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Energy Companies Restructuring in the Transition to a Low-carbon Economy

Abstract

For mitigating the risk of stranded assets, an increasing number energy companies have chosen to restructure their operations in line with a low-carbon future. While some firms have decided to divest their carbon-intensive assets (coal, oil, and natural gas), others have diversified by acquiring renewable energy businesses (wind, solar, and batteries). In this research we investigate the antecedents and outcomes of energy companies transitioning towards low-carbon energy sources. We collected a sample of 2,824 traditional energy companies, out of which 322 have divested a fossil-fuel related asset or acquired a renewable energy company between 2011 and 2018. Firstly, using a logit panel we found that companies with higher institutional ownership, based in countries characterized by higher deployment of renewables technologies and lower dependency on fossil fuel, are more likely to shift to low-carbon sources. Secondly, conducting an event study we found that initiating a low-carbon strategy generates positive significant average cumulative abnormal returns (6.86%), that are consistently higher than those perceived by companies announcing an investment in fossil-fuels (0.15%).

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1 Introduction

A multitude of trends are threatening the current equilibrium in the global energy market. Firstly, countries are recently becoming more aware of **global environmental challenges** and have expressed their interest in combating climate change. At the Cancun Climate Change Conference held in November 2010, world leaders committed to the avoidance of temperature rise to 2 degrees Celsius by limiting greenhouse gas emissions. Moreover, by signing the Paris Agreement in 2015, 169 countries have agreed to intensify their efforts by setting an even more ambitious target: prevent global temperature to rise by 1.5 degrees Celsius. Scientists estimated that almost four fifth of fossil fuels (coal, oil and natural gas) should remain in the ground for meeting this target.

Secondly, due to technological improvements and more effective subsidies schemes, the net present value of the unit-cost of electricity produced by renewable sources has decreased at an exponential rate. In its recent report, Lazar (2017) has demonstrated that wind farm levelized cost of energy (LCOE) is now comparable to conventional gas combined cycle and coal power plants. **Falling clean technology costs**, such as solar PV and Off-shore wind, are posing a threat to the demand growth for fossil fuels. In fact, in its reference case 2018, McKinsey expects coal demand to peak in next decade, oil in the next two and gas to modestly grow due to electric vehicles deployment and industrial electrification.

Thirdly, some countries have decided to introduce new **environmentally friendly regulations** for capping emission and internalizing social cost created by burning fossil fuels. For example, in 2005 the EU launched the Emissions Trading System, an artificial market for pricing carbon and incentivizing companies to reduce their emissions. Similarly, IMO 2020 regulation will impose more stringent sulphur levels for marine fuels with the final aim to reduce shipping emissions.

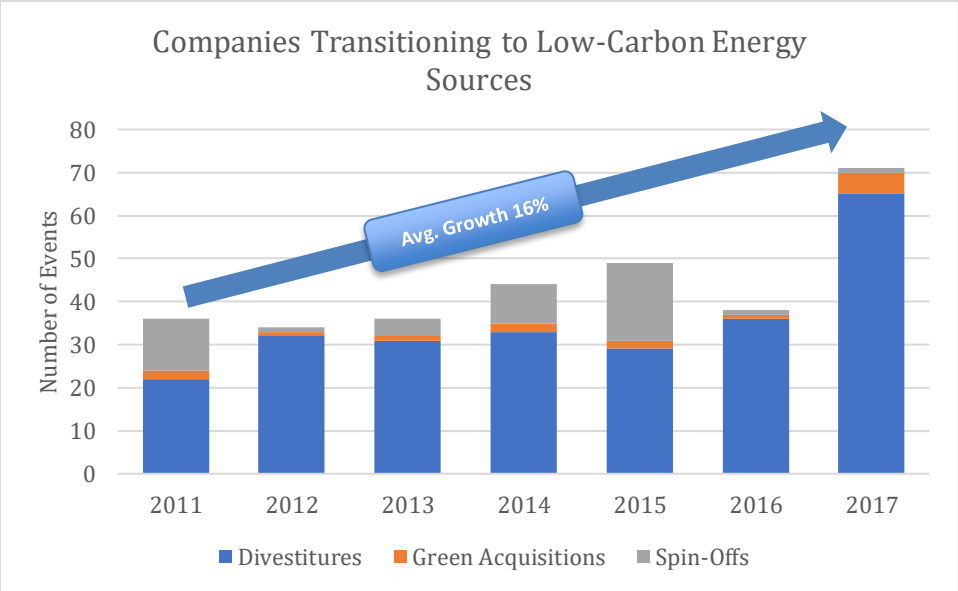
Last but not least, **evolving social norms** among investors have led to the development of socially responsible initiatives, such as the fossil fuel divestment movement. Started in 2010 in the US, among university students, this movement have rapidly gone global by targeting major institutional investors and persuading them to reduce their fossil fuel related stakes. For example, the Norway Sovereign Wealth Fund, French insurance company AXA and Sweden pension fund AP2 have engaged in the movement by liquidating their stakes in fossil fuels companies (Baron and Fischer, 2015).

These trends are rising a concern for traditional energy companies, that have become increasingly more vulnerable to the risk of stranded assets. In fact, due to these factors, environmentally unsustainable assets of oil & gas companies and coal mines might be subjected to unanticipated write-offs, downward revaluations or converted into liabilities (Ansar, Caldecott, Tilbury, 2013).

To dynamically adapt to the adverse market conditions, some energy companies have decided to restructure their operations by selling-off, or spinning-off carbon intensive assets, at risk of being stranded in the transition to a low-carbon economy. For example, while German utility company E.ON decided to split fossil fuel and renewable operations in 2014, oil giant ExxonMobil divested 13 refineries since 2008 (The Guardian).
Other companies, instead, have chosen to diversify their conventional energy operations by acquiring renewable energy companies. For example, in 2011 Total S.A. took over SunPower Corp. for entering the solar energy segment (Bloomberg).

As can be seen from the graph (Thomson One), many energy companies around the globe have resorted to capital markets to restructure their operations and remain competitive in a low-carbon future.

Figure 1 "Low-carbon Transition Trend"



The purpose of this research is analysing how traditional energy companies around the world can hedge the risk of stranded assets, while still maximizing value for their shareholders. For achieving this goal, we investigate the antecedents and outcomes of energy firms shifting to low-carbon sources. Throughout the study, we have defined a transition to low-carbon energy sources as a divestment from carbon-intensive assets, or an investment in renewable energies. Based on empirical literature on corporate restructuring, we showed how a transition towards low-carbon sources differs from traditional types of spin-off, sell-off, equity carveouts and M&As. More precisely, we analysed the

new wave of corporate restructuring in the energy sector by testing the following company and country-level hypotheses:

$H1$: "*Energy companies with higher institutional participation are more likely to initiate a transition towards low-carbon energy sources*"

$H2$: "*Energy companies based in countries with higher renewable energy deployment are more likely to shift to low-carbon energy sources*"

$H3$: "*Energy companies based in countries characterized by higher level of rent from oil, gas, and coal are less likely to initiate a low-carbon strategy*"

$H4$: "*On average, market will react positively to the company's announcement of transition towards low-carbon energy sources*"

For investigating the validity our hypotheses, we have divided our research in two main parts: the motives of transition towards low-carbon energy sources, and the performance of transition towards low-carbon energy sources

In the first part, using a sample of 2,824 traditional energy companies and 322 events, we have modelled the probability of a company to initiate a low-carbon deal. We found that companies with higher institutional ownership, based in country characterized by larger renewable deployment and lower rent from fossil fuels, are more likely to initiate a transitioning to low-carbon energy sources. In the second part, we focused on the short-term performance of traditional energy after they have announced a low-carbon deal. By conducting an event study (Brown and Warner, 1980), we found statistically significant average cumulative abnormal returns (CAR) of 6.86% in the window [-20; +20] days around the event date. Furthermore, by comparing the market reactions to companies transitioning to low-carbon sources, and companies investing in fossil fuel, we found statistically significant differences in average CAR. In fact, while the market reacts positively to a company investing in fossil fuels, it reacts more enthusiastically in case of a company announcing to decrease its carbon intensity.

While the research brings new evidence to the already rich scientific literature in corporate finance and strategic management, our findings have strong managerial implication. In fact, we believe our

results can support managers in energy companies in taking more informed strategic decisions under uncertainly.

To sum up, the paper is structured as follow: In the first part is devoted to the review of past literature on corporate restructuring for identifying relevant control variables, then, we proceed by discussing our hypotheses and presenting the methodology used for testing them, finally we provide an economic interpretation to our results.

2 Literature Review

After having highlighted the motivations and relevance of our research we now proceed to the analysis of the existing empirical literature. Our goal is to connect current market developments in the energy sector to existing corporate finance and strategic management empirical evidence. We believe a rigorous analysis of previous literature will enable us to spot potential literature gaps and provide us with an accurate direction for constructing our hypotheses. The focus of this chapter will be on corporate restructuring, intended as contraction of firm operations through divestitures, or expansion through mergers and acquisitions. Firstly, we describe findings on antecedents of corporate restructuring, by categorizing motives of divestments and M&A in the energy sector. Secondly, we discuss outcomes of corporate restructuring, by reporting evidence on performance of divestment and M&A in the energy sector.

2.1 Antecedent of Corporate Restructuring

2.1.1 Motives of Divestment

Companies have different options when it comes to divestment: spin-offs, equity carve outs, or direct sales of assets. While spin-off are non-cash and tax-free transactions that involve distribution of shares to shareholders and separation of a subsidiary from its parent company, equity carve outs are tax-free cash transactions that involve the sale of fraction of subsidiary's equity. Many researchers have empirically analysed the rationale behind companies' decision to divest. As shown in the literature review of Richard A. Johnson (1996) the main reasons behind corporate divestment are generally connected to business environment, governance, strategy and performance reasons.

