The Impact of the Paris Agreement on Fossil Fuel Companies: An Event Study Analysis

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Abstract: This study employs an event study approach to investigate the impact of the Paris Agreement on the stock returns of 30 major global fossil fuel companies, a critical analysis amid escalating global efforts to decarbonize energy systems. Utilizing daily stock price data extracted from Yahoo Finance, with the Dow Jones Industrial Average serving as the market benchmark, the research calculates abnormal returns (AR) and cumulative abnormal returns (CAR), complemented by t-tests to assess statistical significance. The analysis spans two distinct time windows: a short-term event window (December 7–18, 2015) to capture immediate market reactions and a medium-term post-event window (December 21, 2015–February 5, 2016) to evaluate sustained effects. Results indicate that short-term abnormal returns exhibit substantial volatility without achieving statistical significance, reflecting investor uncertainty regarding the agreement's immediate implications. In contrast, medium-term cumulative abnormal returns demonstrate significant negativity, with coal and power companies recording the most pronounced declines; notably, even diversified energy firms, despite their broader portfolios, face heightened market skepticism. These findings underscore the increasing integration of climate policies into global financial markets, emphasizing the imperative for fossil fuel companies to expedite low-carbon transition strategies to align with evolving global decarbonization objectives.

***Keywords*:** climate change, fossil fuel companies, event study, impact

1. Introduction

Climate change, driven by fossil fuel emissions, presents urgent global challenges, with global temperatures already 1.1°C above pre-industrial levels (2023) [1]. The 2015 Paris Agreement, ratified by 196 parties, aims to limit warming to 1.5–2°C through coordinated decarbonization (2015) [2], introducing profound risks for fossil fuel industries. McGlade and Ekins (2015) [3] estimate that 80% of coal, 50% of gas, and 30% of oil rese©rves must remain unexploited to meet this target, threatening asset values and investor confidence.

Existing literature highlights climate policy's influence on financial markets, including post-Paris shifts toward low-carbon assets (2022) [4] and policy-driven valuation changes (2020) [5]. However, critical gaps persist: few studies explore sub-sectoral differences (e.g., coal vs. integrated energy firms) or regional disparities shaped by varying regulatory stringency. Additionally, short-term volatility is well-documented, but medium-term market adjustments as policies are digested remain underexamined.

This study aims to address these gaps by investigating how the Paris Agreement impacted the stock performance of 30 major global fossil fuel firms. It seeks to answer three key research questions: 1. What is the impact of the Paris Agreement on the short-term and medium-term stock performance of major fossil fuel companies? 2. Are there significant differences in market reactions to the Paris Agreement across different fossil fuel sub-sectors? 3. Are there differences in market responses among fossil fuel companies in different regions?

Using event study methodology (1997) [6], we analyze Yahoo Finance data (Dow Jones as benchmark), calculating abnormal returns (AR), cumulative abnormal returns (CAR), and using t-tests (1985) [7]. Findings will clarify micro-level climate policy impacts, guiding firms' transition strategies, policymakers' harmonization efforts, and investors' risk management—advancing climate-finance integration.

2. Research Methodology

2.1 Research Design

This study employs the event study methodology, a quantitative approach, as its research method. In this study, the Paris Agreement was selected as the research event to examine the effect of this global climate policy on the market performance of the fossil fuel industry. The independent variable is the signing of the Paris Agreement. The dependent variable is the

share price of 30 companies in the fossil fuel industry that is used to measure shifts in investors' behavior. The event window consists of three parts: the pre-event window, the event window and the post-event window. These windows are designed to capture market response in different time horizons prior to and after the Paris Agreement.

2.2 Data Collection

The information for this investigation is obtained from the financial Yahoo Finance database. In evaluating the market performance of the fossil fuel companies before and after the signing of Paris Agreement, this study has used data which span a period of 232 days before the signing of the event, and 30 days after the event.

The sample for this study includes 30 globally representative fossil fuel companies listed in the 2024 Forbes ranking . These companies are from 13 countries including the United Kingdom, the United States, China, France, etc. Their business scope covers coal, oil and natural gas.

