The influence of the Paris Agreement on the strategy of oil & gas majors

An analysis of the investment activities, stock performances and revenues of oil & gas companies

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Abstract

The strategical and environmental reports of IOCs concluded that European oil & gas firms are recently implementing climate change into their business strategy. Even entire sections were dedicated to the adaption of electric vehicles. Former research confirmed the shift towards transportation as a service and the increasing popularity of car, bike and ridesharing. The international Transport Forum even found that only 3% of the current car fleet is required to fulfill all transportation needs. Consequently, a peak in oil demand is expected by researchers. Not only because of the adaption of electric vehicles and the decrease in car ownership, but also influenced by the Paris Agreement as the agreement plans to abundance fossil fuels. A peak in oil demand is predicted and therefore, the carbon intensive IOCs need to diversify their business in line with the Paris Agreement. Thus, investments in renewable energy and transportation are expected. Statistical analyses confirmed the first hypothesis, IOCs are performing more investments in renewable energy and transport after the Paris Agreement. The second hypothesis showed a significant increase in stock price in the three days after the investment compared to the stock price three days prior to the investment. Which shows a positive effect of the transactions on the stock price. However, the third hypothesis, a positive effect of the selected investments of IOCs on the revenue of IOCs was not significant. Above all, this research confirmed the influence of the Paris Agreement on the strategies of European IOCs and the increasing interest in Renewable energy and new forms of transportation.

Contents

List of Abbreviations

Abbreviation	*Explanation*
CO2	Carbon Dioxide
EV	Electric Vehicle
GHG	Greenhouse Gases
ICE	Internal Combustion Engine
IEA	International Energy Agency
IOC	International Oil Company
OPEC	Organization of Petroleum Exporting Countries

1. Introduction

New transportation start-ups are popping up everywhere; last month another Uber competitor began operations in Amsterdam. All these ride-sharing platforms are prompting people to question whether they even need their own car. The people who still choose to buy a car might think twice about the type of car they buy as oil- and petrol-powered cars become decreasingly desired by governments. For example, several big cities have already introduced low-emission zones to ban polluting cars and meet the Paris Agreement.

The Paris Agreement is a global agreement introduced by the United Nations to slow global warming and lower emissions. Although the agreement did not directly mention oil or cars as the cause of global warming, research shows otherwise. The International Energy Agency (IEA) published a study that concluded that transportation counts for 25% of global carbon dioxide (CO2) emissions and that the emissions continue to rise in the transportation sector (IEA, 2017). This has resulted in increasing pressure on governments to introduce various policies and incentives to boost the attractiveness of electric vehicles. To this end, some countries have already introduced car emission bans or tax discounts for electronic vehicles (EVs) (Van der Steen et al., 2015). EVs are better for the environment as they have zero emissions; however, this is only true if they are powered by renewable energy. Significant investment in renewable energy is necessary in order to increase the percentage of renewable energy consumed by individuals and companies (IEA, 2017).

The transportation and energy sectors have generated many new investment opportunities, as the power of the transport sector is shifting. Now more than ever, oil and gas companies face tremendous threats, considering that their revenue largely depends on the use of fossil fuels for the transportation sector. Unger confirmed this threat; his research concluded a significant negative impact of EVs on crude oil demand (Unger, 2015). Oil and gas companies must adapt their strategy to the increasing emphasis on renewable energy and lower emissions in order to survive. It is rare that a decades-old sector is expected to change so rapidly. What happens to the big oil and gas companies if everyone switches to ride-sharing platforms and electric cars? How quickly can oil and gas companies adapt to the changing environmental concerns and remain the strong companies they once were? The answers to these questions depend on the policies of governments, the technological improvements of EVs, and the share of renewable energy in the energy mix to make EVs 100% emission free and start massive adoption. Oil and gas companies should invest in new forms of transportation and the development of renewable energy technology, such as solar and wind energy. Otherwise they risk significant decrease in revenue as the transportation sector decreases its dependence on fossil fuels.

This thesis will explain the influence of the Paris Agreement on the strategy and performance of European oil and gas companies. It aims to ascertain whether oil and gas companies have increased their investment in the new transportation and renewable energy sectors in the wake of the Paris Agreement. Beyond that, it will examine whether these activities have influenced oil and gas companies' stock prices and performance. The changes in the oil and gas and transportation sector have only recently begun; therefore, there exists a lack of scientific research on the recent investment strategies in the oil and gas market.

This thesis will focus on the following research questions:

1. Are oil and gas companies increasing their investment in the transportation and renewable energy sector following the Paris Agreement?
2. What is the influence of these investment activities on the stock prices of oil and gas companies?
3. What is the influence of these investment activities on the performance of oil and gas companies?

Chapter 2 provides the theoretical background of the research. First, the global warming effect will be explained and the resulting agreements to combat global warming will be discussed. Second, oil dependency and the expectation of a peak in oil demand as a result of environmental awareness are outlined. Third, the relation of global warming and the transport sector is explained in combination with upcoming trends, including EVs and car ownership. Then the strategies of investors and the four selected European oil companies according to climate change are discussed. Chapter 3 provides information about the selected data and the observations of the datasets. Chapter 4 discusses the and results of the obtained analysis. All the results will be discussed and checked for limitations and at the end a conclusion will be drawn.

2. Literature review

2.1 The Greenhouse Effect

Global warming and the effect of CO2 were first recognized nearly 200 years ago and first calculated in 1986 by a Swedish chemist. He predicted that doubling the amount of CO2 would lead to an increase in global temperatures of 5 to 6 degrees. At the time, this was not a cause for concern as he predicted that doubling the amount of CO2 in the atmosphere would take at least 3,000 years and that people would enjoy the better temperatures, especially in colder countries (Houghton & Firor, 1995). Not until 1979 did researchers realize the threats of global warming. Following this, a group of scientists advised the US President Council to take mitigating steps immediately (Leiserowitz, 2007). However, it took until 2015 for widespread realization that something must be done globally within a limited timeframe.

Researchers found that the average global surface temperature had already increased between 1.1 and 1.6 degrees Fahrenheit. Such an increase was attributed to the Greenhouse Effect. Greenhouse gases (GHGs), such as CO2 and N2O, are affecting the temperature on earth. This effect is named after a greenhouse, as it works almost the same. The sun shines through the atmosphere during the day and the earth's surface warms up in the sunlight. But, GHGs in the atmosphere prevent the heat from sunlight from escaping at night and increase the temperature on earth slowly. The more CO2 we put in the air, the more sunlight gets trapped and warms the planet (Houghton et al., 1992). Melting ice at the earth's poles, due to the increasing temperature, results in increasing sea levels, floods, and the extinction of some animal species including penguins (National Geographic, 2018). Researchers found that global warming could put 20-30% of plant and animal species at risk of extinction (Bakker, Maat, Wee and Sierzchula, 2014). Additionally, weather patterns have become more extreme, resulting in longer periods of drought and making it difficult for farmers to produce food; in some countries it has resulted in a lack of fresh water as well (National Geographic, 2018). To avoid the dangerous impacts of climate change, scientists have estimated a limited amount of greenhouse gases that can be released into the atmosphere. This amount is called the carbon budget and it aims to limit global warming to an increase of 1.5-2 degrees (Rogelj et al., 2016). Meeting the carbon budget requires urgent global changes. As Europe is one of the largest energy consumers and the largest emitter of GHG in the world, it faces significant challenges in meeting the carbon budget (Liobikiene and Butkus, 2017).

