 1.76%. In the longer event windows, I fail to reject the null hypothesis at all standard significance levels. This means that I cannot say that the cumulative aggregated abnormal returns over any of the longer event windows are statistically different from 0.00%.

5.c. Analysis of Power

A further examination of the statistical significance of the results is performed to draw meaningful conclusions from the results of the event study. This section calculates the power of the results based on the number of events included in the study (Sample Size), determining the statistical probability of rejecting the null hypothesis given different levels of detected abnormal return. Conversely, this analysis also checks the probability that a type II error was committed, meaning that false null hypothesis is not rejected when it should be.

The power calculations, which are shown in Table 6, are derived in the same way they are in MacKinlay (1997), where the author completes a power analysis of financial event studies with multiple events. MacKinlay's power analysis is determined given the presence of the normal distributional assumptions, which include the independence of events. Although divestment announcements are correlated with one another, Brown and Warner (1985) show that the analytical computations and empirical power of studies with correlated and independent events are very close. I repeat the analytical framework used in MacKinlay for this analysis with the qualifying assumption that the statistical power of event studies with correlated and independent events is similar, as found in Brown and Warner (1985).

In Table 6, the power, which is the probability that the null hypothesis will be rejected at significance level of $\alpha = 0.05$, is reported for different sample sizes and different levels of abnormal return detected in an event study with an event window of 2 days, or [0,1]. Rather than using the standard deviations calculated in the results to determine the power, a standard deviation of 2% is used to compare different sample sizes' powers laterally.

Table 6 - Power Analysis

Sample Size	Abnormal Return			
	0.50%	1.00%	1.50%	2.00%
50	0.42	0.94	1.00	1.00
60	0.49	0.97	1.00	1.00
70	0.55	0.99	1.00	1.00
80	0.61	0.99	1.00	1.00
90	0.66	1.00	1.00	1.00
100	0.71	1.00	1.00	1.00

Given the sample size of 50 events used in this study, the probability of rejecting the null hypothesis with a detected abnormal return of 0.50% is 42%. This suggests that there is a 68% probability that the null hypothesis was not rejected when it should have been. The minimum

power that gives confidence in low chance of committing type II error and high chance of correctly rejecting a false null hypothesis is 80% (Bhandari 2022). Given this standard threshold, these results do not have strong enough statistical power to draw any significant conclusions.

To increase the probability of correctly rejecting the null hypothesis, the sample size must be increased, or the magnitude of the abnormal returns detected must be larger. As seen in the table, it is difficult to detect abnormal returns smaller than 1.00%, even with 100 events, double the amount included in this sample. With insufficient event data, small changes in abnormal returns are unlikely to be statistically significantly proven to be different from 0.00%. Larger effect sizes (abnormal returns of 1.00% or higher) are much easier to statistically differentiate from 0.00%, even with an event sample size of 50. For sample sizes of 50 to 100, the power of abnormal returns levels of 1.00%, 1.50%, and 2.00% is at least 94%, with 100% probability of rejecting the null hypothesis with abnormal returns of 1.50% or 2.00%.

This power analysis explains why I am not able to significantly differentiate the abnormal returns calculated in this study from 0.00%. As shown in the table, this can be attributed to a lack of enough event observations and too small of a detected abnormal return. The power of my results could be bolstered by increasing the number of events. However, the probability of rejecting the null hypothesis is still below the standard level of 80% unless a larger abnormal return—above 1.00%—is detected.

6. Discussion

Although many singular events from the event study significantly affected the coal and oil and gas portfolios' abnormal returns significantly, the aggregated returns over all event

periods did not produce results that were statistically significant from 0.00% in most cases. In general, as the length of the event window increases, the less significant the results were. The aggregated returns for both portfolios were significantly positive for the event window of [0,1]. However, as the event window included more trading days, the results lost their significance. This is due to the error produced when estimating the market returns for each company during the estimation window. Although the variance was low and the error was small on any one given day, the aggregated variance used to test for significance produced larger and larger variance values for each additional day included in the event window. Since the variance increases as the event window becomes longer, the results from longer event windows are less significant. The power of all of the results is low due to the lack of sample data and the small percentage changes in abnormal returns.