Firstly, some researchers have argued that firms might choose to divest part of their assets for dynamically adapt to changes in current **market environment** such as introduction of regulations, or an industry shock. For example, Liebeskind and Opler (1992) investigate how alterations in the competitive environment could lead firms to restructure their operations. Using a sample of 2,500 US firms they quantify the impact of variables such as company's Tobin's Q, and market share on its degree of business specialization and relatedness. They concluded that companies undertake refocusing strategies for reducing internal capital market inefficiency, relaxing antitrust law enforcement, and correcting market misevaluation. Erice A. Powers (2003) analysed the rationale behind equity carve-outs using a sample of 181 events occurred between 1981 and 1996. By regressing the percentage of carve-outs subsidiary ownership on valuation multiples (market-to-book ratio), the author showed that firms consider divestments as an opportunity to generate cash by selling potentially overvalued equity.

Secondly, other group of studies have highlighted the link between **corporate governance** and asset divestment decision. In this view, corporate refocusing is dictated by the relationship between management and shareholders. S. Krishnswami and V. Subramaniam (1999) constructed a logit model for relating the likelihood of undertaking a spin-off to the degree of information asymmetry between a company and its investors. Forecast error in earnings forecasts, standard deviation of analysts' forecasts, normalized forecast error, announcement reaction, residual standard deviations were used as a proxy for level of information asymmetry. Their results suggest that firms engaging in spin-offs have higher levels of information asymmetry before spin-off than their size-matched counterparts. Consequently, the separation of a firm's divisions into independently traded units through a spin-off enhances value because it mitigates information asymmetry about the firm. S. Ahn and M.D. Walker (2007) hypothesized that firm that engage in spin-off should be associated with traditional characteristics of effective corporate governance such as smaller and heterogenous boards, and higher outsider's ownership. Researchers used a sample of 102 firms matched with a control group using a propensity score, and collected variables on ownership structure, CEO and board characteristics. Their evidence was consistent with their expectations: while outsider ownership, and diversity of the board have positive influence on the probability of engaging in a spin-off, board size has a negative incidence.

Thirdly, authors have pointed out that the decision to divest has often a **strategic rationale**. For example, divestment might be a necessary correction of past suboptimal strategy formulation or execution, that led to over-diversification of the firm. In the case of large conglomerate, too many past acquisitions, and excessive size, can lead to failure of diversification strategy and condemning a firm to spin-off a division (Çolak and Whited, 2007). Bergh, Johnson and Dewitt (2008) analysed

corporate restructuring in US and found that the likelihood of down scoping increases with the degree of diversification of a firm. In fact, companies with low specialization and high diversification use sell-offs for correcting inefficiencies. Similarly, Hit, Hoskisson, Johnson, and Moesel (1996) argued that as diversification increases, managers become unable to process all the information in an efficient way, making corporate downsizing the necessary step to regain strategic control of the corporation. It is also relevant to denote that divestment is often a consequence of a lack in strategic fit between parent and subsidiary, that can manifest itself at an organizational level (Seth and Esterwood, 1993) and cultural level (Viegas-Pires, 2013). Alternatively, researchers linked divestment to business strategy, by noticing that downsizing a business might facilitate a company to reach its financial goals. For example, Lang Poulsen and Stulz (1995) reported that managers consider divestment as a cheap source of financing to reinvest into core operations or acquisitions opportunities. Interestingly, Heather Berry (2009) claimed that firms are likely to divest home-country subsidiaries after they invested in lower-cost production subsidiaries abroad. Constructing a negative binomial panel model, based on a sample of 190 US based manufacturing firms they found that new investment in lower cost-production opportunities by firms in low-R&D intensive industries significantly impact the number of subsidiaries divested.

Fourthly, one of the most discussed antecedent of corporate downsizing is the level of **performance** of a particular business unit. Several researches underline that management sees mediocre performance of the firm as a major trigger for spin-offs, asset sales, plant closing and cash redistribution to shareholders (Ravenscraft and Scherer, 1991). Denis and Shome (2005) investigate the determinants of the decision to downsize assets in a multivariate logistic regression framework. By testing the significance of performance indicators such as Return on Assets (ROA), they found that the likelihood of downsizing increases with declining performance in the firm and in its industry. For this reason, they concluded that the decision to divest are usually made in contraction rather than expansion phases of the general economic cycle. Finally, Duhaime and Grant (1984) conducts interviews of 40 CEOs of "Fortune 500" firms that have divested at least one business unit during the period from 1975 to 1980. Their analysis showed that business unit performance, and managerial attachment have large significant influence on the decision to downsize. More precisely, companies tend to divest units characterized by low financial strength (ROE, Debt/Equity ratio, Payout ratio), that are less interdependent with other business segments.

2.1.2 Motives of Mergers and Acquisitions in the Energy Sector

Past literature on mergers & acquisitions (M&A) appears to be significantly richer than the literature on divestment. In fact, many researchers have attempted to categorize the multitude of empirical evidence on M&A motives (Calipha, Tarba, Brock, 2010). Academia tends to agree that firms decide to grow inorganically for enlarging their product or service line (Levinson, 1970), increasing their market power (Gopinath, 2003), diversifying risk geographically and by sector (Trautwein, 1990), and achieving synergies (Carpenter and Sanders, 2007). While literature on divestment still lacks industry-specific studies, the vast M&A literature contains numerous sectorial studies. Instead of focusing on general M&A motives, the purpose of this section is to highlight specific antecedents of M&A in the energy sector.

In their theoretical research Ferguson, and Popkin (1982) investigate the source of premium in M&A transactions in the oil & gas sector. They claimed that merger premiums above value of the reserves are justified by the resulting **tax benefits** deriving from the increase in depreciation. Ng and Donker (2013) relates the number of takeovers in the Canadian energy sector, to oil & gas prices and reserves. They construct a negative binomial regression for modelling the number M&A deals as a function of purchasing reserves and lagged yearly changes in WTI and Henry Hub prices. The resulting regression coefficients suggest that **market timing** and **commodity prices** have a significant impact on M&A decision and performance. More precisely, energy companies tend to acquire new targets during low oil and gas price trends.

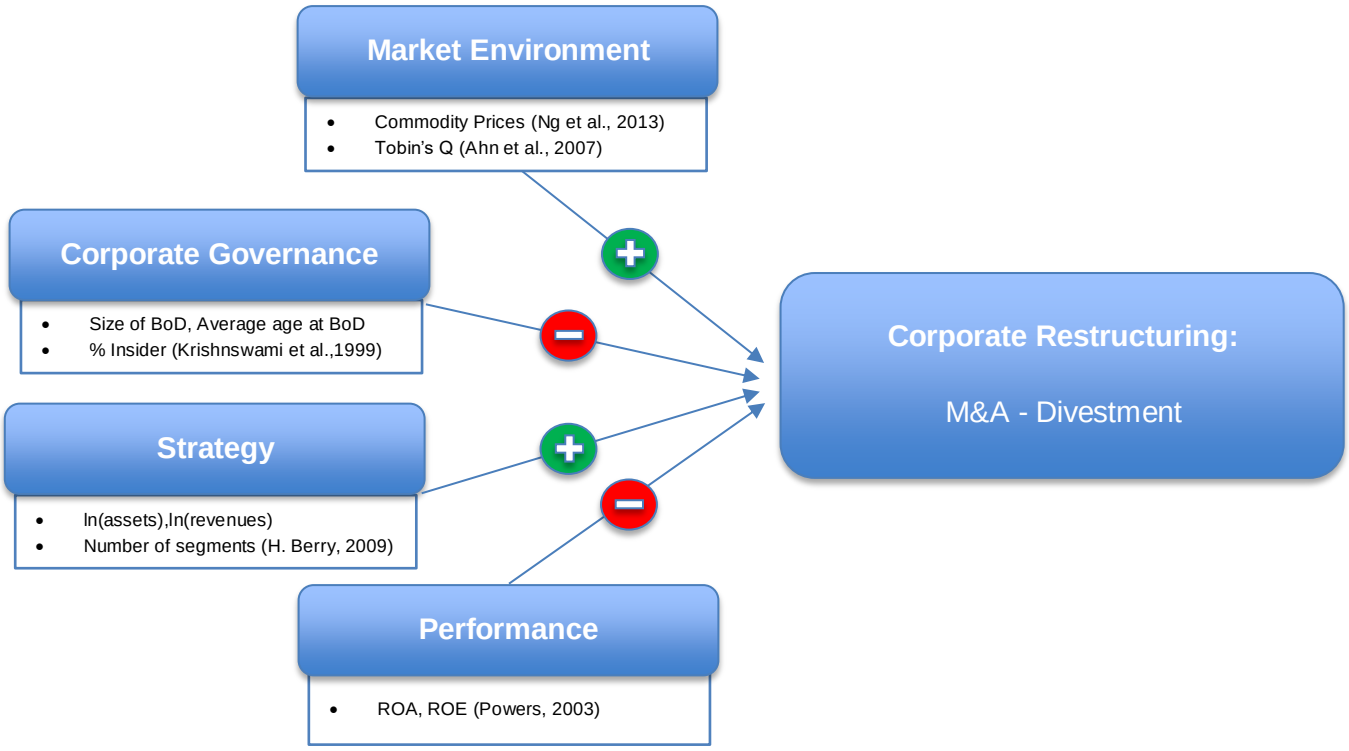
Hse, Wright, and Zhu (2017) examined M&A activity in the US oil & gas sector from 2004 until 2013, using a Poisson time series model. They were able to show that managers attentively monitor oil prices and **production rates** before taking the decision to undertake an M&A transaction. In addition, the authors detected **persistency effect** of M&A in the energy sector, showing positive correlation between past and future capital market activities.