2.2 International Agreements to Prevent Global Warming

The European Union presented a new strategy in 2010 to rebuild Europe after the economic crisis, which also took into consideration climate change. It aimed to achieve smart, sustainable, and inclusive growth that would rebuild Europe in a better way. In fact, one of its top priorities was to promote a more resource-efficient, greener, and more competitive economy (EC, 2010).

The European Commission proposed five ambitious, yet attainable, targets for 2020. One of the targets concerning the environment reads:

"Reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30%, if the conditions are right; increase the share of renewable energy sources in our final energy consumption to 20%; and a 20% increase in energy efficiency."

Achieving this target means reducing emissions and oil dependence significantly and quickly, while also maximizing the potential of new technologies (European Commission, 2010). The EU presented several proposals to achieve the targets, including developing an infrastructure for electric cars to modernize and decarbonize the transportation sector. This would have significant benefits, as oil consumption accounts for 35% of global CO2 emissions, and 65% of the oil demanded is allocated to the transportation sector (Van de Graaf and Verbruggen, 2015).

In addition to the Europe 2020 Agreement, more countries realized the threat of global warming and the desire to prevent it. In December 2015, the United Nations adopted a new global agreement to combat climate change: The Paris Agreement (Rogelj et al., 2016). This agreement, signed by almost 200 countries worldwide, aims to strengthen the global response to the threat of climate change (UNFCCC, 2015), with the overarching goal of:

"Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."

One of the guidelines to achieve this overarching goal, as stated in article 2, is to make finance flows consistent with lowering greenhouse gas emissions. New investments are needed to reach global peaking of GHG emissions as soon as possible (UNFCCC, 2015).

To ensure the achievement of the agreement's long-term goal, each country's progress will be tracked every five years. This will help countries moving to more ambitious actions to meet their long-term goals. This stocktaking should not only focus on emissions reduction, but also on the adaption of new policies and strategies, and their effects (Kinley, 2017). This five-year stocktaking keeps the countries committed and motivated. Every country sets their own targets with the one condition that every new target be an improvement over the previous targets. There are no consequences for countries that do not meet their targets; thus the Paris Agreement is more a political encouragement than a legally binding agreement (UNFCCC, 2015).

Every country sets different targets. For example, France announced that it would ban all petrol and diesel cars by 2040 and ban coal from its energy usage to meet the Paris Agreement (Othman et al., 2018). President Trump is less motivated to prevent global warming and announced that the USA would withdraw from the Paris Agreement on the earliest date possible, November 2020. In response, several states of the USA formed the United States Climate Alliance to continue following the guidelines of the Paris Agreement with or without President Trump (Dong et al., 2018).

2.3 Global Oil Dependency

Countries should reduce fossil fuel dependency to meet the formerly mentioned targets. Thus, the global agreement effectively implies a complete reorganization of the world's energy mix; in particular, this has specific impact on the transportation industry. Agreeing to the Paris Agreement is directly related to a commitment to phase-out fossil fuels entirely by the end of the century (Soltani-Sobh et al., 2016). Net zero emissions should be met in 2050 to meet the Paris Agreement (Rockstrom et al., 2017).

About 65% of the available budget to keep global warming below 2 °C has already been used, which increases the pressure of regulations, customers, and society to force a reduction in carbon emissions (Rogelj et al., 2016). This reduction is especially expected from carbon-intensive firms in the energy and manufacturing sectors. Thus, protecting the climate means increased threats for international oil companies (IOCs) (Cadez & Czerny, 2016; Krane, 2016).

Decreasing CO2 emissions to net zero will be a challenge, as the population, global GDP, and the demand for energy are all increasing (Royal Dutch Shell, 2017). The use of fossil fuels should be replaced by renewable energy in order to meet the increased energy demand and Paris Agreement (IEA, 2017).

2.4 Peak Oil

Several researchers nowadays are predicting the date of an oil demand peak, after which oil demand will drop significantly. However, this was not the case in the 1950s. A geologist named Hubbert claimed that the finite amount of oil would generate a supply peak (Hubbert, 1956). The hypothesis dominated economic thinking and policy making for decades. Oil scarcity increased oil prices between 2004 and 2014, because oil companies needed hundreds of billions of dollars to invest in new technologies to extract oil deeper from the ground (Brandt et al., 2018). The investments led to extreme improvements in extraction technology and discoveries of new oil sources (Dobbs, 2018). The increasing productivity combined with modest demand growth even generated oversupply in 2014, which resulted in an oil crisis (Rendall, 2016).

These days a peak in oil demand is expected to happen, both in response to the Paris Agreement and as a result of the increased competition from renewable energy (Brandt et al., 2018). Environmentally friendly technologies and trends in the transportation sector are cutting oil demand even further. The transportation sector currently accounts for 65% of oil demand, but this share is decreasing due to EVs and the decrease in car ownership. The other 35% of oil demand is mainly for industrial usage, buildings, and power generation. However, the oil demand in this second group is not expected to make up for the loss in demand. These predictions pose a major threat to countries whose GDP largely depends on oil exports and companies whose revenue depends on oil products (Graaf and Verbruggen, 2015).

The International Energy Agency (IEA) has concluded that world oil demand would need to decrease by at least 0.8% each year until 2040 in order to meet the global warming goal of a less than 2-degree increase. This would imply a peak in oil demand around 2020 (Van de Graaf and Verbruggen, 2015).

Various efforts have been considered to reduce oil dependency. Governments are pursuing ambitious initiatives, decreasing their reliance on fossil fuels, and diversifying their energy economies (Yong et al., 2015). The adoption of EVs, influenced by the environmental goals, is the main reason for a suspected peak in oil demand or even an oil crash. In 2016, there were over one billion internal combustion engines (ICEs) in the world. ICEs are traditional vehicles powered by gasoline or diesel. In contrast, there were only two million electric cars, which made an oil crash seem unlikely (IEA, 2017). However, it is not required to replace all gasoline cars to reach an oil crisis. The oil crash in 2014 was a result of an oversupply of only two million barrels a day. If oil demand shrinks enough to cause the same oversupply of two million barrels, it will result in an oil crash as well. Each EV replaces 15 barrels of oil a year; thus, an oil crash might happen in 2023 if the adoption rate of EVs remains the same (BNEF, 2016).

2.5 Changes in the transport sector

The growing concern of climate change stimulated the agreements in Europe, as well as globally, to cut emissions by 80% before 2050. The attempt to decrease emissions is shared by different sectors, but the transportation sector set the most ambitious targets. The sector plans to reduce its emissions by 95% (Rajoo et al., 2017). Besides the effects of traditional transportation on global warming, urban pollution is also crucial, as it causes health problems. With the environment and personal health at stake, it is important to change the world, in particular the transportation sector, towards an environmentally friendly future (Vreugdenhil, 2017). This is achievable in two ways: decreasing the number of cars on the road and replacing ICEs with EVs.

2.5.1. Reduction of car ownership

New transportation solutions are already reducing the needs for private car ownership. Research conducted by the International Transport Forum examines the impact of changing car ownership to a car-sharing model. It found that for a medium city, like Lisbon, only 3% of the current car fleet is required to fulfill all transportation needs. Total vehicle kilometers could be reduced by 37%, resulting in lower costs and emissions (International Transport Forum, 2016). This is a key opportunity for decarbonizing the transportation sector. Research by Malbach et al. also found that people could travel more efficiently. For example, 50% of all car trips made in the UK, the Netherlands, and the US are less than 5 miles. Alternative transportation modes could be used for those trips, such as ride-hailing or bike-sharing (Malbach et al., 2009). Car ownership will be less common in the future and Mobility-as-a-Service will become the new standard. Mobile payment options, apps, and location tracking will provide ease of use and functionality for global adoption. The traditional product-led business model will change to a service model by introducing bike-, electric scooter- and car-sharing, as well as car renting and carpooling. The responsibility and risk will be transferred to the service provider and the emissions will be reduced following the decrease in car ownership (Gould et al., 2015).