This being said, my hypothesis is that the divestment announcements affect fossil fuel stock prices gradually over time, rather than on or close to the actual day of the announcement or the event date. The mechanism by which divestment announcements influence security prices is indirect. A large divestment announcement happens, news sites report on it gradually over the subsequent days. During this time, the public, including investors, discuss and absorb the information from the announcement. The negative press and worsened public perception of the fossil fuel industry that happens days after the announcement is what will ultimately change investor perception of the related fossil fuel companies. This revised outlook that comes from the days of incorporating information from the actual announcement, as well as other information, such as news articles, opinion pieces, statements from other public entities regarding the announcement, is what ultimately moves the stock prices. Based on the mechanism described, the longer event windows, [0,5] and [0,10] particularly, are of most

interest to study whether this effect exists and whether these events meaningfully affect security prices. However, due to an insufficient number of events over the sample period and potentially a lack of the effect described above, or a lack of any change in investor perception of fossil fuel companies after divestment announcements, the results show that any changes during the longer event windows are insignificant.

Due to the insignificance of the results using the entire sample, the split sample results were then calculated to test for significance in announcements of companies with the largest AUM. The results of this exercise were similar to that of the aggregated sample, indicating that the size of the divesting entity in terms of the amount of capital that they manage may not be relevant to inducing a significant reaction in the market following the announcement of divestment.

In all, the results of the study do not show significant results for any event windows longer than [0,1]. This could indicate one of two things: 1) the effect of divestment announcements is absorbed by the market within 2 days after the announcement is made, or 2) the abnormal returns of longer event windows are difficult to determine without a large enough sample of events. Since the CARs in the [0,1] event window are positive for both the oil and coal portfolios in both analyses, we can only conclude that these divestment announcements slightly increase stock returns of fossil fuel companies following the day of the announcement. This could be due to the fact that during the day of the announcement, the stock price goes down due to the negative press, but then is rebought in the following days since investors may not perceive the divestment (or simply the announcement of a divestment) to have any material effect on the fossil fuel businesses. This would present a mispricing opportunity which could be quickly arbitraged away by savvy investors and ultimately increase the security price in

aggregate due to a larger buying swell following the selloff that may or may not have happened immediately following the announcement.

Conversely, these results could indicate that the actual day of the announcement is not what catalyzes a change in attitude from investors. Although previous literature suggest that these announcements do have significant short term effects to fossil fuel security prices, the results of this study may suggest that the real effect of these announcements is an indirect one that happens over a longer time horizon than just a few days after the announcement. This would also suggest that the day that the announcement happens is not necessarily a significant point in time for a change in abnormal returns, but instead this is a process that happens gradually as this information is incorporated into investor outlooks in different ways and at different rates. Some investors may only hear about these announcements through other 3rd party sources after the announcement, while others don't consider the effects of the announcement until much later. All this to say, maybe divestment announcements do not deliver the punch that they are expected to have, and rather, their influence is a slow burn that disseminates through public discourse over a longer and less defined time horizon, much longer than any of the event windows studied in this paper.

7. Conclusion

According to the analysis performed in this study with the data collected, divestment announcements have no tangible effect on the stock price of fossil fuel companies that is statistically measurable. Although the results have low statistical power, this may be due to the indirect effect that divestment announcements have on fossil fuel stock prices, which is harder to observe over short time windows used in the event study methodology. In future studies, it

would be useful to consider qualitatively what investors' reactions to these announcements are. Quantitatively, it would be useful to study this effect over much longer event windows of 20 days or more. However, much more robust and complete data of divestment announcements is required to do so. Overall, divestment announcements are important calls for change regardless of their effect, and help further the energy transition from dirty, polluting substances to clean, renewable forms of energy.