To conclude, a recent study from Reddy and Xie (2017) proposed an integrated geographic view on M&A activity in the global energy industry. Their empirical study focuses on 150 large-scale acquisition transactions announced by oil & gas companies from over 50 countries during the period 2005 - 2015. Their extensive research relates the number of cross-border M&A deals to the regional membership (OECD, IEA, OPEC), macroeconomic indicators (net energy import, fossil fuel energy consumption) and level of competition in the market for corporate control. The output of their analysis highlighted that firms in emerging markets have taken advantages of low crude oil prices to geographically diversify energy risk. Moreover, there is an increasing global engagement of

government owned companies from Asia and the Middle East. Finally, acquiring in the North American market is preferred due to the higher degree of economic freedom.

In the following table we summarize past evidence on motives of divestment and motives of M&A in the energy sector. We believe future researchers should always control for these effects when aiming to bring new evidence to the already rich literature on antecedents of corporate restructuring.

Figure 2 "Theoretical Model on Antecedents of Corporate Restructuring"



Richard A. Johnson (1996)

2.2 Outcomes of Corporate Restructuring

2.2.1 Performance of Divestment

Now that we have explored the main reasons behind divestments strategies, it is also important to understand the impact of these events on company performance. While some researcher has studied the impact of divestment on short-term performance by monitoring stock-market reactions, others have taken a long-term perspective by looking at accounting metrics. For having a complete view on the relationship between downsizing and performance, we will firstly analyse past literature on event studies, then we will review empirical evidence obtained from accounting studies.

Among the event study literature, Wright and Ferris (1997) examined the market reaction to the divestment of South African units performed by companies protesting against Apartheid. Considering a sample of 115 divestment announcements, they computed average excess returns on a 10 days window using the CAPM. Their univariate results display significant average excess returns of -0.249% on the event date.

In their study Slovin, Sushka anad Ferraro (1995) compared valuation effects of carve-outs, spin-off, and asset sell-offs on parent companies and their industry competitors. Following the Dodd and Warner (1983) procedure, they estimated average excess return on 387 divestment announcements. Parent firms realized average excess return of 1.23% from equity carve-outs, spin-offs 1.32% and sell-offs 1.70%. Moreover, authors noted that, on average, rival firms suffer losses of approximately -1.0% of their capitalization in the day of announcement.

Anand Vijh (2002) used event study to investigate asymmetric information, divestiture gains and managerial incentive of 336 equity carve-outs. On average, the announcement-period excess returns amounted 4.92% when the divested subsidiary assets were greater than the non-subsidiary assets, compared to 1.19% when the subsidiary assets were smaller. Market reaction was higher when the subsidiary divested was an unrelated segment, allowing the parent company to achieve a better focus on its core operations. Market also reacted more positively when management announced that the proceeds from the carve-outs will be used to repay debt or meet other financial contingencies, and to invest in new projects.

C. Veld, Y. Veld-Merkoulova (2002) studied the wealth effect of 156 spin-offs in Europe effected between 1987 and 2000. Their event study methodology resulted in 2.62% cumulative average abnormal returns over the window of three days. Moreover, by comparing companies having completed divestment with comparable non-divesting companies they noticed that spin-off is not associated with a significant improvement in long-run performance.

Among the accounting study literature, Haynes, Thompson and Wright (2002) quantified the long-term impact of divestment on UK firms' performance. They constructed a 3 years dynamic panel by regressing company performance (ROCE, PBIT/A, PBIT/R) upon several financial (leverage, size,

relative size) sectoral (market share, industry concentration,), and corporate governance (dummy variable indicating quality of corporate governance) characteristics. It appears that divestment has a positive, significant and substantial effect in rising the profitability of the parent company. Furthermore, this effect seems to be greater for larger, and diversified firm with poor corporate governance regimes.

In their extensive research Hoskisson, Johnson Moesel (1994) examined relationship between governance, strategy and performance among downscoping firm. The effectiveness of divestment was measured using both market-based metrics (Sharpe ratio, Treynor ratio, Jensen's alpha) and accounting ratios (ROA, ROE, ROS). Authors found strong correlation between market and accounting performance, which were positively impacted by corporate downsizing. Moreover, a higher amount of external board members tends to magnify the effectiveness of divestment.

To conclude, Dasilas, Laventis, Sismanidou and Koulikidou (2011) analysed stock-market reactions to spin-off announcements in USA and Europe from 2000 to 2009. They found positive significant abnormal returns of 3.47% mainly explained by the achievement of a better industrial and geographical focus. Furthermore, they investigated changes in operating performance, showing that ROA, EBITDA/TA and CAPEX/TA on average decrease in the year after spin-off, especially in USA.

2.2.2 Performance of Mergers and Acquisition in the Energy Sector

While, generally, divestments appear to have a positive impact on company short-term and long-term performance, the evidence on M&A remains mixed. While some academics claim that M&A are value creating for companies (Sudarsanam, Mahate 2003; Kiymaz, Baker 2008, Krishnan, Lefanowicz, Craig 2009), others found M&A to be value destructing (Schwert 1996; Fuller, Netter, Stegemoller 2002; Hamza 2009).

Some studies have attempted to explain these contradicting results, by highlighting the factors influencing the success or failure of M&A. In fact, it was shown that the outcome of a deal could depend on multiple factors, some of them being the degree of diversification of the acquirer (Lubatkin and Lane, 1996), relative size (Mirvis and Marks, 1992), price paid (Smith, 1997), strategic fit (Schweiger and Weber, 1989), corporate governance (Bhaumik, Selarka, 2012), and culture (Morosini, Shane and Singh, 1998). Instead of focusing on general M&A outcomes, the purpose of this section is to discuss specific aspects of M&A within the energy sector.

Eisenbach, Ettenhuber (2011) examined the wealth effect of 337 renewable energy transactions (solar, wind, hydroelectric, biomass, and geothermal) between 2000 to 2009. Average CAR to the

bidders of renewable companies was significant and positive. By further decomposing CAR using regression analysis they found that acquirer size, level of diversification, market book ratio, and deals announced during the financial crisis correlate negatively with abnormal returns.

Yoo, Lee and Heo (2013) analysed the performance of related and unrelated types of M&A in the renewable energy sector using event study. According to them, motivations behind renewable energy M&A include financial synergy, operating synergy, increasing market power, risk diversification, green premium, and environmental policy compliance. While a renewable company acquiring a renewable target could expect to generate positive CAR (0.610 in the [-10; +15] window), a traditional energy company (Oil & Gas, Utility) acquiring a renewables target is most likely to perceive negative CAR (-1.613% in the [-10; +15] window).

In their study, Ng and Cox (2016) examined 4552 acquisitions in the US oil & gas industry, testing whether energy prices influence the performance of the deals. They found that bidders of oil & gas companies experience significantly negative returns on the announcement date. In addition, low WTI and Henry Hub prices are associated with higher CAR.

Finally, Palmquist and Bask (2016) monitored market reaction to 273 buyout acquisitions in the renewable energy and cleantech sector. Applying an event study approach, they tested whether renewable energy and cleantech deals experienced higher rates of abnormal returns than traditional energy and mining deals. They found that the latter outperformed the former in terms of average cumulative abnormal returns. In fact, their output displayed significant average CAR of -1.91% to acquirors of solar energy targets, compared to 3.29% to acquirors of traditional energy and mining targets.

In the following table we summarize past findings on performance of corporate restructuring. While company's shareholders are generally better off after divestments, wealth effect after acquisitions of renewable energy companies remains uncertain.

Table 1 "Summary of Literature Review on Performance of Corporate Restructuring"

Author	Sample	Countries	Period	Window	Avg. CAR
Hite, Owers (1983)	55 spin-offs	US	1963 - 1981	[-1; 0]	+3.3%
Jain, Kini, Shenoy (2011)	234 Equity-Carveouts	US	1986 - 2005	[-2; +2]	+4.12%
Sun (2012)	266 Sell-offs	Taiwan	1995-2004	[-1; +1]	+0.23%

Eisenbach, Ettenhuber (2011)	337 renewable energy M&A	US, Germany, Canada, and Spain	2000-2009	[0; +1]	+4.15%
Yoo, Lee, Heo (2013)	47 renewable energy M&A	18 Countries	2008 - 2009	[-10; +15]	+1.61%
Palmquist and Bask (2016)	273 renewable energy, and cleantech M&A	30 Countries	1997-2004	[+1; +5]	-1.91%

3 Hypotheses Development

Now that we have highlighted past evidence on corporate restructuring, our goal is to formulate and test four new hypotheses for enriching academic literature in energy finance. In this section, we will discuss how the current trend in corporate restructuring among traditional energy companies differs from historical waves. While traditional determinants and outcomes corporate restructuring are still valid, it is important to make the following considerations when studying ex-ante and ex-post aspects of transition towards low-carbon energy sources.

Divestment campaigns have been historically guided by institutional investors. In fact, in view of the Anti-Apartheid Act of 1986, pension funds and universities divested and stopped financing multinationals' activities in South Africa. Similarly, in the 90's several pension funds decided to divest from tobacco companies, after regulatory pressures by the US Food and Drug Administration created uncertainty about future financial performance of tobacco stocks. The fossil fuel divestment movement is not an exception: started in 2010 in the US, among university students, the movement have rapidly built global momentum by targeting major institutional investors (Ansar, Caldecott, Tilbury, 2013).

Moral pressures to divest form fossil fuels, combined with new environmental regulations (emission trading, or certification schemes) have made pension funds, with 5% of their assets invested in fossil fuel related equities, particularly vulnerable to stranded asset risk.