2.5.2. Increase in electric vehicles and renewable energy

The second way to change the transportation sector to a more environmentally friendly sector is to replace high-emission cars with EVs, as was already mentioned before. Plug-in hybrid electric vehicles (PHEVs) and battery electric vehicles (BEVs), collectively referred to as EVs, use electricity as their main power source and have zero emissions if they are powered with renewable energy (IEA, 2017). EVs are a potentially important technology to help reduce greenhouse gas emissions, local air pollution, and vehicular noise (Coffman, Bernstein and Wee, 2016).

Governments can stimulate electric vehicle adoption. They can introduce incentives and lower the adoption barriers to make EVs more attractive (Jaffe et al., 2005; Yong et al., 2015). The benefits of EVs on the environment are not reflected in electric vehicle prices, which results in market failures and is the main adoption barrier. Research found that EVs become competitive if there is a maximum purchase price premium of 20% compared to ICEs and a 60% increase in charging availability. The research showed that 63% of respondents mentioned purchase price as the biggest barrier to EV purchase (Tran et al., 2013), mainly because of the high battery prices, as most batteries account for 49% of the price of EVs (Coffman, Bernstein and Wee, 2016). EVs are expected to be price competitive without financial government incentives in 2025 (BNEF, 2018).

The relatively high purchase price of EVs, limited driving range, and long charging time are currently the main barriers to EV purchase. However, the accelerating technological evolution of EVs, in particular the improvements to battery technology, and the concerns of people about the environment have increased the popularity of electric vehicles. Massive adoption of electric vehicles is predicted as technological improvements are combined with price reductions, government incentives, policies, and an improved infrastructure (Teixeira and Sodre, 2018; Lutsey, 2015). BNEF predicts that 54% of new car sales and 33% of the global car fleet will be electric by 2040. It predicts an inflection point in adoption between 2025 and 2030, as EVs become price competitive based on total cost of ownership (BNEF, 2017).

However, electric vehicles may seem clean, they are only 100% emission free if renewable energy is used to power them, instead of electricity generated by coal. Renewable energy is any energy source that is naturally refilled, like energy derived from solar panels, windmills, or through geothermal or hydroelectric action. IEA expects a 43% increase of global renewable energy capacity, mainly led by solar panels (IEA, 2017). A change in energy mix, the share of primary energy sources in global energy consumption, is required to meet the Paris Agreement, and investments are requisite. Norway is the leading global country in renewable energy, with almost 100% renewable energy use in its energy mix. Other European countries are improving their energy mix as well. For example, in Germany, renewable energy usage has increased from just 3.1% in 1990 to 17% in 2010 and is projected to increase to 28.6% by 2020 (Nguyen et al., 2016). One of the main problems with renewable energy is the threat of voltage and frequency instability. However, the deployment of EVs in the energy market can compensate for the fluctuations in the electric grid (Mwasilu et al., 2014). Globally, electricity consumed by electric vehicles is expected to double by 2022, which automatically solves the major barrier of renewable energy adoption (IEA, 2017). Investments in renewable energy are, alongside investments in EVs, required to meet the clean energy demand of the transportation sector and the Paris Agreement.

2.6 Strategies and Opportunities IOCs

2.6.1 EV forecasts

The question remains of how seriously IOCs take the threat of EVs and to what extent they are adopted. The Organization of Petroleum Exporting Countries (OPEC), which represents 14 oil-exporting nations, presented a forecast in 2015 of the EV market. The organization estimated 46 million EVs on the road by 2040; only a year later they changed their forecast by nearly 500% to 266 million EVs. This clearly shows how the oil industry can underestimate the threat of EVs. After all, OPEC was not the only one changing their forecast. Exxon Mobil adjusted their 2040 expectations from 65 million to 100 million EVs, and BP increased their outlook by 40%, to 100 million EVs by 2035 (BNEF, 2016). The major reasons for these underestimations are the above-mentioned technology improvements and the bold statements of automakers. For example, Volvo aims to change to an all-electric and hybrid fleet by 2019. Volvo’s CEO, Håkan Samuelsson, even said: “This announcement marks the end of the solely combustion engine-powered car” (Vaughan, 2017).

IOCs are confronted with the need to reposition their business strategies, as it is estimated that 33% of current oil reserves and 50% of gas reserves must stay in the ground to meet the Paris Agreement (Zhong & Bazilian, 2018). This turns an amount of the proven fossil fuel reserves in stranded resources and the investments made in this sector into stranded assets. This means that they lose their economic value prior to the end of their economic life, or "book" life, and the assets need to be written off, resulting in a loss for the investor (Bos & Gupta, 2018).

"Trillions invested in oil will be lost and trillions invested in renewables will be won, the power of nations will shift" (BNEF, 2016). According to BNEF, however, the situation could be less dramatic, especially if one remembers the remarkable flexibility of OPEC—oil companies have survived several price crashes in the past (Wallington et al., 2017). The most desirable strategy, especially from the point of view of global welfare, is a diversification of the main business of oil companies (Van de Graaf & Verbruggen, 2015).

2.6.2 Changing investment strategies

Shareholders of IOCs are also calculating risks and putting pressure on the carbon-intensive companies to diversify their business. Some large investors are even changing their strategies and banning investments in IOCs. Recently, Norway's 960bn USD sovereign wealth fund—the Swedish AP7—announced their divestment from firms that violate the Paris Agreement or are lobbying against climate policies. The World Bank has decided to stop funding IOCs as well (Zhong & Bazilian, 2018). Additionally, other investment funds are changing their strategy towards environmentally friendly investments. The 45bn USD Dutch pension fund for the metal industry aims to improve its ESG (Environment Sustainable Governance) policy by connecting 10% of their assets with the United Nations' sustainability targets. This is in line with the policies of the 189bn USD Dutch healthcare pension fund PFZW and the 387bn USD ABP fund (IPE, 2017).

In response, IOCs have started to invest in renewable energy and in the new environmentally friendly transportation sector. Total and Shell changed their investment strategies; even BP has followed this trend and started to invest in renewable energy, after abandoning their solar energy investments in 2011 due to disappointing results. In 2016, Statoil established an investment arm dedicated to investments in clean energy. They also recently changed their company's name to Equinor, as they seek to evolve from an oil and gas company to a broad energy company. IOCs have completed more than 428 transactions in clean energy; their ambitions are also reflected in their yearly clean energy budget (Bloomberg, 2017). Besides renewable energy, advanced transportation is emerging; as the IOCs seek to diversify, more transportation eschews gas for electricity (Hirtenstein, 2017). Recent moves from Royal Dutch Shell and Total indicate that they are expanding their business focus towards the transport sector.

Shell is acting on the threat of global warming, as the company is currently changing their business to be in line with the Paris Agreement. Their department of new energy states that IOCs should reduce their carbon footprint even faster than society, because their starting point as carbon-intensive firms is higher. Therefore, Shell is already investing in new mobility, for example with their recent acquisition of New Motion, an electric vehicle charging company, but the necessary energy transitions require enormous levels of investments and they are thus expecting to increase their investment activities in new energy. The company tries to reduce the emissions of their current activities, but most of the reductions will be a result of a changing portfolio. Shell expects that there will be no fossil fuels in the power sector after 2060 and no ICE vehicles sold anywhere in the world after 2050. The company's changing strategy is an attempt to reduce the risk of having assets that are uneconomic to operate or oil and gas reserves that are uneconomic to produce. The company plans capital investments of 1-2 billion US dollars for 2018; however, this is only a small part of the 25 billion US dollar general investment budget (Royal Dutch Shell, 2018).