First, the historical data download function provided by Yahoo Finance was used to obtain daily closing prices data for each company. In addition, in order to estimate the normal rate of return more accurately, this study also collected the daily closing prices of the Dow Jones Industrial Average as a market benchmark. The downloaded stock market data comes from three exchanges in New York, Hong Kong and India. Except for weekends, the holidays of the three exchanges are not exactly the same. Therefore, after removing non-trading days from each exchange, the data of the three exchanges were compared, and only the common trading days were retained. In addition, the stock price unit is unified in US dollars, and the stock price data of the Hong Kong Stock Exchange and the Indian Stock Exchange are converted into US dollars according to the exchange rate at that time.

2.3 Event Study Methodology

According to Ji et al. (2022) [8], an event study is based on the efficient market hypothesis. This hypothesis assumes that the financial markets are efficient, implying that new events affect the prices of the assets in a given market as soon as this information becomes available.

For this study, the pre-event window is defined as 229 trading days before the event window. This longer time span can reduce the impact of short-term market fluctuations on the normal return rate estimation. The event window is defined as a period starting from five trading days before the event and ending five trading days after the event, thus 10 trading days in total. Specifically, the post event window in this research will be 30 trading days after the event.

First, this study employs a market model to estimate expected returns to find the normal returns, which present the expected returns on a company's stock without an event. ALAM, ALAM and CHAVALI noted that based on the literature, the market model is the dominant paradigm in event studies (2020) [9]. Its formula is as follows:

$$R_{j,t} = \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) \tag{1}$$

$$\hat{R}_{j,t} = \alpha_j + \beta_j R_{m,t} + \varepsilon_{j,t} \tag{2}$$

Where $R_{j,t}$ is the actual stock return of company *j* at time *t*; $\hat{R}_{j,t}$ is the estimated normal return of company *j* at time *t;* $R_{m,t}$ is the market return rate, which is usually used to reflect the overall performance of the market. It is derived from the Dow Jones Index by $R_{m,t} = \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)$; α_j and β_j are the parameters obtained by performing regression analysis on the data within the pre-event window; and $\varepsilon_{j,t}$ is the error term.

The formula for the abnormal return is:

$$AR_{j,t} = R_{j,t} - \hat{R}_{j.t} \tag{3}$$

Among them, $AR_{j,t}$ represents the abnormal return rate of company *j* at time *t*, $R_{j,t}$ and $\hat{R}_{j,t}$ represent the actual return rate and normal return rate of company *j* at time *t* , respectively. In order to evaluate the cumulative impact within the entire event window, the cumulative abnormal return is calculated as follows:

$$CAR_j = \sum_{t=t_1}^{t_2} AR_{j,t} \tag{4}$$

CAR_j is the cumulative return of company j, and t_1 and t_2 are the start and end times of the event window, respectively.

However, according to Ji et al. (2022) [8], since stock market returns do not conform to normal distribution, especially during extreme events, it may lead to deviations in t-statistics. Therefore, this study also calculated the standard deviation of abnormal returns and standardized the cumulative abnormal returns.

$$\overline{AR}_j = \frac{1}{n}\sum_{t=1}^{n} AR_{j,t} \tag{5}$$

$$\sigma_{AR_j} = \sqrt{\frac{1}{n-1}\sum_{t=1}^{n}\left(AR_{j,t} - \overline{AR}_j\right)^2} \tag{6}$$

$$SCAR_j = \frac{CAR_j}{\sigma_{AR_j}} \tag{7}$$

$\overline{AR}_j$ is the average abnormal return of company j in the estimation window. σ_{AR_j} is the standard deviation of company j' s abnormal returns within the estimation window. n is the number of days in the estimation window. $SCAR_j$ is the standardized cumulative abnormal return.

As pointed out by He et al. (2020) [10], the t-test is recommended as a suitable means of quantifying the dynamics of the capital market. In order to determine whether the abnormal returns are statistically significant, this research adopts the t-test. If the abnormal returns are statistically significant, this would indicate that the market responded to the signing of the Paris Agreement within the event window. If the cumulative abnormal return is statistically significant then it signals that a particular event in the aggregate causes a significant effect on the stock price of the company.