8. References

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9. Appendix

Table 1 - Selected Divestment Announcements

Organization	Organization Type	Type of Divestment	Date	Total AUM ($MM)
Schmidt Family Foundation	Philanthropic Foundation	Full	1/30/2014	$1,063
Stanford University	Educational Institution	Coal Only	5/6/2014	$30,300
City of Oakland, CA	Government	Full	6/17/2014	$2,028
Rockefeller Brothers Fund	Philanthropic Foundation	Full	9/3/2014	$1,430
Chico State University	Educational Institution	Full	12/1/2014	$8,349
Yale University	Educational Institution	Partial	4/1/2015	$31,202
California Public Employees' Retirement System	Pension Fund	Coal Only	9/3/2015	$781,200
City of Kansas City, MO	Government	Full	11/19/2015	$1,097
Rockefeller Family Fund	Philanthropic Foundation	Full	3/28/2016	$4,444
District of Columbia Retirement Board	Pension Fund	Full	6/13/2016	$9,072
Oregon Metro	Government	Full	7/1/2016	$1,104
Amalgamated Bank	For Profit Corporation	Fossil Free	9/21/2016	$6,600
SSM Health	Healthcare Institution	Coal Only	10/4/2016	$2,895
California State Compensation Insurance Fund	For Profit Corporation	Coal Only	4/6/2017	$20,630
BMO Global Asset Management	For Profit Corporation	Partial	5/15/2017	$273,000
MetLife	For Profit Corporation	Coal and Tar Sands Only	1/2/2018	$642,400
Wespath Investment Management	Faith-based Organization	Coal Only	10/11/2018	$29,889
Threshold Group	For Profit Corporation	Full	12/12/2018	$20,000
Middlebury College	Educational Institution	Full	1/30/2019	$1,580
BNP Paribas Asset Management	For Profit Corporation	Coal Only	3/14/2019	$580,000
The City of Denver	Government	Full	4/23/2019	$5,292
Chubb Insurance LTD	For Profit Corporation	Coal Only	7/1/2019	$190,774
University of California	Educational Institution	Full	9/18/2019	$140,000
Reform Pension Board	Faith-based Organization	Coal Only	11/13/2019	$1,000
Liberty Mutual	For Profit Corporation	Coal Only	12/13/2019	$151,802
BlackRock Investment Management	For Profit Corporation	Coal Only	1/14/2020	$9,463,662
Brown University	Educational Institution	Full	3/4/2020	$4,657
George Washington University	Educational Institution	Full	6/29/2020	$2,411
Minnesota State Board of Investments	Pension Fund	Coal Only	8/24/2020	$102,372
Los Angeles City Employees Retirement System	Pension Fund	Full	9/22/2020	$17,700
University of Illinois	Educational Institution	Full	10/14/2020	$1,130
New York State Common Retirement Fund	Pension Fund	Full	12/9/2020	$268,300
City of Seattle, WA	Government	Full	1/13/2021	$2,765
Bill & Melinda Gates Foundation	Philanthropic Foundation	Full	2/16/2021	$52,699
University of Michigan	Educational Institution	Full	3/25/2021	$23,719
Prudential plc	For Profit Corporation	Coal Only	5/7/2021	$525,121

Table 1 - Selected Divestment Announcements (Cont'd)

Organization	Organization Type	Type of Divestment	Date	Total AUM ($MM)
Harvard University	Educational Institution	Full	9/9/2021	$61,948
MacArthur Foundation	Philanthropic Foundation	Full	9/22/2021	$8,200
Baltimore City Employees' Retirement System	Pension Fund	Full	10/4/2021	$3,500
City of San Diego	Government	Full	11/29/2021	$2,330
New York State Teachers' Retirement System	Pension Fund	Coal Only	12/28/2021	$148,000
San Mateo County	Government	Full	1/12/2022	$7,201
Soros Fund Management	For Profit Corporation	Full	3/1/2022	$7,300
City of Chicago	Government	Full	3/21/2022	$9,000
Williams College	Educational Institution	Full	5/4/2022	$4,751
University of Washington	Educational Institution	Full	9/8/2022	$4,712
Princeton University	Educational Institution	Full	9/27/2022	$37,000
Chicago Teachers' Pension Fund	Pension Fund	Full	10/20/2022	$12,982

Source: divestmentdatabase.org