While a growing number of pension funds have started to move away from companies that generate revenues from oil, gas and coal commodities (Financial Times, 2017), others have preserved their investments but engaged in a more "**responsible ownership**" (O'Rourke, 2003). In fact, while divestment from fossil fuels can punish energy companies by increasing their cost of equity financing (HSBC, 2015), divested assets are always acquired by other actors in the market with unclear climate

change awareness. Moreover, by divesting their stake, institutional investors lose their ability to influence corporate behaviour of energy company's behaviour to become more environmental friendly and improve transparency on their carbon footprint. Considering the benefits of socially responsible ownership in decreasing stranded asset risk, we expect institutional investors to push energy companies to hedge their operations in the likelihood of a low-carbon future. Therefore, our first hypothesis is formalized as follow:

$H1$: "*Energy companies with higher institutional participation are more likely to initiate a transition towards low- carbon energy sources*"

In the past decade, due to technological improvements and more effective governmental subsidies, the net present value of the unit-cost of electricity produced by renewable sources has decreased at an exponential rate. In its recent report, Lazar (2017) has demonstrated that wind farm levelized cost of energy (LCOE) is now comparable to conventional gas combined cycle and coal power plants. While morally preferred, renewable energy sources remain significantly less flexible than fossil fuels. In fact, despite their increasing cost effectiveness, power generation from solar and wind remains vulnerable to intermittency, storability problems, and are strongly dependent on geographical factors, such as climate (G. Luciani, 2013).

Because a national energy portfolio is strongly dependent on policy support and geographical position, world deployment of renewable energy appears to be modest (9% of world energy supply) and unequally distributed among countries. (World Energy Outlook, 2017). In fact, while Portugal or Spain thanks to their strategic geographical position are able to derive 20-25% of their electricity form wind and solar, in Japan these sources have virtually no weight in country energy mix (IEA, 2018)

Traditional energy companies still show reluctancy to invest in alternative energy sources, as early efforts of BP to rebrand into "Beyond Petroleum" and shift towards solar, resulted in a $ 200 million loss (The New York Times, 2017). Made exception for some minor projects, companies like ExxonMobil and Chevron have chosen to post-pone major investments in renewable energies for collecting more information and wait for more favourable market conditions. Contrarily, companies like Shell and Statoil have announced major investments in off-shore wind power for taking advantages of domestic renewable energy potential.

Considering current equilibrium in the global energy mix, we expect energy producers to be more inclined to shift to alternative sources when based in countries with more developed renewable energy

market infrastructure. A better access to renewable energy technologies should decrease riskiness of investments and attract more capital inflows. In other terms:

H2: "Energy companies based in countries with higher renewable energy deployment are more likely to shift to low-carbon energy sources"

In some countries earnings from rent of fossil fuels, account for a substantial share of the national economic output. From an economic perspective, rent is defined as revenues above the cost of extracting resources and arise because of scarcity of a specific commodity.

Economic rent from coal, oil, and gas plays often a vital role in the GDP equation of countries rich of natural resources. For example, 44% of GDP of Kuwait derive from oil rent, 11% of GDP of Turkmenistan depends natural gas rent, and 4% of GDP of Mongolia is based on coal rent (World Bank, 2016). Because of economic and political interests, we expect countries with strong dependency on fossil fuels, to be more resistant to decarbonisation pressures. J. Hyckmans (2003) examined the game theoretic aspects of global climate negotiations, showing that countries such as Russia would be worse-off in case of enforcement of Paris agreement's emission mitigation provisions. Energy companies based in countries rich of economically viable natural resources are commonly state owned and will be more resilient to low-carbon transition (F. Geels, 2014). Our third hypothesis is strictly related with H2 and can be formalized as follow:

H3: "Energy companies based in countries characterized by higher level of rent from oil, gas, and coal are less likely to initiate a low-carbon strategy"

We have seen that divestment (spin-off, sell-off or equity carveouts) can enhance the performance of firm due to an improvement in focus, correction of negative strategies and reduction of asymmetry of information (Richard A. Johnson, 1996). While evidence from M&A studies remains mixed, many authors have found takeovers to be value generators (Sudarsanam, Mahate 2003; Kiymaz, Baker 2008, Krishnan, Lefanowicz, Craig 2009).

A more recent waves of studies highlighted the link between company performance and effectiveness of its **corporate social responsibility** practices. For example, Cheung (2010) analysed stock reactions on the date of company inclusion in the Dow Jones Sustainability World Index and found short term improvements in firm's performance. In a long-run study, Waddock and Graves (1997) found significant positive relationship between firm's level of social responsibility and financial

performance indicators such as ROA. Finally, Chan and Walter (2014) investigated the effects of socially responsible investment on stock performance and the effectiveness of IPO and SEO of environmentally friendly firms. Their empirical tests on buy-and-hold abnormal returns were significant and positive, signalling the presence of a "green" equity premium.
We believe that companies initiating a low-carbon strategy can boost their performance not only due to traditional benefits of corporate restructuring, but also due to an improvement in their corporate social responsibility. Therefore, our last hypothesis is as follow:

$H4$: "*On average, market will react positively to the company's announcement of transition towards low- carbon energy sources*"

4 Methodology

In this section we will present the methodology used to test the abovementioned hypotheses. Note that the methodology is based on existing empirical literature on corporate restructuring, readapted for studying the current phenomena of low-carbon transitioning energy companies. For cleaning, visualizing and analysing data we used Excel, VBA and STATA.

This chapter will be divided in two parts. In the first section, we explore what factors influence traditional energy companies to divest from fossil fuels or invest in renewable energy companies. We match our sample with a control group of non-transitioning firms and construct a logit panel model for testing H1, H2, H3, H4. In the second section, we only focus on companies that have initiated a transition towards low-carbon energy sources and investigate their ex-post performance. We apply event study to test H5 and conduct an ANOVA to identify differences in transitioning strategies.

4.1 Motives of Transition Towards Low-carbon Energy Sources

4.1.1 Sample

Using the Bureau van Dijk's **Orbis** database, the full population of active, listed and traditional energy and mining companies was selected (Palmquist and Bask, 2016). More precisely, based on the **NAICS 2017** industry classification, we have selected oil, gas and coal companies with the following codes:

211. Oil and Gas Extraction
2121. Coal Mining
213111. Drilling Oil and Gas Wells
213112. Support Activities for Oil and Gas Operations
213113. Support Activities for Coal Mining
2211. Electric Power Generation, Transmission and Distribution
2212. Natural Gas Distribution
23712. Oil and Gas Pipeline and Related Structures Construction
324. Petroleum and Coal Products Manufacturing
333132. Oil and Gas Field Machinery and Equipment Manufacturing
4247. Petroleum and Petroleum Products Merchant Wholesalers
4861. Pipeline Transportation of Crude Oil
4862. Pipeline Transportation of Natural Gas
48691. Pipeline Transportation of Refined Petroleum Products

The query yielded 2,824 fossil-fuel related companies from 114 different countries. The Orbis database was merged with the **Thomson One** database to identify which of these companies have announced a divestment from fossil fuels or investment in renewables between January 2011 and March 2018. Note that, the starting date of our sample coincides with the December 10, 2010 United Nations Climate Change Conference held in Cancun. In this occasion, 197 countries have agreed to hold the increase in global average temperature below 2°C above pre-industrial levels, by limiting greenhouse gas emissions. McGlade and Ekins (2015) found that for meeting this ambitious target emissions should not exceed 1,240 GtCO2 between 2011 and 2050. However, they also showed that global fossil fuel reserves are estimated to be about 11,000 GT of CO2, which means that a substantial amount of these resources should not marketed.

The growing risk of stranded assets instigated a series of strategic reactions among traditional energy firms by pushing them to hedge against likelihood of a global decarbonization. For example, Total S.A. acquired SunPower Corp. in 2011 to diversify its operations (Bloomberg), E.ON decided to split fossil fuel and renewable operations in 2014 (The Guardian), and Shell announced to sell its carbon-intensive Canadian oil sand resources in 2018 (Financial Post).

We consider a company that have announced one of the following corporate restructuring events as a company that have initiated a transition towards low-carbon energy sources:

Table 2 "Low-Carbon Transition Events"

Event	Target	Acquirer	Observations
Fossil Fuel Spin-off, Equity Carve-Out, Two-Step Spin-off	Subsidiary of a publicly traded energy and power companies. Target mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	Shareholders	48
Fossil Fuel Asset Sell-off	Fossil Fuel related asset of a publicly traded energy and power company. Target mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	Publicly traded energy fossil fuel related company. Acquirer mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	259
Renewable Energy Investment	Renewable energy companies. Target mid industry must include Alternative Energy Sources, Other Energy & Power	Publicly traded energy fossil fuel related company. Acquirer mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	15

It appears that 322 companies, from 69 different countries between January 2011 and March 2018, have announced a corporate restructuring which is consistent with a low-carbon future. While some energy companies such as Eni (Solar and Biomass R&D centre in Novara) and ExxonMobil (Algae-bio fuel research partnership with Synthetic genomics) have expressed a committed to a low-carbon future by means of internal capabilities, we only focus on companies transitioning using inorganic means, i.e. trough activities in the capital markets. Throughout the paper we have assumed that each of these events represent a credible commitment to a low-carbon future. Out of a population 2,824 companies, only 322 (11%) have initiated transitioning towards low-carbon energy sources by divesting their fossil fuels assets or incorporating renewables energy divisions. Since our sample contains missing value for certain variables, our final sample consist of 1379 companies.