3. Results and Findings

3.1 The Average of Abnormal Return and Cumulative Abnormal Return

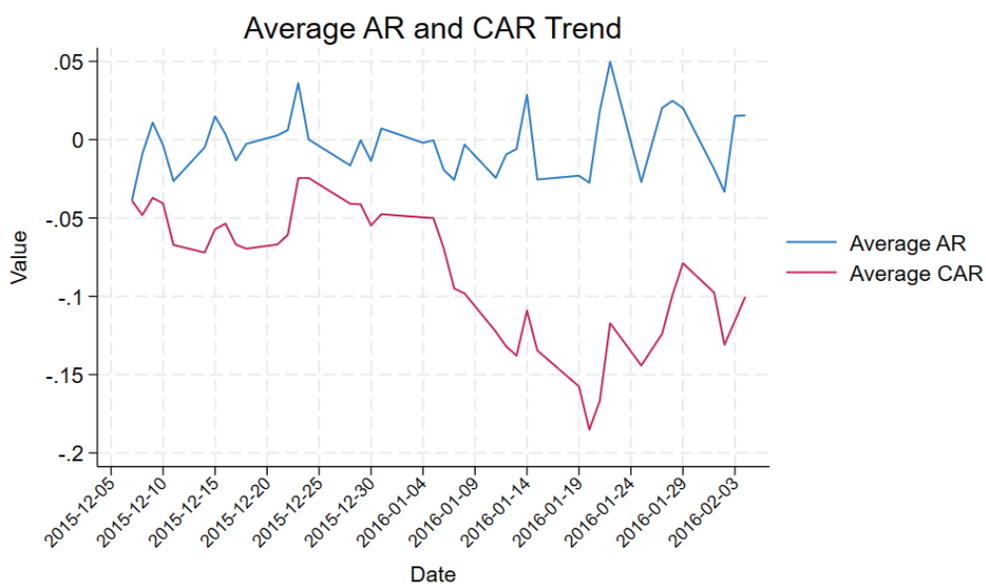

Figure 1. Average AR and CAR Trend

It graphs the trend of the average of the abnormal returns and also the cumulative abnormal returns. The data reveals two distinct phases of market behavior: the first one is the event window during which the event is expected to happen and it is from December 7 to December 18, 2015, while the second period is the post-event period that is from December 21, 2015. Concerning the average of abnormal return during the event window as explained above in Figure 1, the results depict great volatility around zero for values. This suggests that the investor response is inconclusive and ambiguous as far as the analysis

of the impacts of the Paris Agreement is concerned. As for the results of the abnormal returns, investors' expectation is quite ambiguous. However, it is evident that the trend of the abnormal returns does not have a particular directional preference within the event window. This suggests that there is no market consensus on the long term effect of the agreement on the fossil fuel firms.

In the medium term, the evidence of a decreasing cumulative abnormal return is presented. This is especially noticeable after mid-January and goes even deeper into negative territory in early February. This seems to be a trend that is unfolding as investors begin to understand the implications of the agreement and thus divest or reduce on investments in fossil fuel companies. This behavior results in a further reduction of the overall value of cumulative abnormal return. This medium-term trend answers the first research question, stating that the negative impact of the event will reveal itself as investors transition from short-term emotional reactions to a deeper analysis of long-term business prospects.

3.2 The results of the t-test

The analysis of abnormal returns during the event window (2015.12.7-2015,12.18) shows that for most companies, the abnormal returns are not statistically significant (Table 1). For example, Shell, one of the largest and most influential companies in the fossil fuel industry, has a t-value of -1.3072 and a p-value of 0.2236, indicating that the abnormal returns are not significantly different from zero. This suggests that the market's immediate reaction to the Paris Agreement was neither overwhelmingly positive nor overwhelmingly negative. These results suggest that while the event triggered some short-term volatility, the market did not react uniformly in one direction.

