Assessing the Impact of Oil Price Changes on the Profitability of Listed European Oil Companies Engaged in Refining Activities

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Abstract:

Oil has remained globally as an essential energy source throughout the decades since industrialization at the end of the 18th century. The changing oil prices have significant, far-reaching impacts on economies, companies, and consumers. Regardless of acknowledging the existence of impacts, the identified consequences in prior research on the industry level are not aligned.

This study investigates the relationship between oil prices and the profitability of listed European oil companies with refining activities. The purpose is to identify whether the companies' profitability still depends on crude oil price changes, as prior research suggests. Crude oil has been an essential input since refining it into different petroleum products has brought major profits for these companies. However, this relationship could be changing due to increased pressure to transfer green energy and the impacts of oil price shocks on profitability during a crisis.

The quantitive method is OLS regression with pooled data from the Compustat database and Thompson Reuters. This study includes yearly data from 26 listed European oil companies from 2000-2022. The dependent variable, ROE, is the company's profitability measure, and the main control variable of interest is the Brent Spot price, which represents the oil price. The other control variables included are the company size, debt, current ratio, and assets turnover and dummies to represent the identified crisis periods.

The study's findings suggest that oil prices negatively impact the European listed oil companies' profitability. Furthermore, the companies' profitability also suffered in 2020 during COVID-19, when oil prices fell. Still, in 2022, when the oil prices peaked during the Russian war in Ukraine, the impact of oil prices on companies' profitability was positive. The contribution of this study is to provide comprehensive and recent information on this complex relationship that can be helpful for regulators, managers, and academics.

Keywords: Oil price, crude oil, oil, oil industry, oil price shock, profitability and ROE

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

For years, it has been acknowledged that oil prices affect economies. Oil prices affect energy prices, and all economies and companies need energy in some form. Furthermore, 30% (Enerdata, 2022) of the world's energy production is from oil. Additionally, evidence shows that oil price increases have predicted most of the recessions in the US (Hamilton, 1983).

1.1 Background

Oil is the world's most important commodity and a commonly used energy source in its different forms (Genova & Falola, 2005); hence, its price is also an important factor. The oil price is, in the end, defined by supply and demand (Genova & Falola, 2005); thus, it can differ significantly during different periods. Since oil is an essential energy resource, its price impacts economies, companies, and end consumers.

Oil had an essential role in industrialization worldwide at the end of the 18th century and in the 19th century since it was the critical input for modernizing the transportation industry (Genova & Falola, 2005). Oil was refined into petroleum and kerosine, which were cheaper and more flexible than coal, and the demand for them grew drastically since more people could afford a car (EKT Iteractive, 2023). Furthermore, transportation became cheaper, which offered more growth and expansion opportunities for different companies.

Oil price changes have far-reaching impacts since, as an essential energy source, the price increase can be transferred to a subsequent party in a supply chain. This price transfer can cause inflation, accelerating even more when salaries increase in conjunction. Furthermore, oil price shocks have different impacts on economies and consumers (Hamilton, 2000) depending on the reason behind them. Positive and negative price shocks have different effects, but based on prior literature, they appear simultaneously with the crises.

Oil price impacts have been researched on macroeconomic and microeconomic levels for decades. But, this study focuses on the effects on a company level; hence, it falls under the microeconomic category. Nevertheless, oil prices are also affected by macroeconomic variables, and they will be introduced in this study as well.

This study focuses on two concepts: the first one is oil price changes, and the second one is profitability. Profitability is one of the ways to measure company performance, and this study focuses more precisely on oil companies' performance. Performance measurement is an essential way to recognize how the decisions made by the management affect the company's success or failure, and this information interests several parties, such as investors, analysts, and the board.

There are numerous ways to measure company performance, but one of the most widely acknowledged methods is DuPont's identity. DuPont's identity is one way to evaluate company performance, and it includes return ratios as follows: return on assets (ROA), return on equity (ROE), and return on investment (ROI) (Sheela & Karthikeyan, 2012). The chosen return ratio for this study is ROE since its characteristics were considered the most suitable, and they will be introduced in the following chapters.