4.1.2 Dependent Variable

For understanding what can influence an energy company to initiate a transition towards low-carbon energy sources, we have decided to model the probability of undergoing corporate restructuring. As already pointed out, in this research, we have considered divestment from fossil fuel or investment in renewable energy sources as the only restructuring strategies in line with the transition towards a low-carbon future. We modelled the decision to restructure by means of a logistic regression, following the approach of S. Krishnswami and V. Subramaniam (1999) for predicting spin-offs, and Routledge, Sacchetto and Smith (2013) for predicting takeovers. However, to simultaneously account for cross-sectional differences of companies, and inter-temporal variation of their features we found appropriate to extend our analysis using a logit panel (M. Verbeek, 2004). We opted for a **random effects logit panel model** because it allows us to test both time-varying and static regressors, which will be essential for our hypotheses testing procedure. In fact, the fixed effect panel is demeaned by construction and does not allows to estimate coefficients for dummy variables or other variables fixed over time (M. Verbeek, 2004).

We have coded the dependent variable as 1 if an energy company has announced a spin-off, sell-off, equity carveouts of a carbon-intensive asset, or purchased a renewable energy asset in a given year or in the previous one. This implies that after an event is announced all subsequent years will be coded as 1, because we have assumed that the firm have initiated a transition towards low-carbon energy sources.

A preliminary analysis of our sample highlighted curious patterns in energy company's restructuring strategies. Interestingly, we have noticed that some firm have opted for restructuring their entire portfolio of assets by divesting multiple business segments rather than a single one. For example, the spin-off of ConocoPhillips's refinery business in 2011 was accompanied by a series of divestitures of other non-core fossil fuel assets (Forbes). Other companies, instead, have combined sales of their dirtiest assets with acquisitions of alternative energy businesses. In fact, French electric utility company Engie bought Solairedirect in 2015, but also sold most of its LNG infrastructure to Total in 2017 (Reuters). Finally, while Italian utility company Enel started excluding from its portfolio some of its least environmental performant assets (sell-off of Reftinskaya coal power plant in 2017), it also decided to reabsorb its previously spun-off alternative energy division, Enel Green power. These examples indicate that **fossil fuel divestment and green acquisitions shall not be considered as mutually exclusive**, but rather complementary.

4.1.3 Independent Variables

We test our hypotheses by regressing the probability of initiating a transition toward low-carbon energy sources on a set of regressors. The dataset is composed by both ultimate parent's company characteristics and macroeconomic indicators of the country in which the company is registered. Considering the strategic dimension of corporate restructuring, all explanatory variables included in our analysis were **lagged one year** (H. Berry 2009). Observations were collected using Orbis, **World Bank Open Data** and Thomson One. In this section, we provide a detailed description of all the variables employed in our analysis, as well as their a priori impact on the dependent variable.

In the previous chapter we have discussed our a priori beliefs about the phenomena of companies transitioning towards low-carbon energy sources. To effectively test our hypotheses in a regression analysis framework, we have identified a series of quantitative indicators to include in our equation. Firstly, we have hypothesized that a larger participation of institutional investors will increase the likelihood of a company restructuring, because of their interest to immunize their long-term capital investments from the growing eventuality of a low-carbon future. We have included the percentage ownership of mutual and pension funds, expecting a positive coefficient. Our second hypothesis is built upon the rationale that a higher level of renewable energy deployment should facilitate transition due to lower entry barriers to the renewables M&A market. The percentage of renewable energy in total final energy consumption in a country will be used for testing this hypothesis, anticipating a positive relationship with the decision variable. Thirdly, we have hypothesized that companies based in economies that are strongly dependent on natural resources will be less likely to initiate a transition to low-carbon energy sources. We verify this statement by including into our regression the economic rent from fossil fuels, i.e. the country's excess return over the cost of production of oil, gas and coal as a fraction of GDP. The correspondent beta coefficient is expected to be negative.

We have seen that the decision to restructure can come from other reasons that might be disconnected by the desire to comply to a low-carbon future. In fact, it is important to account for other companies' specific characteristics when aiming to bring new evidence on the issue of corporate restructuring in the energy sector. Firstly, we should control for **size**, since restructuring is often a necessary step to correct past suboptimal diversification strategies and others organizational inefficiencies. The free cash follow hypothesis dictates that managers, driven by empire building desires, tend to use excess funds for implementing sub-optimal expansion strategies (Jensen, 1986). For this reason, it often believed that firms choses to restructure their portfolios for solving agency problem (Gibbs, 1993).

Consistent with previous literature, we measure size using the logarithmic transformation of company total asset, positive incidence on probability to transition is expected. Similarly, we account for **degree of complexity** of an organization by including the number of subsidiaries controlled by the parent company. Consistent with the asymmetric information hypothesis, we expect conglomerates controlling multiple segments, to be more likely initiate restructuring in order to off-set negative synergies, enhance transparency and firm value (Bergh, Johnson, Rocki-Lee Dewitt, 2007).

Serial acquirers are companies characterized by a prominent level of activity in the market for corporate control. As shown in previous researches (Aktas and Roll, 2011), companies that have developed an expertise in capital markets are more likely to divest or invest in the future. We account for company's **experience in capital markets** by including the annual cash outflows from companies acquisitions and anticipate a positive incidence on the decision variable.

As we have highlighted in the literature review, poor **operational performance** often signals the need for a change. In fact, management can decide to spin-off unprofitable units, or diversify in fast-growing segment for boosting down-trending performance of the firm (Ravenscraft and Scherer, 1991). We have measured company performance with ROA, net income over total asset, and predict a strong negative relationship on the probability of transitioning.

When restricting our sample on companies transitioning towards low-carbon energy sources only by divesting from fossil fuels or acquiring a renewable energy company, we make the stringent assumption that a company cannot initiate a transition internally by spending on research and development. We can relax this assumption by accounting for **innovation performance** of a corporation, typically approximated with R&D expenditures and patenting (Cloodt, Hagendoorn, Kranenburg, 2006). Relationship is expected to be negative (Markides, 1992), since highly innovative companies should be more prone to initiate a transition organically, rather than inorganically.

When analysing deals in energy markets, we have seen that commodity **market timing is crucial** (Ng and Donker, 2013). In fact, when fossil fuel prices are high, the development of certain oil, gas or coal reserves become economically feasible, stimulating producers to initiate new projects. In addition, from a microeconomics perspective, high energy commodity prices tend to magnify the producers' surplus. Considering our geographically diversified sample, we find appropriate to consider annual average WTI price as a proxy for global fossil fuel prices This is because, while natural gas and coal prices displays regional idiosyncrasies, crude oil markets appears to be more integrated, with more uniform price benchmarks (G. Luciani, 2004).

Finally, many researchers have highlighted differences in capital markets dynamics between developed countries and developing countries. In fact, traditional evidences from M&A studies conducted on developed market samples, is rarely generalized to developing market, such as BRICS

(Grigorieva and Petrunina, 2013). Out of 114 countries considered, 24 are developed countries and 87 are developing countries. To account for difference in degree of capital market development and pace of economic growth, we include a dummy variable indicating whether a country is a member of OECD. We expect developing economies to be less likely to transition towards low-carbon energy sources, as fossil fuels are still a plentiful and cost-effective source for supporting their rapid economic growth (Institute of Energy Research, 2017). In fact, it was empirically shown by A. Afzal (2014) that economic growth has historically granger caused the consumption of fossil fuels. To conclude, we include dummy variables for every year (8) and country (114) considered in our sample.

Our final dataset consists of 14 variables, for each 1379 companies for each 8 year, i.e. a total of 7485 observations. The following table contains a summarized list of variables used for testing our hypotheses, as well as control variables based on past academic literature.

Table 3 "List of Independent Variables"

Characteristics	**Proxy Used**	**Expected Sign**	**Reference**
Institutional Participation	% ownership of mutual and pension fund, nominee, trust, trustee	+	Hypothesis 1
Renewable Energy Deployment	% of renewable energy consumption in country energy mix	+	Hypothesis 2
Rentability of Fossil Fuels	Country Economic rent from oil, gas and coal as a % of GDP	-	Hypothesis 3
Size	ln (Assets)	+	Hoskisson et al, (1994)
Financing	ln (Debt)	+	Ahn,Walker (2007)
Performance	$ROA = \frac{Net\ Income}{Total\ Assets}$	-	Bergh et al. (2008)
Innovativeness	• $R\&Dint = \frac{R\&D\ expenses}{Revenues}$ • Number of patents	-	Liebeskind, Opler (1992)
Corporate Governance	Number of directors at the board	-	Ahn,Walker (2007)
Complexity	Number of subsidiaries	+	Denis, Shome (2005)
Experience in Capital Markets	Cash flows from acquisitions activities	+	Aktas and Roll, (2011)
Market Environment	• Average annual WTI price	-	Hse, Wright, Zhu (2017)

	• Tobin's Q ratio	+	Liebeskind, Opler (1992)
Economic development	Dummy 1 if company is based in OECD country, 0 otherwise	+	Reddy and Xie (2017)

4.2 The Performance of Companies Transitioning Towards Low-carbon Energy Sources

4.2.1 Sample

In the second part of our study, we narrowed our analysis on the effectiveness of low-carbon transitioning strategies. Instead of considering the entire population of traditional energy companies as we did in the previous section, we focused only on the players that have initiated an environmentally friendly deal, that is, a divestment form fossil fuels or an acquisition in the alternative energy market. The goal of this section is to quantify the performance of traditional energy companies conditionally on the fact that they have initiated a transition to low-carbon sources, i.e. testing the validity of H4.

It is important to denote that when a company is divesting its fossil fuels assets, the counterparty of that transaction is investing into fossil fuels. For comparison purposes, we include into our sample of events also traditional energy companies that have agreed to purchase divested fossil fuel assets. Therefore, our final sample contains 322 announcements of companies transitioning to low-carbon sources, and additional 127 announcements of fossil fuel commitment.