Table 1. The t-test results of abnormal returns

Company	AR	T-test	P-value
Shell	-0.0085162	-1.3072	0.2236
ExxonMobil	-0.0002858	-0.0447	0.9653
Chevron	0.0018495	0.2618	0.7993
TotalEnergies	-0.0044132	-1.0040	0.3416
BP	-0.0062891	-1.0766	0.3097
Petrobras	-0.0078973	-0.6395	0.5384
Equinor	-0.0077996	-1.0514	0.3205
ConocoPhillips	-0.0091045	-1.2218	0.2528
Marathon Petroleum	-0.0082343	-0.9930	0.3466
Eni	-0.0065181	-1.3200	0.2194
Phillips 66	-0.0095646	-1.7660	0.1112
Valero Energy	-0.0001853	-0.0269	0.9791
Suncor Energy	-0.0024679	-0.3936	0.7031
Canadian Natural Resources	-0.0068242	-0.6223	0.5492
Occidental Petroleum	-0.0055462	-0.9145	0.3843
EOG Resources	0.0102034	-1.2758	0.2340
Ecopetrol	-0.00734	-0.6015	0.5623
Repsol	-0.0066716	-0.7887	0.4506
Cenovus Energy	-0.0104833	-1.3169	0.2204
Cheniere Energy	-0.0193928	-2.5387	0.0318
Oneok	-0.0252714	-1.4953	0.1690
Woodside Energy Group	-0.009754	-1.4014	0.1946
YPF	-0.0064458	-0.8909	0.3962
PetroChina	-0.0067335	-1.1562	0.2774
Sinopec	-0.0022922	-0.2713	0.7923
CNOOC	-0.0123765	-1.6740	0.1284
Oil & Natural Gas	-0.0000157	-0.0026	0.9979

Company	AR	T-test	P-value
Indian Oil	0.0011057	0.3158	0.7594
Coal India	-0.0040646	-0.7316	0.4830
China Coal Energy	-0.0070767	-1.2159	0.2550

Source: author's calculation

In contrast to the abnormal return results, the analysis of medium-term cumulative abnormal returns in the post-event window (2015.12.21-2016.2.5) reveals a more clear and consistent negative market reaction (Table 2). For example, Shell's cumulative abnormal returns show a t-value of -11.2134 and a p-value of 0.0000, indicating a highly significant decline. Other major companies such as BP (t = -9.4935, p = 0.0000) and TotalEnergies (t = -11.1116, p = 0.0000) also show equally significant negative cumulative abnormal returns, further supporting the view that the medium-term market consensus has clearly turned negative. The cumulative abnormal returns of almost all major fossil fuel companies are significantly negative, indicating that investors are becoming more aware of the risks of carbon-intensive companies as the market has more time to digest the impact of the Paris Agreement.

Table 2. The t-test results of cumulative abnormal returns

Company	CAR	T-test	P-value
Shell	-0.0917453	-11.2134	0.0000
ExxonMobil	-0.0013873	-0.4008	0.6908
Chevron	-0.0126255	-2.4446	0.0191
TotalEnergies	-0.0534743	-11.1116	0.0000
BP	-0.0444855	-9.4935	0.0000
Petrobras	-0.195222	-8.0584	0.0000
Equinor	-0.0999658	-10.6101	0.0000
ConocoPhillips	-0.1490607	-8.8620	0.0000
Marathon Petroleum	-0.155689	-9.5258	0.0000
Eni	-0.0680425	-16.4611	0.0000
Phillips 66	-0.0907428	-21.4717	0.0000
Valero Energy	-0.0164994	-3.1136	0.0035
Suncor Energy	-0.0919924	-8.3378	0.0000
Canadian Natural Resources	-0.0997585	-7.1695	0.0000
Occidental Petroleum	-0.0527499	-10.4327	0.0000
EOG Resources	-0.1237324	-13.3865	0.0000
Ecopetrol	-0.1240446	-10.7720	0.0000
Repsol	-0.1113142	-10.7853	0.0000
Cenovus Energy	-0.1171401	-20.5386	0.0000
Cheniere Energy	-0.2251848	-11.6817	0.0000
Oneok	-0.0593126	-4.5163	0.0001
Woodside Energy Group	-0.0746063	-13.2143	0.0000
YPF	-0.0798032	-8.0982	0.0000
PetroChina	-0.1127068	-12.0129	0.0000
Sinopec	-0.0633388	-9.0451	0.0000
CNOOC	-0.1383246	-15.7108	0.0000
Oil & Natural Gas	0.0130966	2.3537	0.0237
Indian Oil	0.0075868	1.3420	0.1874
Coal India	-0.0325485	-7.9148	0.0000
China Coal Energy	-0.1059744	-9.9346	0.0000