Previous research has been conducted to understand how oil prices affect stock returns, especially around crises such as the financial crisis (Masood et al., 2019; Mollick & Assefa, 2013; Sim & Zhou, 2015; Supriyanto et al., 2021). However, there is little research on the relationship between oil price changes and oil companies' profitability, especially on European listed companies. Most relevant studies focus on the relationship between oil price volatility and stock returns. Nevertheless, some literature exists on oil price volatility affecting oil price profitability (Dayanandan & Donker, 2011; Vătavu et al., 2018; Wattanatorn & Kanchanapoom, 2012).

Furthermore, this paper aims to fulfill the research gap in the area since there exist only a few prior studies on oil prices and oil companies' profitability. Hence, the purpose is to provide more recent research based on data between 2000 and 2022. Additionally, this study will also include three significant crisis periods: the financial crisis, the COVID-19 period, and the Russian war in Ukraine. The last two crises are from recent years, and the prior research was conducted before those crises started. Crises during the period are notable to mention since the level of oil price changes depends on the factors causing it, e.g., during a crisis, other factors, in addition to supply and demand, are also causing dramatic fluctuation (Malliaris & Bhar, 2011).

1.2 Purpose of the study

The motivation behind the study is to recognize if there is a relationship between oil companies' profitability and oil prices. During recent years, such factors as pressure to transfer green energy, sustainability, and fear of insufficient oil supply in the future have given thought to whether oil companies are less dependent on oil prices nowadays.

This study also aims to explain why European oil companies are making record-high profits (Visual Capitalist, 2023) when they have suffered huge losses (Business Day, 2023) after the Russian war in Ukraine started, which caused oil prices to fluctuate even more. This study also considers factors relevant to the oil industry, such as company size and liquidity impact on profitability.

Additionally, the study considers three significant crises, the financial crisis, COVID-19, and the Russian war in Ukraine, which have impacted oil prices.

The research results can help provide information on the relationship between oil prices and oil companies' profitability to the following parties. Shareholders and company management could utilize the results, e.g., when deciding whether to engage in projects that require massive amounts of oil. Governments and legislators who regulate laws related to fuel demand and supply might be able to recognize their impact on oil companies' profitability.

1.3 Scope of the study

This study aims to answer the following research question: *Do oil price changes affect oil companies' profitability?* By oil prices, this study refers to crude oil prices, more precisely, Brent spot price, the world's most-followed crude oil benchmark (S&P Global Commodity Insights, 2021). Oil companies in this study include listed European oil companies with refining activities. Hence, pure oil extraction companies and companies with only distribution activities will be excluded from this study. The data in this study is from the years 2000 to 2022. Oil companies' profitability will be defined using the return on equity (ROE). Additionally, this study considers several control variables, such as size and debt, which are expected to impact profitability.

The structure for the study is the following. The first theory chapter introduces the oil industry and its characteristics. The second theory chapter shows how company performance can be measured and introduces commonly used profitability ratios. After the previous chapters, the hypothesis development is explained, and the study's hypothesis is formulated. After hypothesis development, the research methodology is introduced, including the model estimation and description of the data, followed by results from the research model. And lastly, the limitations and conclusions of the study are discussed.

2 OIL INDUSTRY

This section describes the oil industry characteristics, demonstrates the importance of oil prices, and introduces the previous studies on the topic.

2.1 Importance of oil globally

The oil industry is one of the most critical industries in the world since all around the world, energy is needed, and as noted, 30% of the world's energy production is from oil (Enerdata, 2022). Thus, this commodity has some unique features.

Oil is sometimes called "black gold" since this essential resource has brought billions to oil-exporting companies and countries and has revolutionized the transportation industry (Genova & Falola, 2005). Additionally, not everyone has access to oil reserves; some countries, such as OPEC countries, have more oil reserves than European countries. Furthermore, oil exploration and drilling, part of upstream processes (Genova & Falola, 2005), require at least 4 million USD for only the drilling phase (Tidal Petroleum, 2023). The processes related to downstream refer to refining petroleum and utilizing oil in other production (Genova & Falola, 2005), which requires a proper production plant. The previously described upstream and downstream activities both require a significant amount of capital to be invested before receiving the possible profits.