Table 4 "Extended Sample of Corporate Events"

Event	**Target**	**Acquirer**	**Observations**
Fossil Fuel Spin-off, Equity Carve-Out, Two-Step Spin-off	Subsidiary of a publicly traded energy and power company. Target mid industry code must include Oil & Gas,	Shareholders	48

	Petrochemicals, Pipelines, or Power		
Fossil Fuel Asset Sell-off	Fossil Fuel related asset of a publicly traded energy and power company. Target mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	Publicly traded fossil fuel related energy company. Acquirer mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	259
Renewable Energy Investment	Renewable energy company. Target mid industry must include Alternative Energy Sources, Other Energy & Power	Publicly traded fossil fuel related energy company. Acquirer mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	15
Fossil Fuel Investment (Control Group)	Fossil Fuel related asset of a publicly traded energy and power company. Target mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	Publicly traded fossil fuel related energy company. Acquirer mid industry code must include Oil & Gas, Petrochemicals, Pipelines, or Power	127

4.2.2 Event Study Method

Since our sample contains corporate events announced between 2011 and 2018 we were unable to detect long-run effects of low-carbon transition strategies. In fact, long-run studies, based on accounting ratios or economic value added, typically require observations from 1 to 5 years after a corporate event has occurred (Sirower and O'Bryne, 1998). Due to the novelty of the topic of our research and the consequent sample limitation, we focused only on short-term performance of restructuring. We have discussed in the literature review that one of the most popular methodology for analysing the effectiveness of restructuring in the short run, is examining stock market reactions during the corporate event announcement. In this section we discuss in more details the event study approach suggested by Brown and Warner (1980) and how used it to test H4.

For every event selected, we defined multiple event windows of [-1; +1], [-5; +5], [-10; +10], [-15; +15], [-20; +20], [-30; +30] days around the deal announcement. Then, we have chosen an estimation window of 254 days prior the event window, that corresponds to the number of trading days in a year. We computed the continuously compounded stock returns for each company i:

$$R_{i,t} = \ln\left(\frac{P_{i,t}}{P_{i,t-1}}\right)$$

The forward looking expected returns for the securities were estimated using the global CAPM, by regressing stock returns on the selected index returns. Since our sample contains companies from 69 different countries around the world, we found appropriate to consider the returns over the MSCI World Index as an explanatory variable (Bialkoswaski et al., 2006).

$$R_{i,t} = \alpha_i + \beta_i R_{Market,t} + \varepsilon_{i,t}$$

After having estimated the parameters for each company i, using OLS, we compare fitted values in event window $[t_1; t_2]$ with observed ones. The difference between the two components is known as abnormal returns:

$$AR_{i,t} = R_{i,t} - \hat{R}_{i,t} = R_{i,t} - (\alpha_i + \beta_i R_{Market,t} + \varepsilon_{i,t})$$

Next, the abnormal returns obtained were aggregated for each event window$[t_1; t_2]$, for obtaining the cumulative abnormal returns:

$$CAR_i[t_1; t_2] = \sum_{t=t_1}^{t_2} AR_{i,t}$$

Finally, by averaging CAR across all N companies, we obtained the average cumulative abnormal returns:

$$\overline{CAR}\,[t_1; t_2] = \frac{1}{N}\sum_{t=1}^{N} CAR[t_1; t_2]$$

To test whether average CAR is statistically different from zero (H_0: $\overline{CAR} = 0$) we cumputed the following parametric t-test statistics.

$$t_{\overline{CAR}} = \sqrt{N}\frac{\overline{CAR}}{\sigma_{CAR}} = \sqrt{N}\frac{\overline{CAR}}{\sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(CAR_i - \overline{CAR})^2}}$$

Under H4 we expect average CAR to be significantly higher than zero, meaning that $t_{\overline{CAR}}$ >1.96.

5 Results

5.1 Motives of Transition Towards Low-carbon Energy Sources

In this section we discuss the factors influencing traditional energy companies to initiate a transition towards low-carbon energy sources. For investigating H1, H2 and H3 we estimated the following random effects logit panel regression:

$$\begin{aligned} ln\left(\frac{P(t)_{i,t}}{1-P(t)_{i,t}}\right) = \alpha + \beta_1 institutional_{i,t-1} + \beta_2 renewables_{i,t-1} + \beta_3 rentfossilfuels_{i,t-1} \\ + \beta_4 \ln assets_{i.t-1} + \beta_5 \ln debt_{i.t-1} + \beta_6 roa_{i.t-1} + \beta_7 rd_{i.t-1} + \beta_8 patents_{i.t-1} \\ + \beta_9 directors_{i.t-1} \beta_{10} subsidiaries_{i.t-1} + \beta_{11} acquisitions_{i.t-1} + \beta_{12} wti_{i.t-1} + \beta_{13} q_{i.t-1} \\ + \beta_{14} oecd_{i.t-1} + \varepsilon_{i,t} \end{aligned}$$

$$where: \quad P(t)_{i,t} \ probibility\ of\ company\ i\ to\ transition\ at\ time\ t$$

$$\varepsilon_{i,t}\ are\ company's\ specific\ random\ effects$$

The summarized output of the regression is reported table 5. While magnitude of the β coefficients shall not be interpreted directly, their signs and significance are still of interest (M. Verbeek, 2004). Note that, calculating the **odds-ratios** is an effective way to directly interpret the magnitude of the estimated parameters.

As we had hypothesized, the stronger the presence of institutional investors in company's ownership structure, the higher the probability of an energy company to decrease its carbon intensity. Our results suggest that long-term investors such as pension funds, and mutual funds, are becoming increasingly concerned about climate change and stranded asset risk, requiring fossil fuels to transition towards a lower-carbon strategy. The pension funds of the Church of England and the UK Environment Agency are currently pressing Royal Dutch Shell to adopt tougher targets for reducing its carbon footprint (Financial Times, 2018). Similarly, BlackRock and Vanguard Group, biggest shareholders of

ExxonMobil have successfully persuaded the oil & gas giant to evaluate and disclose the viability of its portfolio under the 2-degree Celsius scenario (The Washington Post, 2017).

We also find that the level of development of renewable energy within a country significantly impact the decision of transitioning towards low carbon sources. This indicates that in countries where renewables energy markets are more developed, traditional energy companies are more likely to consider divestment fossil fuels or diversification trough renewable energy M&As. Note that instead of testing the percentage of renewable energy consumption in country energy mix in the current year, we have used a 1-year lagged observation for avoiding endogeneity biases in our results. A striking example is Norway which produces 98% of its electricity using renewables (97% from hydro and 1% from wind according to IEA data 2017). In 2016, its national giant Statoil divested carbon-intensive oil sand operation in Canada to hedge the risk of stranded assets (Reuters, 2016). More recently, Statoil revealed its strategic plan to change its name to "Equinor" by the end of May 2018 to exploit existing offshore wind opportunities in the domestic market (Chron, 2018).

Our third hypothesis appears to be consistent with our a priori beliefs on the incidence of fossil fuels rentability on the decision to transition. In fact, companies based in economies characterized by strong dependency on oil, gas or coal are less likely to shift towards low-carbon sources. While some improvement in CO2 emissions can be achieved by investing in energy efficiency systems, as at today, energy companies based in countries rich of viable natural resources are less likely to alter their business operations. In fact, none of the companies based in OPEC nations have announced a divestment form fossil fuels or an investment in renewables. One exception is Saudi Arabia, where government company Aramco have announced the IPO of 5% of its assets (Bloomberg, 2018). As pointed out by F. Geels (2014) energy markets are experiencing resistance to a low-carbon economy, mainly due to regime actors with strong economic and political interest in fossil fuel resilience.

Now that we have validated our main hypotheses on the antecedent of transition towards low-carbon energy sources, it is important to devote some time on the discussion of the control variables. Consistent with previous evidence on asymmetric information, the likelihood of initiating a restructuring increases with size, and level of complexity of an organization (Krishnaswami, Venkat Subramaniam, 1999). Moreover, companies that display poor performances, and are unable to efficiently monetize their assets, are more likely to shift to a low-carbon strategy in search for new profitable market opportunities.

Curiously, innovative performance seems not having a significant influence on the dependent variable. This indicates that the **transition towards low-carbon energy sources by organic means and inorganic means are not mutually exclusive**. In other words, companies with high R&D intensity and strong patenting, might still choose to diversify by engaging in renewables M&A activities. This finding might be justified by the fact that renewable energy technologists master a completely distinct set of skills than petroleum and mining engineers, forcing traditional energy companies to combine internal R&D efforts with activities in capital markets for facilitating the transition toward low-carbon energy sources. A competitive advantage in oil & gas explorations and refining, does not translate in a favourable position in the alternative energy market, therefore, companies will still consider capital markets as a mean of preserving their competitiveness in the eventuality of a low-carbon future.

Consistent with the literature review on corporate restructuring in energy markets, higher energy commodity prices decrease the probability of a company to refocus or diversify its operations. This is because when oil prices are high, producers can benefit from a larger profit poll compare to times when prices are low (Bain & Company, 2018). Board size has a significant, although minimal impact on the decision variable. While this independent variable has a statistically significant effect, it seems not having an economical significant impact. Finally, the odds of shifting to low-carbon sources for companies in developed countries (OECD members) is 7.795 times higher than the one of companies in developing countries.