Source: author's calculation

3.3 Industry Differences

The coal industry companies have the most apparent negative cumulative abnormal returns; for example, China Coal Energy (-9.9346, 0.0000) and Coal India (-7.9148, 0.0000). Based on these results, it can be concluded that investors are most negatively disposed towards the future of coal-reliant companies.

The oil and gas industry showed a more diverse response. Integrated energy majors such as Shell ($t = -11.2134$, $p = 0.0000$) and BP ($t = -9.4935$, $p = 0.0000$) had significantly negative cumulative abnormal returns, highlighting market concerns about the future of carbon-intensive businesses, even for companies that have invested heavily in renewable energy.

As integrated oil firms, even those with renewable energy portfolios such as TotalEnergies ($t = -11.1116$, $p = 0.0000$), our sample firms suffer significantly in terms of cumulative abnormal returns. These companies may be perceived by investors as companies that are in some sort of a disadvantageous position. According to them, it is difficult to manage their conventional hydrocarbon business and at the same time venture into the renewable energy business.

3.4 Regional Differences

Among these companies, European companies Shell and BP and Equinor are most negatively positioned in terms of cumulative abnormal returns with t=-11.2134; p=0.0000; t=-9.4935; p=000; and t =-10.6101; p= 0000 respectively. This goes to show the expectations of the market on the side of the regulators in Europe to be stricter in the enforcement of regulations. This is in line with the observation made in the research of Guterres as presented above (2022) [11]. The EU has over the years provided a global example of how to set higher climate goals and enforce strict policies hence making investors more cautious of the risks associated with funding corporations with high carbon footprints in the region. In addition, the dramatic reduction in cumulative abnormal returns for European companies indicates that regardless of the early and effective strategic response, such as Total Energies with the t-statistic of -11.1116 and the p-value of 0.0000, the market remains skeptical.

In contrast, mid-cap North American companies such as ExxonMobil ($t = -0.4008$, $p = 0.6908$) and Chevron ($t = -2.4446$, $p = 0.0191$) experienced relatively smaller declines in profits. The less pronounced market reaction for these companies can be attributed to the belief that climate policies in the United States and Canada will be implemented more slowly or face significant political resistance.

Emerging market companies also show different reactions depending on the regional regulatory outlook. For instance, the cumulative abnormal returns of Chinese companies like Petro China ($t = -12.0129$, $p = 0.0000$), Sinopec ($t = -9.0451$, $p = 0.0000$), and CNOOC ($t = -15.7108$, $p = 0.0000$) all declined. In contrast, companies in other emerging markets, like Indian Oil Corporation, exhibit more neutral or even positive responses ($t = 1.3420$, $p = 0.1874$). This means that in countries like India for instance where energy security and economic development are valued more than environmentally friendly policies the investors are likely to anticipate that climate policies will be executed slower.

4. Conclusion

This research analyses the effect of the Paris Agreement on the stock performance of 30 leading fossil fuel firms to help investors understand the effect of international climate regulation on their decisions. On short term analysis, the results indicate that market reaction is inconclusive while in the medium term, the data suggest that the majority of companies have experienced substantial negative returns. Many high-carbon industries have suffered heavy losses such as coal and even integrated energy companies with renewable energy portfolios have been met with market doubts. This can be attributed to investors' changing perception in terms of the viability of industries that rely on fossil carbon. To sum up, according to this research, the global climate policies are important for financial markets and particularly for such sectors that rely on the use of fossil fuels. It becomes important for investors, policy makers and industrialists to understand and respond to these market shifts as the global economy transitions towards a low-carbon economy.

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