Genova and Falola (2005) highlight that international politics significantly impacts oil through price since the price is determined by demand and supply. Additionally, they conclude oil is the most important and traded commodity in the world, making it a desired commodity by economies. However, for decades, there has also been discussion of the insufficiency of oil supply and its negative environmental impacts. The previous has caused societies to demand renewable solutions from the oil industry (IEA, 2020). Nevertheless, the role of oil in the world is still notable.

2.1.1 Key players in Europe

The largest oil production countries in Europe are Russia, Norway, the UK, Italy, and France (The Global Economy, 2023). Russian companies such as Rosneft and Lukoil are not displayed in Table 1 since their data from 2022 is not comparable with other European-listed oil companies due to the war in Ukraine. However, the other prominent European listed oil companies from the previous countries are shortly introduced in this section.

Equinor (former name Statoil) is mainly owned by a Norwegian government company established in 1972 (Equinor, 2023). BP is an old British company founded in 1908 and was a state-owned company until it was fully privatized in 1987 (BP, 2023b).

Another British oil giant, Shell, resulted from a merger of Shell Transportation and Dutch company Royal Dutch Petroleum in 1907 (Shell, 2023b). Eni SpA is an Italian-based company founded in 1953 and has had a crucial role in enhancing Italian economic growth (Eni, 2023). Lastly, a French company, TotalEnergies, is also one of the largest European companies (The Global Economy, 2023). Compagnie française des pétroles (initial name) was founded in 1924 to let France operate in the oil and gas industry, and later, in 1999, the company merged with another French company, Elf Aquitaine, and a Belgian company, Petrofina (TotalEnergies, 2023b).

		2022		
Country	Company	Revenue billion USD	Gross profit billion USD	No of employees
Norway	Equinor	149	88.8	22,000
UK	BP	241.4	55.1	30,000
UK	Shell	381.3	78.8	93,000
Italy	Eni SpA	133.4	24	32,000
France	TotalEnergies	263.3	81.6	101,000

Table 1: The largest oil companies in Europe (Yahoo Finance 2023).

All the previously mentioned companies also have operations around the world. However, they are still included in the study sample since they have their headquarters in European countries and they have refining activities.

2.2 History of oil prices

Why do oil price levels matter? And more precisely, crude oil prices. Crude oil is still a crucial energy source used for various purposes, such as in transportation, heating, and producing electricity. Crude oil is refined into different petroleum products for various purposes, but it is also widely used to produce items made from plastic (Bureau of Ocean Energy Management, 2019). Hence, when crude oil prices fluctuate, there are far-reaching impacts on economies, companies, and consumers.

Figure 2 illustrates the yearly oil price (USD) per barrel fluctuation and shows the oil price can change significantly compared to the previous year. Relevant for this study is to note during the three different crises, the oil price has either peaked or fallen. During the financial crisis of 2008, one can see a notable increase in the oil price compared to 2007. Furthermore, in 2020, when COVID-19 was present globally, the oil price dropped compared to 2019. Lastly, in 2022, when the Russian war in Ukraine started and COVID-19 was still present, oil prices peaked, and a significant difference can be seen compared to the years 2020 and 2021.