Total is also counting on electric vehicles, but with less ambitious forecasts. The company expects that 25% of the global fleet accounts for EVs, but Total expects that the decrease in oil demand from passenger vehicles will be covered by an increase in trucks and buses. Total's focus is on increasing the energy efficiency in existing cars, but they also announced plans to increase the EV-charging infrastructure. In May 2017, the company acquired Pitpoint, a European leader in providing clean vehicle fuel, including EV-charging stations. Total is also actively supporting car-sharing and believes that the traditional car ownership model is supplanted by the sharing mobility models. Besides the emerging focus on mobility, Total is strategically investing in renewable energy for some time now; the company started with a 60% acquisition of US-based SunPower in 2011 and is increasing their investments in line with the Paris Agreement to reach their goal of becoming a responsible energy major (Total, 2017).

BP was one of the first IOCs to "go green" and invest billions in renewables. The company even adopted the slogan "Beyond Petroleum", as BP linked their conservative business with global warming. The company started investing in solar as early as 1981 and was the number 2 solar company in the world. As new entrants came in the market, solar supply outreached demand and the price of solar decreased strongly. BP exited the solar sector completely before 2011 as it could not make enough money with solar (Miller, 2013). Today, BP is moving back to renewable energy, as the company expects renewables to account for 40% of the energy increase. The increase in energy is mainly influenced by the mobility revolution. The company implemented the possibility of a global ICE ban in their 2018 strategy, as this could result in a 66% presence of EVs in the global fleet. BP suspects that EVs and sharing mobility are decreasing the oil demand and a global ICE ban could increase the EV presence to 66% of the total car fleet. Their forecast shows that BP still expects an 85% share of ICEs in the global fleet in 2040 if there is no ICE ban. However, the limited 15% of EVs will count for 30% of the vehicle kilometers driven. As part of the mobility revolution, BP is exploring how the company could use their retail stations to keep serving customers under changing energy demands. The company invested in Freewire, an electric charging solution, and Storedot, an electric battery company. BP plans to offer fast charging solutions at their retail sites in the upcoming future (BP, 2018).

Although most IOCs see global warming as a threat to their business, Equinor believes it is an opportunity. The company is developing their business in support of the ambitious Paris Agreement. Equinor already reduced 10% of the CO2 emissions in the production of each barrel of oil last year. The company's climate strategy announced that the company wants to invest around 15-20% of their annual capital expenditure in new energy solutions by 2030. Windfarms are already part of their business scope since last year (Equinor, 2018). Besides renewable energy, the company recognizes the emerging green shift in the transport sector. However, regulations and incentives by governments as well as investments in electrification of the global fleet are necessary to drive the shift (Equinor, 2017). Equinor started investing in mobility with their investment in Chargepoint, the world's largest electric vehicle charging network, in 2016 (Chargepoint, 2016).

The research of Zhong and Brazilian scanned the investments of IOCs, including the previously mentioned investments, and found that IOCs are particularly active in funding the scaling-up phase of start-ups that have already showed financial performance. Moreover, they are looking for start-ups with a strong suite of investors, as this limits the responsibility of IOCs to mentor start-ups in unknown markets and reduces the risk of loss of returns (Zhong & Brzilian, 2018).

3. Methodology

The recent developments in the transport sector and the renewable energy sector, influenced by the Paris Agreement, evoke certain reactions. These reactions are especially expected from IOCs, in response to the international realization that oil consumption must be reduced to prevent global warming. Oil and gas companies are facing revenue losses as they approach peak oil demand in the near future. This makes them more eager to invest in the new transportation and renewable energy, to change or expand their business strategy. This thesis will examine if IOCs are indeed investing more in new transportation and renewable energy in response to the Paris Agreement. Secondly, it will test the relation between these investments and the stock prices of IOCs and then the relation between these investments and the revenue of IOCs.

Hypothesis 1

The Paris Agreement aims to fight climate change and reduce the use of fossil fuels. This is incontestable influencing the investment strategy of IOCs, as they are active in a carbon intensive sector. Therefore, the first hypothesis examines the effect of The Paris Agreement on the investment strategies of IOCs.

$H0_1$: Oil and gas companies increase their investment activity in transportation and renewable energy in response to the Paris Agreement
Ha_1: There is no relation between the investment activity of oil and gas companies in transportation and renewable energy and the Paris Agreement

A dummy variable named: *AfterParis* will be used to split the time frame in two periods, namely the period before the Paris Agreement and the period after the Paris Agreement. The dummy variable equals one if the period after the signing of the Paris Agreement is selected and the dummy equals 0 if the period before the signing of the Paris Agreement is selected. The dummy is used to find the effect between the number of transactions performed by IOCs and the Paris Agreement. A linear regression will be performed to test the relation, with the number transactions as the dependent variable and the dummy variable of the Paris Agreement as the independent variable.

$$Transactions = b_0 + b_1 * AfterParis + e$$

The null hypothesis will be accepted if the test implies a significant relation between the Paris Agreement and the number of transactions performed by the selected IOCs. Accepting the null hypothesis is inextricably linked to the conclusion that there are more transactions of oil and gas companies in the new transportation and renewable energy sector after the Paris Agreement.

Hypothesis 2

The second hypothesis examines the effect of the selected "green" transactions of IOCs on the stock prices of the company. Past and current investors in oil and gas companies are increasingly refocusing their investment strategy towards companies that are in line with the Paris Agreement. The stock price of oil and gas companies is expected to be influenced by the Paris Agreement and especially positively influenced by the performed investments by IOCs that are in line with the Paris Agreement.

$H0_2$: Investments in transportation and renewable energy have a positive effect on the stock prices of oil and gas companies
Ha_2: There is no relation between the investments of oil and gas companies in transportation and renewable energy and their stock prices

For the second hypothesis, a general linear model (GLM) repeated measures will be performed. A GLM repeated measures ANOVA is used to compare two or more group means where the participants are the same in each group. This usually occurs in two situations: first, when participants are measured multiple times to report changed; or second, when participants are subjected to more than one condition and the response to each of these conditions wants to be compared. The first situation is applicable for this hypothesis, as testing the effect on the stock price before and after the Paris Agreement is of interest. This model is used to not only understand the effect of the selected transactions on the stock price, and testing this effect before and after the Paris Agreement but also to test the difference in strength of the effect before and after the Paris Agreement. Meaning, testing the interaction effect of the Paris agreement and the performed investment on the stock price. A general linear model is more extensive than a regression, because the output is not limited to the effect of one or more independent variables on a dependent variable. It also tests the interaction effect of two independent variables. The model makes it possible to understand if the effect of a selected transaction on the stock price is stronger after the Paris Agreement.

A general linear model consists of a dependent variable and two independent variables. One of the independent variables is named the within-subject-variable, the within-subject-variable measures the same independent variable on two or more points in time. In the repeated measures design, the dependent variable represents the measurements of one variable for the different levels of the within-subjects factor. The within-subjects factor will have as many levels as there are repetitions. In this hypothesis, it measures the stock price of an IOC 3 days before a selected transaction and 3 days after the transaction, with the transaction as the dependent variable influencing when the stock price is measured. The other independent variable is named the between-subject-variable, this variable measure between different subjects and splits a group in two different samples. In this case, it measures between two periods, before and after the Paris Agreement.