Table 5: "Summary of Results Logit Panel Random Effects Regression"

Variable	*Expected Sign*	*β*	*Odds-ratio*
Institutional Participation	+	*+ 0.074****	*1.077****
Renewable Energy Deployment	+	*+ 0.053****	*1.054****
Rentability of Fossil Fuels	+	*- 0.548****	*0.577****
Ln (Assets)	-	*+ 0.861****	*2.367****
Ln (Debt)	+	*- 0.106*	*0.899*

ROA	-	*- 0.023****	*0.976****
R&D Expenditures	-	*+ 0.04*	*1.004*
Patents	-	*-0.000*	*0.999*
Directors	-	*+0.001***	*1.001***
Subsidiaries	+	*+0.003**	*1.003**
Acquisitions	+	*+0.000*	*1*
WTI Price	-	*-0.063****	*0.938****
Q Tobin	+	*+0.097*	*1.102*
OECD Dummy	+	*+2.053****	*7.795****
Constant	0.000***		
Observations	7,485		
Groups	1,739		

*p < .10. **p < .05. ***p < .01.

5.2 Performance of Transition Towards Low-carbon Energy Sources

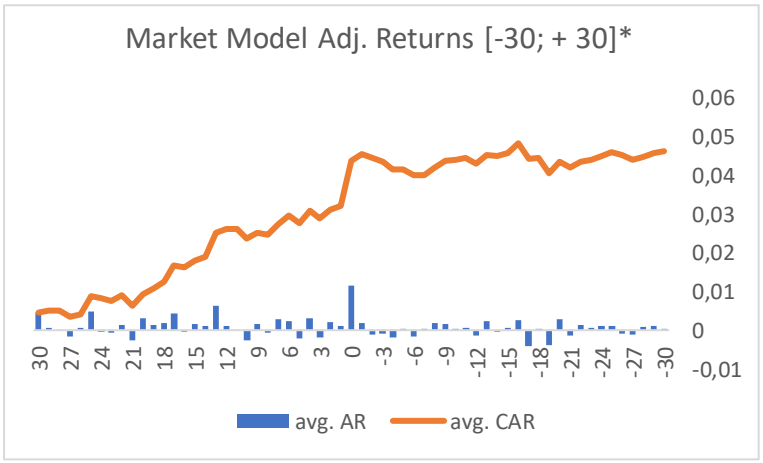
5.2.1 Event Study

Now that we have identified significant antecedents of the transition towards low-carbon sources, we can now proceed for looking at the effectiveness of the implemented strategies and test H4. In this section we analyse short-term performance of companies after having announced a low-carbon transition strategy. Furthermore, we test the presence of grouping effects, by comparing the effectiveness of different restructuring methods: spin-offs, sell-offs, and renewable energy acquisitions. In addition, to check the robustness of our results we compare the performance of energy companies that have divested from fossil fuels with the one of energy companies that have invested in fossil fuels.

For analysing company performance, we perform a t-test on average CAR for the event windows [-1; +1], [-5; +5], [-10; +10], [-15; +15], [-20; +20], [-30; +30]. Mean estimates are reported below:

Table 6: "Summary Mean estimates for CAR"

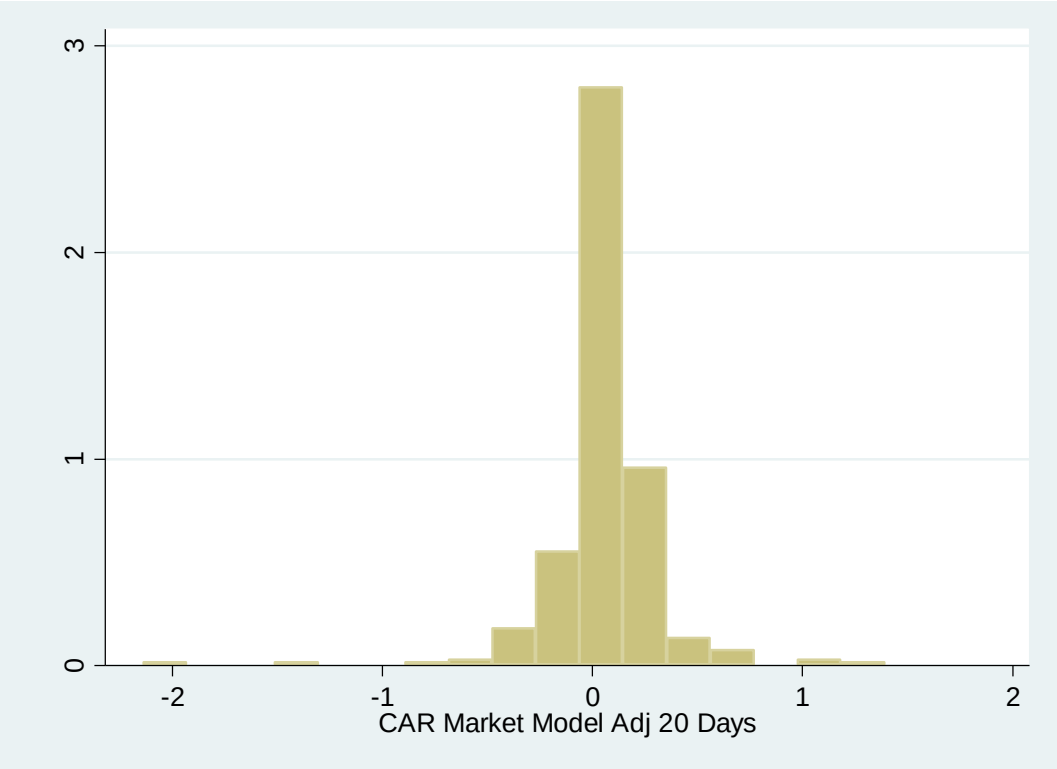
$[t_1; t_2]$	$\overline{CAR}$
[-30; +30]	6.33% ***
[-20; +20]	6.86% ***
[-15; +15]	6.31% ***
[-10; +10]	4.06% ***
[-5; +5]	3.03% ***
[1; +1]	3.13% ***



*average of 50 companies

Our results suggest that, on average, initiating a transition towards low-carbon energy sources generates significant positive cumulative abnormal return for shareholders. Following the methodology of Brown and Warner (1980), we look at the event window [-20; +20] days around the announcement, in which shareholders expect around 6.87% increase in wealth.

Figure 3 "Distribution of CAR [+20; -20]"



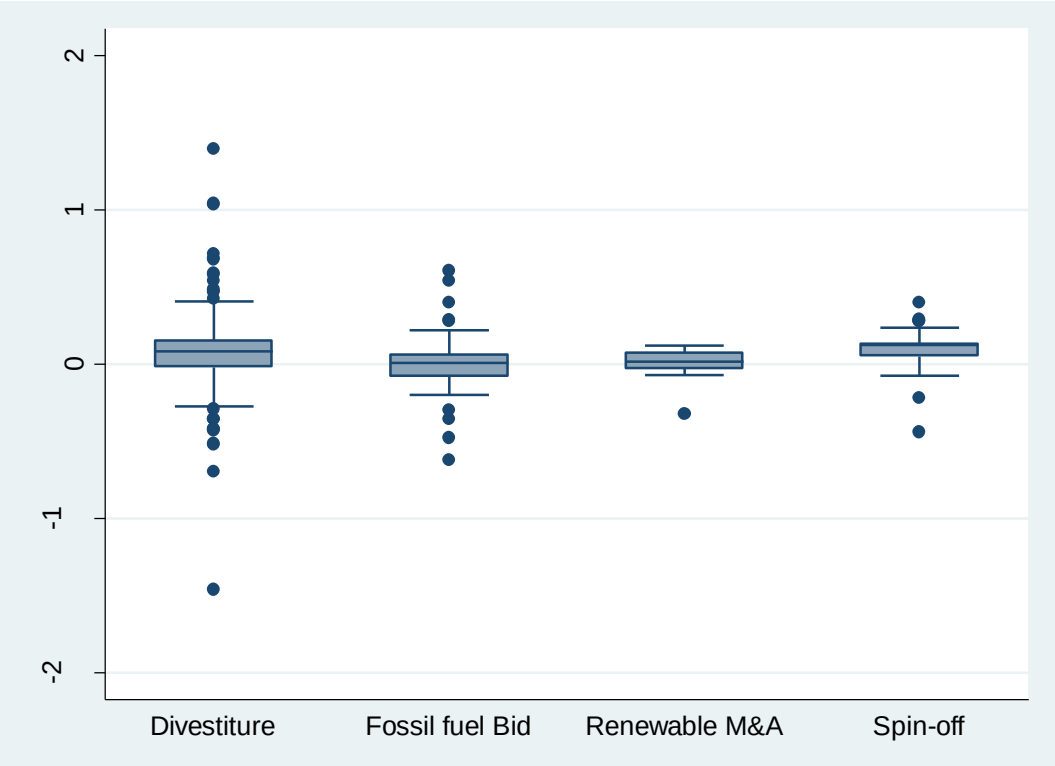
This finding is not only consistent with past empirical literature on corporate restructuring (Jain, Kini, Shenoy, 2011), but also with the evidence on superior performance of environmental friendly firms (Chan and Walter, 2014). In fact, divesting carbon intensive assets and acquiring a stake in alternative energy are regarded as socially responsible conducts and will be priced positively by the market (O'Rourke, 2003).

In the next subsections we go one step further and investigate which type of restructuring strategy, company characteristics, and country characteristic can impact the magnitude of CAR. For achieving this purpose, we firstly construct an analysis of variance of CAR per strategy, then we run a regression of CAR on a set of independent variables.