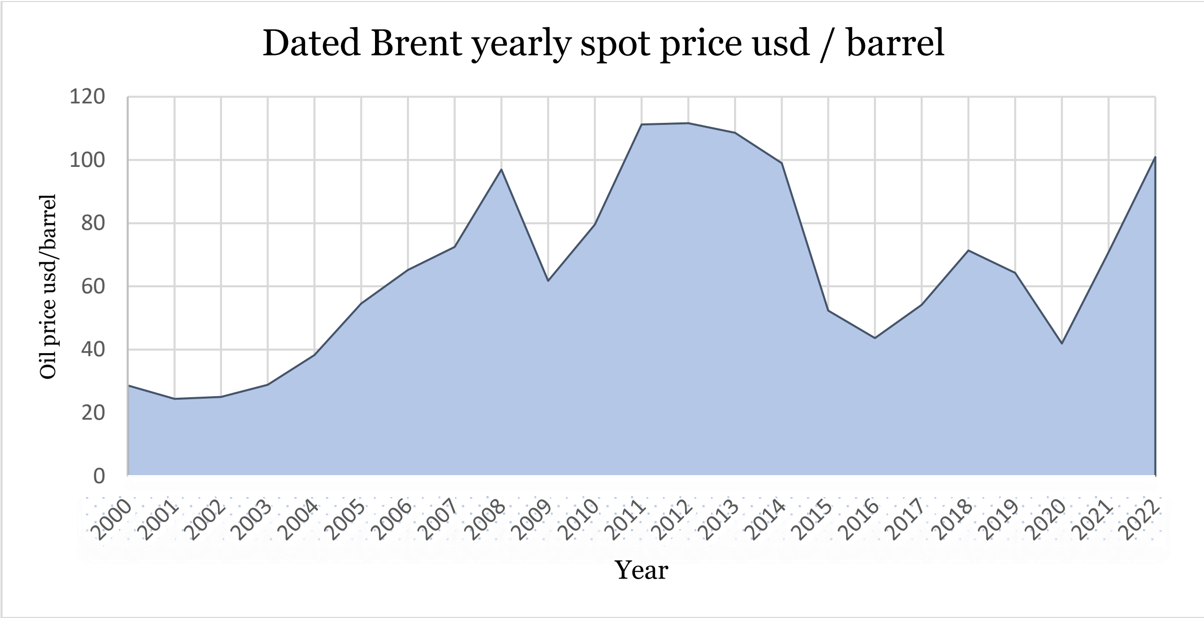

Figure 1: Oil price changes (Thomson Reuters 2023).

On a broad level, oil price impacts can be divided into three different categories, which are impacts on the macroeconomic level, effect on stock returns in general, and effects on companies' returns (Dayanandan & Donker, 2011).

Impacts on the macroeconomic level were discussed and studied already in 1983 when Hamilton discovered a negative relationship between increased oil prices and gross national product (GNP). Hamilton (1983) found a positive association between oil prices and recessions from 1948 to 1972, almost all except for one U.S. recession. Furthermore, evidence suggests oil prices affect economies also through inflation (Hamilton, 1983) since, e.g., more expensive transportation costs can make the companies increase product or service prices to customers. Additionally, high oil prices can cause reallocations in companies (Still, 2007) since most of them are affected either directly or indirectly by oil prices.

Oil price shocks have been recognized to impact economies (Hamilton, 2000; Kilian & Park, 2007; Still, 2007). Especially, sudden oil price increases after the stable period significantly affect economies; they disturb consumer spending and affect companies' activities (Hamilton, 2000). However, the reason for the oil price shock also defines what kind of consequences there are. The common assumption is that the relationship between oil prices and stock returns would be negative (Kilian & Park, 2007; Masood et al., 2019). At the same time, this assumption might not be completely accurate. Evidence shows that the stock market's response to oil price increases depends on the reason for it.

If the oil price increases due to a negative factor, e.g., fear of lack of supply in the future, the relationship has been found negative, but if the oil price increase is due to positive reasons such as global economic growth, the cumulative stock returns were higher (Kilian & Park, 2007). However, Sim and Zhou (2015) found with the quantile-on-quantile (Q.Q.) approach that stock returns in the U.S. improved during a negative oil price shock when the U.S. market performed well. They also showed in their study that the relationship between oil prices and stock returns is weak in the presence of a positive oil shock. Hence, recognizing oil price shocks and the reason behind them during the chosen period for research is essential, but the final results might vary.

The relationship between oil prices and stock returns is widely studied (Masood et al., 2019; Mollick & Assefa, 2013; Sim & Zhou, 2015; Supriyanto et al., 2021; Waheed et al., 2018). Several parties, such as investors, institutions, and companies, are interested in predicting stock returns. Masood et al. (2019) research, which utilized the Arbitrage pricing theory- APT model, suggests some G7 countries, such as Italy, France, Japan, and Germany, have a negative relationship, which indicates the stock market performed worse when oil prices increased. However, evidence from Pakistan based on panel data estimation shows that for most industries, the stock returns increase when oil prices rise (Waheed et al., 2018). Hence, the relationship appears not to be the same among all industries.