The independent variables are the dummy variable *AfterInvestment,* which is measured 3 days before and 3 days after the transaction, and the dummy variable *AfterParis.* The first dummy variable, *AfterInvestment,* equals 0 if it shows the stock price three days prior to the investment and equals 1 if it shows the stock price 3 days after the investment. This is the within-subject-factor, this effect measures how much the stock price tends to change over time, influenced by a selected transaction.

The second dummy, *AfterParis,* equals 1 if the period after the signing of the Paris Agreement is selected and equals 0 if the period before the signing of the Paris Agreement is selected. *AfterParis* is the between-subject-factor, as it divides the data set into two groups and explains the interaction effect between the two periods.

The dependent variable is the investment; however, this variable cannot be seen directly in the equation below. But the variable is present as the time: t of the stock price. The stock price refers to the day of the investment and S*tockprice (t-3)* to the stock price three days before the investment and *Stockprice (t+3)* to the stock price three days after the investment. The measurements of the stock price are therefore completely linked with the investment.

The equation bellows shows that the stock price three days after the investment is influenced by the stock price three days before the investment, adding the effect of the Investment, the effect of the period in which the investment occurs, namely before or after the Paris Agreement, and the interaction effect.

$$Stockprice\ (t+3) = Stockprice\ (t-3) + b_1 * \ AfterInvestment + b_2 * \ AfterParis \\ + b_3 * AfterInvestment * AfterParis + e$$

The null hypothesis, which states that transactions have a positive effect on the stock price, will be accepted if the GLM finds a significant effect for the lag3 and lead3 variables. Besides potentially accepting the null hypothesis, this model also explains the effect of the Paris Agreement on the stock price and the interaction effect of the Paris Agreement and the stock prices before and after a transaction.

Hypothesis 3

The third hypothesis concerns whether the presumed increase in stock price is in line with an increase in performance and thus an increase in revenue. Stock prices normally increase if an increase in revenue is expected. However, this could be not the case for this specific research because the investments are more a security for an emissions-free future and not currently a large part of oil and gas companies' business performance, as most of the investments are in startups. However, this will be extensively discussed in the discussion section if this is the case.

For now, the assumption will hold that the selected investments by oil and gas companies in new transportation and renewable energy sectors have a positive effect on the performance, and thus the revenue, of the companies. Based on this, the following hypotheses are formulated:

$H0_3$: The investments in transportation have a positive effect on the revenue of oil and gas companies
Ha_3: There is no relation between the investments of oil and gas companies in transportation and renewable energy and their revenue

The dependent variable is the quarterly revenues and the independent variable is the number of transactions for each quarter. A regression will be performed to test the effect of the selected transactions on the revenue of the IOC in the same quarter. Respectively the test will be performed for the revenue one quarter later and two quarters later. The lead variables: *Revenue (t+1)* and *Revenue (t+2)* are generated to test for a delayed effect of the transactions on the revenues of IOCs. This test will be used to prove the positive relation between the number of transactions of an IOC and the revenue of that company. The null hypothesis will be accepted if the regression finds a significant effect. The test will be performed three times, for the three different revenues:

$$Revenue = b_0 + b_1 * Transaction(t) + e$$
$$Revenue(t+1) = b_0 + b_1 * Transaction(t) + e$$
$$Revenue(t+2) = b_0 + b_1 * Transaction(t) + e$$

If the null hypothesis cannot be rejected, it means verifying the positive response of the number of transactions of an oil & gas firm on the revenue of that company.

4. Data

Real-world data is seldom perfectly normally distributed. Therefore, this assumption can be considered reasonably met if the shape of the data graph looks approximately symmetric (Pallant, 2013). Observation of the data sets does not hand enough prove that it does not meet the normal distribution standards.

Data about the transactions, stock prices and revenues of IOCs has been collected and put into three different data sets, because different time frames are used for all three hypotheses. The data is measured on a yearly basis for the first hypothesis, as the transactions in the years before the Paris Agreement are compared with the transactions in the years after the Paris Agreement. The data set of the second hypothesis shows the transactions and stock prices on a daily basis, because the stock price is available every day. The third data set is structured on a quarterly basis, as revenue is made public every quarter.

The null hypothesis might be rejected when it is actually true. This is referred to as a type 1 error and is a common problem in smaller datasets. A small data set makes it a bigger challenge to obtain significant results and increases the risk of a type 1 error. The dataset used in this research is restricted to only the data of moments when there were transactions. This is critical for the hypotheses, but it also decreases the size of the data set. There is always the risk of reaching the wrong conclusion while testing the hypotheses. As the data set used is small, the risk of type 1 error is common and should be taken into account when drawing conclusions (Pallant, 2013). The significance level is the criterion used for rejecting the null hypothesis; it indicates how much confidence there is in the obtained results. It is harder to reach the significance level if a small data set is used; while, in a large dataset, a very small correlation might reach significance (Pallant, 2013).

Four companies are selected in the oil and gas sector, namely; BP, Equinor, Total, and Shell. These companies are chosen for two reasons. First, they are all headquartered in Europe, which is the focus area of the thesis. Second, these companies are among the biggest companies in their sector and therefore their data was easily available.

Hypothesis 1

In order to test the first hypothesis - the relation between the Paris Agreement and investments in new mobility and alternative energy by oil and gas companies - data about the number of "green" investments by oil and gas companies is obtained. Investments in renewable energy and new transportation are measured on a yearly basis within a selected time frame starting 2012 and ending 2018.

Capital IQ was used to find transaction data, as all companies are publicly traded companies. Capital IQ is a research and analysis software and data company that serves thousands of investment managers, investment banks, private equity funds, advisory firms, corporations, and universities. The company provides people with research and analysis on publicly traded companies, including historical investment data, which can easily be exported to Excel (Phillips, 2012).

Besides the yearly investment data, a dummy named *AfterParis* was created to split the data into two timeframes: 0 equals before the Paris Agreement or until 12 December 2015, and 1 equals after the Paris Agreement or after 12 December 2015.

There are a couple of things that stand out while observing the data in SPSS, as shown in table 1. The dataset does not contain any outliers or missing data, as all the values are between 0 and 9, which means that the whole dataset can be used. The average amount of transactions is higher after the Paris Agreement, compared to before the Paris Agreement. IOCs performed yearly on average 1.000 transaction before the Paris Agreement and 3.420 transactions after the Paris Agreement. The data set does not prove non-normal distribution; Graph 1 shows a histogram of the standardized residuals, which shows that almost all data points are between -2 and 2, and thus usable for regressions (See appendix graph 1).

Table 1: Descriptive statistics

	N	Minimum	Maximum	Mean	St. Dev
#Transactions *Before 12-12-2015*	16	0.000	2.000	1.000	0.894
#Transactions *From 12-12-2015*	12	0.000	9.000	3.420	2.466

N=28

Table 1 – Hypothesis 1: Description of the number of transactions before and after the Paris Agreement

There is a total of 28 data points from the four companies, and for each company there is data for seven years. The average number of transactions before the Paris Agreement is 1, while the average number of transactions after the Paris Agreement is 3.42.