5.2.2 Analysis of Variance

To check which corporate restructuring strategy results in the highest average CAR, we split our sample into distinct types of deals: Fossil fuel spin-off, fossil fuel sell-off, renewable energy investment, and fossil fuel investment (control group). A preliminary graphical analysis of the distinct categories signals that restructuring strategies differs in mean and variance:

Figure 4 "Box-plot CAR [-20; +20] by strategy"



Corporate Restructuring Strategy	Mean	Std. Deviation	Frequency
Fossil Fuel Spin-off	7.53%	24.35%	259
Fossil Fuel Asset Sell-off	0.15%	15.34%	127
Renewable Energy Investment	-0.19%	10.72%	14
Fossil Fuel Investment	9.92%	13.58%	48

To test whether the differences in average CAR across strategies are statistically significant, we can implement a one-way analysis of variance (Ajit C. Tamhane, 1976). More formally, the ANOVA allow us to test the following null-hypothesis:

$$H_0: \overline{CAR}_{spin-off} = \overline{CAR}_{sell-off} = \overline{CAR}_{renewableM\&A} = \overline{CAR}_{fossilfuelM\&A}$$

Against the alternative:

$$H_1: \overline{CAR}_{spin-off} \neq \overline{CAR}_{sell-off} \neq \overline{CAR}_{renewableM\&A} \neq \overline{CAR}_{fossilfuelM\&A}$$

The resulting test statistic is 4.68, which is higher than the critical value relative to the F-distribution (p-value = 0.0031). This implies that at least one pair of 20 days CAR means differs across restructuring strategies. In addition, we found that strategies not only differ in term of average CAR, but also in terms of variance, as denoted by Bartlett's test (p-value = 0.000) for equal variances (Snedecor et al., 1989).

The Bonferroni correction matrix (Dunnett, 1955) allow us to identify which pair(s) of mean of CAR significantly differ from each other:

Table 7: "Bonferroni Comparison of CAR [-20; +20] by strategy"

Row Mean Column Mean	Fossil Fuel Asset Sell - off	Fossil Fuel Investment	Renewable Energy Investment
Fossil Fuel Investment	*-7.37%**** *(0.007)*	-	-
Renewable Energy Investment	*-7.77%* *(1.000)*	*- 0.35%* *(1.000)*	-
Fossil Fuel Asset Spin-off	*2.39%* *(1.000)*	*+ 9.77%*** *(0.035)*	*+ 10.12%* *(0.662)*

By looking at the first column of the matrix, we observe that on average a divestiture from fossil fuels generates 7.37% CAR higher compared to an investment in fossil fuels. Furthermore, the second column indicates that the difference is even wider when comparing investment of fossil fuel with spin-off of fossil fuel divisions. In fact, this latter strategy generates, on average, 9.77% CAR higher than the former. While acquisition of renewable energy businesses seems yielding negative average CAR, the difference with other low-carbon transition strategy is not significant. This is mostly due to limited observations (14 events) of oil, gas and coal companies shifting to renewable sources.

5.2.3 Regression Analysis

Now that we have seen that the performance of companies transitioning to low carbon sources is significantly higher than the performance of companies committing to fossil fuel, we aim to go one step further and highlight determinants of CAR using a regression analysis framework. We construct a cross-sectional linear regression, in which CAR for selected event window [-20; +20] is the dependent variable, and the previously introduced variables (Table 3) are regressors. An additional control dummy variable with value 1 if the correspondent event is an investment in fossil fuel was included into the model. The final regression equation looks as follow:

$$CAR_i[-20;+20] = \alpha + \beta_1 institutional_i + \beta_2 renewables_i + \beta_3 rentfossilfuels_i + \beta_4 \ln assets_i + \beta_5 lndebt_i + \beta_6 roa_i + \beta_7 rd_i + \beta_8 patents_i + \beta_9 directors_i + \beta_{10} subsidiaries_i + \beta_{11} acquisitions_i + \beta_{12} wti_i + \beta_{13} q_i + \beta_{14} oecd_i + \beta_{15} FossilFuelsInvestmentDummy_i + \varepsilon_i$$

The obtained results for the CAR decomposition are illustrated as follow:

Table 8: "CAR Regression Analysis"

Variable	β
Institutional Participation	*+ 0.001*
Renewable Energy Deployment	*+ 0.001**
Rentability of Fossil Fuels	*- 0.011*
Ln (Assets)	*+ 0.011*
Ln (Debt)	*- 0.018**
ROA	*- 0.003****
R&D Expenditures	*- 0.007*

Patents	*- 0.000*
Directors	*+ 0.000*
Subsidiaries	*- 0.000*
Acquisitions	*+ 0.000*
WTI Price	*+ 0.000*
Q Tobin	*+ 0.030**
OECD Dummy	*+ 0.047***
Fossil Fuel Investment Dummy	*- 0.010**
Constant	*0.286***
Observations	285
R^2	14.25%

*p < .10. **p < .05. ***p < .01.

It appears that most of the factors influencing the probability to transition towards low carbon energy sources do not have a significant impact on ex-post short term performance of companies. One the one hand, the estimated coefficients suggest that market tends to reward transitioning energy companies characterized by higher growth opportunities (q Tobin's ratio), that are based in OECD countries with superior share of renewable energy utilization. On the other hand, energy companies with larger amount of debt outstanding that attempts to liquidate their assets for repaying debt receive lower CAR. Quite strikingly, companies with superior asset profitability (ROA) are also penalized by the market. The rationale behind this controversial result could be that companies that had a profitable financial year might be more vulnerable to managerial hubris when managing excess cash, therefore more likely to signal the market of a sub-optimal allocation of cashflows when initiating a corporate event. In addition, it is important to denote that certain decadent companies might still

display high accounting performances because of earning management. In fact, by strategically divesting assets, companies can artificially inflate their return on capital figures.
Consistently with our previous results obtained in the ANOVA test, shareholders of companies that have invested in fossil fuels receive, on average, lower returns than owners of companies that have shifted to low-carbon energy sources.
We should point out that the significant constant has a high magnitude (28%) and denotes the presence of additional factors determining short term performance of energy companies restructuring. The identification of all the determinants of CAR is beyond the scope of this paper, since this might require the quantification of several non-easily observable factors such as: technical characteristics (capacity and efficiency) of asset divested or acquired, or the degree of strategic fit between headquarters and the country where the asset is divested or acquired.

To sum up, the ANOVA has shown that while the market seems not penalizing companies investing in fossil fuels (average CAR 0.15%), because of better corporate social responsibility, companies initiating a transition towards low carbon sources perceive a higher premium (average CAR 6.86%). Due to limitations in our sample, we were unable to show whether average CAR differs across mode of transitions toward low-carbon economy. In fact, while sell-off (7.53%), spin-off (9.92%) and renewables acquisitions (-0.19%) seem to yield, on average, to different levels of CAR, these differences are not significant.
The regression analysis highlighted that returns are maximized when an energy company with higher Q-Tobin's ratio than its peers, based in renewable-intensive OECD country, is initiating a low carbon strategy. Conversely, market seems punishing restructuring companies that are highly leveraged and have higher returns on assets.

Conclusion

In this study, we have analysed antecedents and outcomes of corporate decision to transition towards low carbon sources. We have seen that energy companies have dynamic capabilities of complying to a low-carbon future. In fact, traditional energy companies can exploit capital markets for divesting from fossil fuels or investing in renewable energies, to hedge the growing risk of stranded assets. While the corporate restructuring literature is already well developed, we brought new evidence from the energy sector by applying existing methodologies to a new sample. Beside the academic

contribution, we believe our evidence could support managers in global energy companies when planning downsizing or diversification strategies.

In the first part of our empirical research, we have used a logit panel model to identify factors influencing company decision to initiate a low-carbon strategy. As we had hypothesized, energy companies with larger pension fund and mutual fund ownership, are more likely to transition because of more socially responsible shareholder's activism. Moreover, companies based in countries where renewables and alternative energy technologies are more developed, will be less risk averse and more incline to initiate a decarbonisation strategy. Finally, we found that because of strong political and economic interests in fossil fuels, companies based in countries with large dependency on oil, gas or coal rent, are less likely to commit to a low-carbon future.

In the second part of our empirical research, we have analysed ex-post performance of companies that have initiated a transition to low-carbon energy sources. Using the traditional event study method (Brown and Warner, 1980), we have quantified short-term market performance and found statistically significant average cumulative abnormal returns of 6.86% in the window of 20 days before and after the event. This finding was consistent with our fourth hypothesis. Furthermore, by implementing an ANOVA, we have seen that average CAR for companies transitioning towards low carbon sources are 7.37% higher, than the one generated by companies that have acquired fossil fuel assets. Finally, we found that CAR correlate positively with Q-Tobin's ratio, country's share of renewable energy, degree of national economic development, but correlate negatively with financial profitability indicators and amount of debt outstanding.

Beside an uncomplete identification of significant factors influencing CAR, we do not hide that our study contains some bold assumptions, and few analytical drawbacks. In fact, when we have categorized divestment form fossil fuels, or investment in renewables, as a company initiating a transition, we were unable to distinguish between credible commitment to a low-carbon future or a mere "**green-washing**" strategy. For example, recent emission abatement plan proposed by BP was strongly criticized and dismissed as "greenwash" by former UK government adviser Tom Burke (The Guardian, 2018). Another limitation of the study comes from the use of event study as a measurement of company performance. In fact, as pointed out by Fama (1991), while event study is the cleanest evidence of short term efficiency, it becomes less reliable on the long run. More precisely, practitioners have found that the event study results are susceptible to joint-test problem, and thus vulnerable to biases (Haleblian et al. 2009).

Despite the few highlighted methodological drawbacks in our approach, we consider our research as a first attempt to empirically analyse latest corporate restructuring trends in the global energy sector. In fact, studies published so far were mostly based on qualitative methods and case study approach. When more data on this emergent phenomenon will be available, researchers could extend this study by looking at long-term performance of companies transitioning to low-carbon energy sources, using accounting or EVA methods. From an asset pricing literature perspective, future researches could elaborate on the difference in stock performance between energy companies transitioning and non-transitioning peers for investigating the presence of a "green premium".

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