Prior research suggests that the oil and gas industry has better performance during oil price shocks caused by increased demand, when again, e.g., the retail industry and the automobile sector had a weaker performance (Kilian & Park, 2007). The previous was also supported by Bagirov and Mateus's (2019) vector autoregressive model (VAR), which showed that European listed oil and gas companies' performance suffered during the geopolitical crisis in 2014 and the financial crisis in 2008 when oil prices increased. Thus, the industry impacts the relationship between oil prices and companies' performance, and according to evidence, the energy and food sectors are significantly affected by oil price changes (Wattanatorn & Kanchanapoom, 2012).

Some prior literature exists investigating the relationship between oil price volatility and oil companies' profitability. Wattanatorn & Kanchanapoom's (2012) research suggests a marginally significant positive impact of oil prices on the petrochemical industry. They conducted a fixed effect model with a generalized square estimator (GLS), used quarterly return on asset (ROA) as a profitability measure, but excluded risk management from their model. However, Vătavu et al. (2018) reported a marginally negative relationship by utilizing a generalized method of moments (GMM) and used return on assets (ROE) as a dependent variable to describe profitability.

They found oil prices and traded volume have little effect on the UK-listed oil companies' profitability. They highlighted the possibility of oil companies' ease in increasing oil prices to their customers.

Dayanandan & Donker (2011) obtained contradictory results in their study on North American oil companies with a GMM with ROE being the profitability measure. They reported that oil prices statistically significantly positively impact companies' accounting returns. Additionally, they found that the crisis of 9/11 in 2001 did not affect the performance of oil companies in North America, while the Financial crisis 2008 did have a negative impact. Bagirov & Mateus (2019) study, which was performed with VAR, supports the previous; they found that oil prices positively affect Western European listed oil and gas companies. Furthermore, the performance of the companies was also negatively impacted by the financial crisis in 2008, as did the recent geopolitical crisis in 2014. Thus, it is essential to recognize wide crises and the reasons behind them during the chosen research period, as they may affect in different ways.

2.3 Oil pricing methods

This chapter introduces the factors such as OPEC, Dated Brent, and Hedging, which affect European oil pricing.

2.3.1 OPEC

Organization of the Petroleum Exporting Countries (OPEC) is an organization that aims to ensure sufficient petroleum supply to consumers, fair income to petroleum producers, and reasonable return for investors in the industry (Organization of the Petroleum Exporting Countries, 2021). OPEC was initially founded in 1960 by major oil-producing countries to prevent income from oil exports from decreasing (Fattouh et al., 2013). The organization is publicly known to be an international cartel. Cartel refers to an agreement between organizations, countries, or groups that agree on prices, significantly impacting supply, especially when the regulated commodity is oil (Cremer & Salehi-Isfahani, 1991). No European country is part of OPEC, but OPEC countries have 80.4% (Organization of the Petroleum Exporting Countries, 2022) of the oil reserves in the world. Hence, changing oil price levels can be expected to impact imported oil pricing significantly in Europe, where there are only a few oil reserves in addition to Russian ones (Statista, 2023).

2.3.2 Oil benchmark indexes

In the oil industry, benchmark oil indexes are crucial for various reasons, and the most notable ones are as follows. Refiners and distributors receive prompt information on roughly how much the oil or refined product values, oil markets have become more liquid, and oil market price is also utilized in risk management (ICE, 2023a).

A few of the most frequently followed oil benchmark indexes in the global oil market are Dated Brent and West Texas Intermediate (WTI), published in USD per barrel.

Dated Brent, often referred to as Brent or Brent crude, is the most followed crude oil index in the world, used for pricing physical oil or oil-refined product spot and term deals (S&P Global Commodity Insights, 2021). The price in the index is formulated based on the trading activities in the North Sea oil market, and the dominant publisher of the prices is Platts (Frino et al., 2016). Hence, Brent is commonly used by European oil companies when selling or buying crude oil. Additionally, there are also Brent futures, which companies can use for hedging or evaluating investments (S&P Global Platts, 2021).