Hypothesis 2

To test the second hypothesis—the influence of environmentally friendly investments on companies' stock prices—stock price data is required. This data is also retrieved from Capital IQ. The closing price is selected for every company on a daily basis. The currency of the selected stock prices is not of interest, as the correlation between stock price and investments will be tested and the stock prices of different companies will not be compared. A dummy is created for the previously used investment data, with 0 equals no transactions on that specific day and 1 equals one or more transactions. There is also a lag variable created, Lag3, which shows the stock price three days before the transaction. There is also a lead variable created, Lead3, which shows the stock price three days after the transaction. The data is retrieved for a period starting June 1, 2012, and ending June 1, 2018. There are some missing stock prices, as the stock market is not open on weekends and several holidays. If the investment is made on a day without stock price information, the investment will be recorded on the next available day. However, this adjustment was only required two times.

Observing the dataset provides important information. First, there are 116 observations as there is a total of 58 investments; for each investment, the stock price is obtained for the three days before the transactions and three days after the transaction. Second, the average stock price of oil and gas companies is higher in the period before the Paris Agreement, compared to the period after the Paris Agreement. Third, the average stock price three days after the transaction is higher, compared to the average stock price three days after the transaction, as shown in table 2. This is in line with the expectation that transactions in renewable energy and new transportation have a positive effect on the stock price of the investing company. Shown for the period before the Paris Agreement and the period after the Paris Agreement.

Table 2: Descriptive statistics

	Mean	Std. Dev.	N
Before 12-12-2015			
Stockprice (t-3)	40.729	13.107	18
Stockprice (t+3)	41.116	12.670	18
After 12-12-2015			
Stockprice (t-3)	37.167	15.162	40
Stockprice (t+3)	37.369	15.261	40

N= 116 with t = day of a selected transaction

Table 2 – Hypothesis 2: Descriptive statistics of the stock prices 3 days before and 3 days after a transaction divided in two periods: before and after the Paris Agreement

Hypothesis 3

The third hypothesis requires the revenue data of the companies. The revenue data is also retrieved from Capital IQ and is only available on a quarterly basis. The number of investments is now distributed over the different quarters, starting in Q2 of 2012 and ending with Q1 of 2018, as the revenues of Q2 of 2018 were not yet available at the time of this study.

Two more lead variables are generated namely: Revenue (t+1) and Revenue (t+2). For the first regression, the normal revenue variable is used, which contains 96 observations. The second regression contains 92 observations and the third regression contains 88 observations, as shown in table 3. The average number of transactions is 0.510, with a maximum of 3 transactions in 1 quarter and a minimum of 0 transactions. Graph 2 shows a histogram of the standardized residuals of the revenue variable. The graph shows that almost all data points are between -2 and 2, and thus usable for regressions (See appendix graph 2).

Table 3: Descriptive statistics

	N	Minimum	Maximum	Mean	St. Dev
Revenue	96	10087.000	118047.000	56121.598	31037.225
Revenue+1	92	10087.000	118047.000	55302.225	30672.400
Revenue+2	88	10087.000	118047.000	54505.666	30374.963
Transactions	96	0.000	3.000	.510	.871

N=372

Table 3 – Hypothesis 3: Descriptive statistics of the revenues, including lead1 and lead2, and the transactions

5. Results

Hypothesis 1

The results of the regression of the first hypothesis indicates a linear relation between the dummy: *AfterParis* and the transactions, as the two variables are correlated (See appendix table 2). A linear regression is used to test the effect of the Paris Agreement on the transactions in renewable energy and new transportation. The number of transactions is used as the dependent variable and the dummy: *AfterParis* is used as the independent variable. The results obtained with the regression are significant at a 1% level, as shown in table 4.

Table 4: Regression

Dependent variable: Transactions	b	Std. Error	t	Sig.
Constant	0.875	.436	2.296	.030
AfterParis	2.417	.665	3.632	.001

N=28

Table 4 – Hypothesis 1: Regression analysis of the number of transactions before and after the Paris Agreement

Therefore, the first hypothesis cannot be rejected at the 1% level:

$H0_1$: Oil and gas companies increase their investment activity in transportation and renewable energy in response to the Paris Agreement

To further explain the effect, the constant term has a value of 0.875and the dummy has an effect of 2.417, resulting in the following equation:

$$Transactions = 0.875 + 2.417 * PostAgreement + e$$

Which means, the signing of the Paris Agreement increases the number of transactions by 2.417.

Hypothesis 2

The data illustrated that the stock price is higher 3 days after a transaction, compared to 3 days prior to a transaction. A general linear model is used to test if the influence of a transaction on the stock price is significant. However, this model also examines the effect of the Paris Agreement and if the effect of a transaction is stronger after the Paris Agreement, compared to before the Paris Agreement.

Table 5: General Linear Model

	Type III Sum of Squares	df	Mean Difference	F	Sig.
AfterInvestment	2.147	1	0.294	3.660	.061
AfterParis	331.582	1	-3.562	.785	.380
*AfterInvestment * AfterParis*	.210	1	-3.360	.359	.552

Table 5 – Hypothesis 2: General Linear model of the stockprice lag3 and lead3 and the interaction effect with the Paris Agreement

The results are shown in table 5. The dummy *AfterInvestment* has a significant effect, meaning there is significant prove that the stock price of an oil and gas company is higher 3 days after a selected transaction, compared to three days prior to the investment. This effect has a mean difference of 0.294, meaning the stock price three days after a transaction is on average 0.294 higher, compared to the stock price three days before the transaction. Therefore, the second null hypothesis cannot be rejected at a 10% significance level, because 0.061<0.01. Concluding*: Transactions in transportation and renewable energy have a positive effect on the stock prices of oil and gas companies.*

The general linear model is providing insights in the between-subject-factor and the interaction term as well. Although, this is not directly influencing the hypothesis, it might be interesting. The dummy *AfterParis* measures the difference in the stock price before and after the Paris Agreement. This effect is negative, as the average stock price is lower after the Paris Agreement. This effect is not significant at a 10% level either, meaning: there is no significant prove that the Paris Agreement is influencing the stock price of an IOC.

The model shows the interaction effect as well. The interaction effect *AfterInvestment * AfterParis* is not significant at a 10% significance level and therefore, there is no significant difference between the effect of a transaction on the stock price before 12 December 2015, compared to after the Paris Agreement. There is no prove that the effect of a selected investment on the stock price is bigger after the Paris Agreement. Graph 3 in the appendix shows that the effect might even be bigger before the Paris Agreement, as the line looks a bit steeper, however there is no significant prove for this.

Hypothesis 3

The correlation matrix of the third hypothesis (See appendix table 3) shows no significant correlation between the number of transactions and the revenue of an IOC. The different revenue variables are extremely correlated; however, this is not of interest.

Three linear regressions are used to test the effect of the selected transactions on respectively, the revenue of the same quarter, the revenue one quarter past the transaction (Revenue+1) and the revenue two quarters past the transaction (Revenue+2). The revenue is used as the dependent variable and the number of transactions as the independent variable. The results obtained with the regressions show a positive effect of transactions on the revenue in the same quarter, the next quarters and 2 quarters later. For example, shown in table 6, a transaction has a positive effect of 2893.001 on the revenue in the same quarter. However, the effects of all three regressions are not significant at a 10% level.