WTI is another one of the most followed oil benchmark indexes in the world. It originates from North America, and most of the traded oil is from Texas (Purple Trading, 2023). Like Brent, WTI is also considered a high-quality oil, and its price is crucial information for oil sellers and suppliers (Purple Trading, 2023). Additionally, there are also WTI Futures, which can be traded electronically (ICE, 2023b) and utilized similarly to Brent Futures.

The reference oil price used in this study is the Brent spot price. The justification is that this research concentrates on European listed oil companies; hence, the geographical area is Europe. Nevertheless, the companies in the sample might have activities outside Europe. However, the assumption is that Brent is more commonly followed in pricing oil and refined products than WTI in these companies.

2.3.3 Hedging

The purpose of hedging is to protect value decreases in risky situations by receiving gains from another investment (CFI, 2023a). In the oil industry, hedging is widely applied since the oil companies are price takers for crude oil (Sadorsky, 2001); hence, the losses can be significant due to high volatility and high volumes. Additionally, the more the company has total assets, the more likely it is to engage with hedging (Haushalter, 2000). Oil companies, especially the ones with refining activities, tend to have significant total assets.

However, according to Modigliani and Miller's (1958) theorem, companies' hedging activities would be irrelevant to firm valuation due to the following "the market value of any firm is independent of its capital structure and is given by capitalizing its expected return at the rate p_k appropriate to its class " (Modigliani & Miller, 1958, p. 268). Yet, the authors have set certain assumptions to the theorem, such as perfectly efficient markets, no taxes, and symmetrical information.

Nonetheless, in the real world, oil companies engage in hedging activities. Numerous hedging strategies are used in oil companies, but often, hedging against oil price risk is done with derivatives that can be bought from the market (Pincus & Rajgopal, 2006).

More precisely, hedging is done by trading futures or options from the exchange, which enables the reduction of the price fluctuation risk but also reduces future profit opportunities if markets are favorable (New York Mercantile Exchange, n.d.). Hence, if the hedging is well performed in the oil companies, it might affect their profitability. However, this study does not include hedging in the empirical model due to the lack of comprehensive and quality hedging data for European companies.

2.4 The impacts of the EU on oil

The European Union (EU) consists of 27 European countries (European Union, 2023), and most of the companies included in the sample of this study are based in those countries. This economic and political union establishes laws, directives, principles, and sanctions that the member countries must follow.

The most recent sanctions relevant to this study are the ones set on Russia and its allies as a consequence of starting a war in Ukraine. The EU has set several economic sanctions, e.g., related to import and export and engaging in any business with Russia, to cause significant damage to the country’s economy until the war is ongoing (European Union & Council of the European Union, 2023). The EU was the largest importer of Russian oil until its ban became effective in February 2022 (CREA, 2023). The ban caused oil prices to peak in March 2022 during 14 year period (Bhaskar & Biswajit, 2023). Hence, excluding Russian oil from the market has significantly impacted oil price volatility.

The EU is also promoting renewable energy sources, and its ambition is to receive 32 % of energy from renewable resources by 2030 and reach climate neutrality by 2050 (European Parliament, 2023). Furthermore, to reduce dependence on fossil energy sources, the legislation is adjusted according to the previous ambitions. In practice, the adjustments are such as removing reduced tax rates for fossil fuels, an obligation to exploit renewable energy in new buildings, and demand specific industries to increase significantly the share of renewable energy as an energy resource (European Parliament, 2023).

The mentioned legislation changes affect the number of European companies directly, and if not, then indirectly. The reason is that the EU companies have to adjust their activities according to EU laws if the industry is affected, and this also impacts their suppliers and customers if, e.g., additional certificates and permissions are required or if some substance or material is forbidden in the future.

While all European countries are not in the EU, most still have business with EU countries, which must follow EU regulations. The previous means, e.g., if a European country that does not belong to the EU would still buy Russian crude oil, an EU country would breach the law if it bought oil of Russian origin. However, several prominent non-EU countries, such as the UK, Norway, and Switzerland, have also imposed sanctions on Russia.

2.5 Sustainability and renewable energy

Oil is considered a non-renewable energy resource since it takes millions of years to form (U.S. Department of Energy, 2023). Thus, it has raised questions regarding oil supply sufficiency and sustainability of oil usage. According to U.S. Energy Information Administration (2021) the world's oil supply is sufficient until the year 2050 to satisfy the demand. However, the previous estimation is based on considering the known oil reserves, and most likely, new ones will be discovered in the future with more advanced technology (U.S. Energy Information Administration, 2021). Nevertheless, the number of oil reserves is not infinite, at least not in the short run.

In addition to concern about oil supply sufficiency, oil also negatively impacts the environment. Oil production and usage causes harmful compounds and emissions such as methane, a greenhouse emission that affects climate change, and numerous carcinogens that have links to causing cancer (Ngene et al., 2016). In addition to oil production, if operations or transportation of oil goes wrong, the result might be an oil spillage. Oil spillages are one of the most harmful forms of pollution; they destroy ecosystems on land and water, and the damage can be long-lasting (Ndeh et al., 2017). One of the largest oil spillages in history is Deepwater Horizon, which happened in 2010 and spilled 134 million gallons of oil into the sea, and the restoration of the area is still ongoing today (National Oceanic and Atmospheric Administration, 2020). Thus, oil companies have multiple matters to consider to ensure safety and sustainability in their activities since the damages caused by oil are also monetary and reputation-wide costly. The Deepwater Horizon 2010 spillage cost more than 65 billion USD for BP (Reuters, 2018), which is a significant amount even for a major oil company.

Renewable energy has been a heavily discussed topic during this decade. Climate change challenges have caused an energy revolution, which has made oil and gas companies reconsider their activities to stay in business in the future (Abraham-Dukuma, 2021). Especially after the Russian war in Ukraine, several European oil companies have started to rethink their strategies regarding fossil raw materials. The reasons for the previous are the restrictions for importing Russian oil and strongly fluctuating oil prices. But the shift had already started before since the companies have acknowledged oil has a limited supply in the world in addition to climate change concerns.

Several major European oil companies, such as Shell, BP, and TotalEnergies, have set a net-zero emission target for the year 2050 (Honma, 2021). Additionally, they claim they will significantly invest in renewable energy solutions and expand their portfolios by utilizing renewable energy sources (BP, 2023; Shell, 2023; TotalEnergies, 2023). However, Bukold 2023 argues companies' annual reports look like the companies have just become aware of the climate crisis and criticize companies for still having high oil production in energy production. Additionally, companies are accused of greenwashing in such ways as including essential information in footnotes where it is more difficult to find, misleading visuals of company activities, and insufficient explanation of numbers (Bukold, 2023).

The previous paragraph demonstrates contradictive views on oil companies' activities regarding green energy. This study aims to consider the possibility of whether oil companies' profitability is less associated with oil prices if there is such an association when they utilize more renewable feedstock. However, there will be no variable in the research model indicating the use of renewable feedstock, but the possible impact is still discussed.

3 PERFORMANCE MEASUREMENT

This chapter introduces how company performance is measured from an accounting point of view and emphasizes the factors that are especially relevant for oil companies.

3.1 Company profitability

The first part of this study focuses on oil prices, but the second part concentrates on oil companies' profitability. Profitability is a broad topic, but essentially, it refers to companies' profits relative to their costs (Gartner Finance Glossary, 2023), i.e., how efficiently the company can create profit (DICU et al., 2019). Hence, the higher the rate, the better the company exploits its resources. Profitability is one of the ways to measure a company's performance. More precisely, financial performance, and this can be done with different profitability measures metrics. The ratios can be divided into two groups, which are *margin ratios* and *return ratios* (CFI, 2023b).

3.1.1 Margin ratios

Margin ratios include metrics such as gross profit, operating profit, and (CFI, 2023b). The below-simplified income statement illustrates the margin ratios. In this scenario, all the margins are calculated by dividing them by total sales revenue; e.g., gross profit of $ 211 million is divided by total sales revenue of $ 500 million, which gives a margin of 42%.