Table 6: ANOVA Revenue (t)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	602513363.215	1	602513363.215	.623	.432
Residual	90911875158.565	94	967147608.070		
Total	91514388521.780	95			
	B	SE	β	t	Sig.
Constant	54644.962	3684.358		14.832	.000
Transactions	2893.001	3665.317	.081	.789	.432

Table 6 – Hypothesis 3: Regression analysis of the transactions in one quarter and the revenue in the same quarter

Table 7: Anova Revenue (t+1)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	1042043869.544	1	1042043869.544	1.109	.295
Residual	84570406992.825	90	939671188.809		
Total	85612450862.369	91			
	B	SE	β	t	Sig.
Constant	53429.585	3657.412		14.609	.000
Transactions	4006.945	3805.032	.110	1.053	.295

Table 7 – Hypothesis 3: Regression analysis of the transactions in one quarter and the revenue of one quarter past the transaction

Table 8: Anova Revenue (t+2)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	807562481.132	1	807562481.132	.874	.352
Residual	79461838529.086	86	923974866.617		
Total	80269401010.218	87			
	B	SE	β	t	Sig.
Constant	52859.828	3687.679		14.334	.000
Transactions	3811.414	4076.882	.100	.935	.352

Table 8 – Hypothesis 3: Regression analysis of the transactions in one quarter and the revenue of two quarters past the transaction

The third null hypothesis, which is tested on three different levels, should be rejected due to lack of a significant effect at a 10% significance level. Which means:

Ha_3: There is no relation between the investments of oil and gas companies in transportation and renewable energy and their revenue

6. Conclusion and discussion

Analyzing the strategical and environmental reports of IOCs concludes that the companies are implementing climate change into their business strategy. In specific, IOCs even dedicate entire sections about EV adaption into their planning and business performance expectations. Information about car ownership is limited in the strategy reports of IOCs, however research confirmed the shift towards transportation as a service and the increasing popularity of car, bike and ridesharing. The international Transport Forum even found that only 3% of the current car fleet is required to fulfill all transportation needs. Thus, car ownership is expected to decrease, forming another threat for IOCs or another investment opportunity. Information about the changed investment plans of IOCs towards an environmental friendly approach of the transportation and energy sector were also represented in the strategy report. However, IOCs were not the only sector to change their investment approach in line with the Paris Agreement, activities of investment funds are also shifting towards a better environment. For example, Norway's sovereign wealth fund stopped investing in carbon intensive firms in response to the Paris Agreement. Altogether, there is enough evidence to expect a shift in investments of carbon intensive firms such as IOCs. Former research explained the peak oil theory and the dependence of IOCs on the transport sector. This confirmed the expected threat of IOCs. After the theoretical background, data is gathered to test the three hypotheses.

As predicted, observing the dataset of the first hypothesis shows more investments in the selected sectors performed by IOCs after the signing of the Paris Agreement. Statistically analyzing the hypothesis confirmed the null hypothesis on a 1% significance level. Therefore, the first null hypothesis cannot be rejected. IOCs are investing significantly more in renewable energy and transportation after the Paris Agreement.

Observing the data in the second hypothesis confirms the expectation. The stock price is higher three days after the transaction, in comparison with the stock price three days prior to the transaction. A general linear model confirms this and the second null hypothesis cannot be rejected at a 10% significance level, if we compare the stock price 3 days prior to the transaction with the stock price 3 days after the transaction. The average stock price three days after a transaction is 0.294 higher, than three days before the transaction. However, a significant effect cannot be found if we use data of stock prices closer to the transaction, for example 1 day prior to the transaction and 1 day after the transaction. This can be explained by the delay in reaction of investors and therefore stock prices. The interaction effect of the transactions and the Paris Agreement is not significant, which means that the effect of transactions on stock prices of IOCs is not stronger after the Paris Agreement, compared to before the Paris Agreement.

Statistical analyses of the third hypothesis does not confirm a significant result between the transactions and the revenue of IOCs. However, a positive effect of the investment activity on the revenue of IOCs is detected, but this effect does not reach significance. This effect can be found on the revenue of the same quarter, but also on the revenue of the two quarters after the transactions. But as this result is not significant, the null hypothesis will be rejected. The investment activities of IOCs in renewable energy and transportation do not have a significant positive effect on their revenue, nor the revenue one or two quarters after the transaction. This could be explained by the size of the investments, compared to the size of the IOC itself. IOCs are multinational firms with a high revenue respectively to companies in other sectors, an investment in a relatively small company outside their business scope might not influence their revenue directly. The investments are probably more an insurance for the expected carbon free future than an attempt to improve their revenue right now. This might be the reason for the lack of significant proof of the relation between investments and the revenue of IOCs.

This research outlined the trends in the new transport sector, the growth of renewable energy in the energy mix, the threat of peak oil demand and the influence of the Paris Agreement on transportation and renewable energy. These trends altogether led to increased investments of IOCs in renewable energy and transportation. A significance effect in the first hypothesis confirmed this. The stock price is also positively influenced by the "green" transactions of IOCs, as confirmed by the second hypothesis. The fact that the revenue is not significantly influenced by investments in the mentioned sectors could be due to the relatively small investments compared to the yearly revenue of IOCs in underdeveloped markets.

7. Limitation and further research

It is worthwhile to mention that the findings are limited to certain restrictions. The first restriction is the lack of previous studies in this research area. This is mainly because the signing of the Paris Agreement was only three years ago and partly because the mobility sector is still underdeveloped, although changing fast. The theoretical research is therefore mostly focused on the Paris Agreement and strategy or environmental reports of IOCs. There were only a few researchers who have investigated the connection between transport or the investment strategy of IOCs and the Paris Agreement. As the transport sector is changing rapidly, older papers are often outdated, as the forecasts of EV adaption increases every year. The second restriction is due to the limited scope of this research in two levels. First, only Europe is researched, and therefore the results cannot be generalized on a global level without further research. Second, information about other projects of IOCs in renewable energy and transportation are not considered, while those activities could influence the stock price, revenue and could be a result of the Paris Agreement. Third, the general market fluctuations are not considered. For example, in the second hypothesis the general fluctuations in stock price are not examined and for the third hypothesis the global changes in revenue are not compared with the fluctuations in revenue. The last restriction is the use of the signing date of the Paris Agreement as a turning point. The Paris Agreement was of course already a point of discussion before the signing and could thus already effect the investments before the selected turning point. However, investments require some preparation and research indicated that IOCs were underestimating the effects of the Paris Agreement in the beginning. Taken this into account, it is justified to assume that this effect will be limited.

There are several directions for future research that would undoubtedly have a scientific impact. Most importantly there is the need for a feasible global research on this topic, as the Paris Agreement is executed on a global level as well. This would increase the possibility of finding significant results because of a larger dataset. Furthermore, there is a demand for more research related to car ownership and the forecasted number of cars on the road in the future, especially combined with the peak oil theory.

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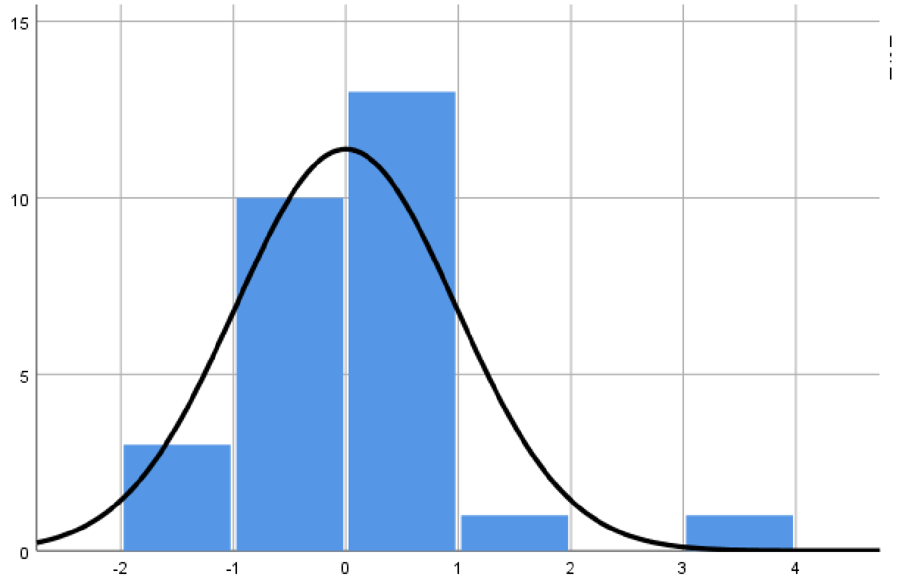
9. Appendix

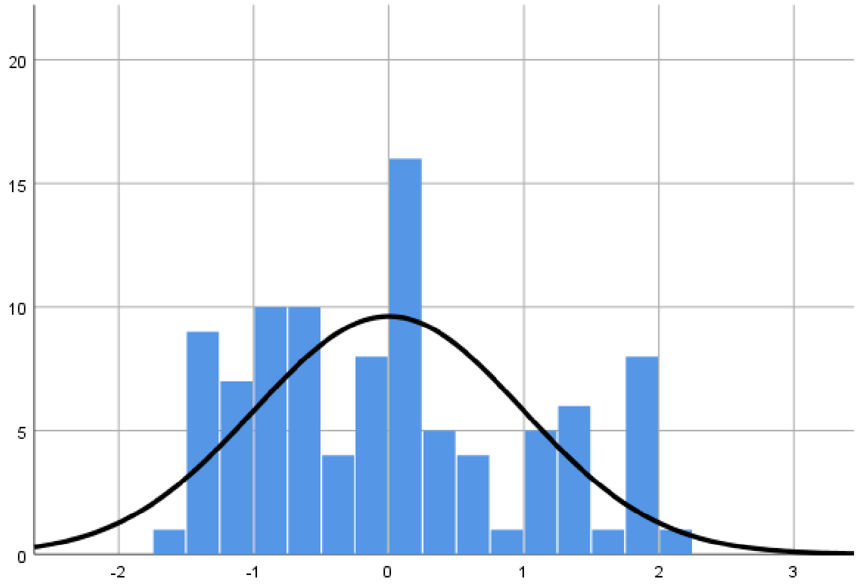
9.1 Graphs

Graph 1: Histogram of the standardized residuals



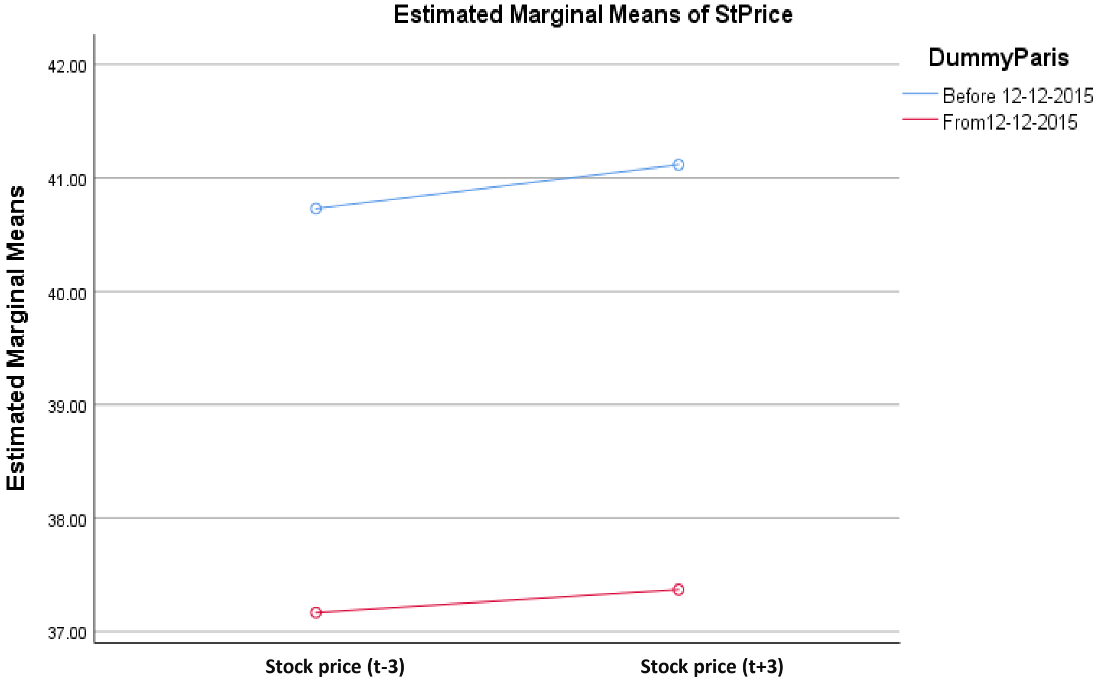
Graph 1 – Hypothesis 1: Histogram of the standardized residuals, with as dependent variable the transactions

Graph 2: Histogram of the standardized residuals



Graph 2 – Hypothesis 3: Histogram of the standardized residuals, with as dependent variable the revenue

Graph 3: Effect of the investments and the Paris Agreement on the Stock Price of IOCs



Graph 3 – Hypothesis 2: Graph of the effect of the investment before and after the Paris Agreement

9.2 Tables

Table 1: Descriptive statistics

	Dummy	N	Minimum	Maximum	Mean	St. Dev
Lag3	0 *Until 12-12-2015*	18	23.840	66.790	40.729	13.107
	1 *From 12-12-2015*	40	17.400	62.500	37.167	15.161
Lag1	0 *Until 12-12-2015*	18	24.140	66.910	40.727	12.991
	1 *From 12-12-2015*	40	17.130	62.990	37.311	15.211
Stockprice	0 *Until 12-12-2015*	18	24.300	65.400	41.003	12.886
	1 *From 12-12-2015*	40	17.010	63.790	37.376	15.264
Lead1	0 *Until 12-12-2015*	18	24.820	65.260	40.968	12.790
	1 *From 12-12-2015*	40	16.980	64.240	37.388	15.313
Lead3	0 *Until 12-12-2015*	18	24.490	65.100	41.116	12.670
	1 *From 12-12-2015*	40	16.950	64.240	37.369	15.261

N=290

Table 1 – Hypothesis 2: Descriptive statistics of the stock prices before and after a transaction divided in two periods: before and after the Paris Agreement

Table 2: Correlations

		#Transactions	Dummy
#Transactions	Pearson Correlation	1	.580
	Sig. (2-tailed)		.001
	N	28	28
Dummy	Pearson Correlation	.580	1
	Sig. (2-tailed)	.001	
	N	28	28

N = 28

Table 2 – Hypothesis 1: Correlation matrix of the number of transactions before and after the Paris Agreement

Table 3: Correlation matrix

		Rev	RevTplus1	RevTplus2	Transactions
Rev(t)	Pearson Correlation	1	.981	.954	.081
	Sig. (2-tailed)		.000	.000	.432
	N	96	92	88	96
Rev(t+1)	Pearson Correlation	.981	1	.980	.110
	Sig. (2-tailed)	.000		.000	.295
	N	92	92	88	92
Rev(t+2)	Pearson Correlation	.954	.980	1	.100
	Sig. (2-tailed)	.000	.000		.352
	N	88	88	88	88
Transactions	Pearson Correlation	.081	.110	.100	1
	Sig. (2-tailed)	.432	.295	.352	
	N	96	92	88	96

N =372

Table 3 – Hypothesis 3: Correlation matrix of the revenues and the number of transactions