Income statement

$ Million	**2023**	**Margin**
Total sales revenue	500	
Cost of goods sold	289	
Gross profit	**211**	**42%**
Selling, general and administrative expenses	100	
Research and development	25	
Operating profit	**86**	**17%**
Interest expense	6	
Pretax profit	**80**	
Taxes	16	
Net profit	**64**	**13%**

Table 2: Income statement compiled by the author

A higher gross profit margin indicates that the relative cost of sales is lower (Nariswari & Nugraha, 2020), which can be interpreted as efficient usage of supplies and better profit margins. Operating profit margin is used to assess the capabilities of a company's management since a higher rate indicates efficient operations, which can enable those companies to compete at lower prices (CFI, 2023b).

Net profit margin is the final margin that evaluates a company's profitability by considering all costs, interest, and taxes paid; however, it might also include costs and gains that occur once, thus making it difficult to compare among companies (CFI, 2023b).

Other notable margin ratios are cash flow margin and assets turnover (TAT). The first one is crucial for companies to stay positive and rather higher since if there is not enough cash for the company to pay its costs, its costs will increase, and it might need to take expensive loans to cover them (CFI, 2023b). TAT measures how efficiently a company uses its total assets relative to its sales (Nariswari & Nugraha, 2020); however, as with other margins, one should compare the measure among similar companies. For clarity, in this study, total assets turnover AT is equivalent to TAT.

3.1.2 Return ratios

Return ratios show the companies' capability of creating returns for their owners (CFI, 2023b). The most commonly used return ratios include return on assets (ROA), return on equity (ROE), and return on invested capital (ROIC) (CFI, 2023b).

3.1.3 DuPont identity

ROA can be calculated with different returns, but essentially, the purpose is the same. It is to show how efficiently assets generate profit, but a low value is not necessarily a bad value since it is relative among the industries, e.g., asset-intensive industries usually have lower ROAs (Harward Business Review, 2016). Initially, ROA was recognized by an employee in the early 1900s working at DuPont Corporation who noticed popular profitability valuation ratios, total assets turnover, and net profit margin can be combined into return on assets (Sheela & Karthikeyan, 2012). Return ratio ROA can be displayed as follows (Kim, 2016).

$$\frac{Net\ profit}{Total\ revenue} \times \frac{Total\ revenue}{Average\ total\ assets} = \frac{Net\ profit}{Average\ total\ assets}$$

However, there exists inconsistency when calculating ROA. Wahi et al. (2020) use ROA in their study, which is calculated by dividing earnings before interests and taxes (EBIT) by total assets, but CFI (2023b) provides a different formula by dividing net earnings by total assets. Thus, when comparing ROA among different companies operating in the same industry, one should clarify how exactly ROA is calculated. A good example of the previous is companies' annual statements; in order to receive comparable measures, one should calculate the ROA in a similar way for each company to obtain more reliable analysis on comparisons.

ROE measures the rate of return on shareholders' money, i.e., net profit divided by shareholders' equity, and a high ROE indicates that the company can cash without taking a significant amount of debt (CFI, 2023b).

According to DuPont analysis (Sheela & Karthikeyan, 2012) it was formulated as follows: the profit margin, asset turnover, and equity multiplier are multiplied to receive a return on equity.

$$\frac{Net\ profit}{Total\ revenue} \times \frac{Total\ revenue}{Average\ total\ assets} \times \frac{Total\ assets}{Total\ equity} = \frac{Net\ profit}{Equity}$$

Furthermore, ROE is particularly interesting for investors (CFI, 2023b) since it shows how efficiently their potential investment would be used in the company. ROE became more popular than ROA in the 1970s for evaluating a company's profitability when the total assets to equity ratio was adjusted to the DuPont method (Kim, 2016). Contrary to ROA, the new measure of ROE showed the company's profitability considering company debt; hence, the higher ROE became the desired ratio.

The third ratio in DuPont analysis is ROI, which shows how much return has been received from an investment made by a company (Kim, 2016). This ratio indicates whether the operational management is making profitable decisions (Sheela & Karthikeyan, 2012); thus, the ratio measures operational performance. Sheela & Karthikeyan (2012) have shown ROI in their study as follows.

$$\frac{\text{Operating income}}{\text{Total assets}} \times \frac{\text{EBIT}}{\text{Operating income}} = \frac{\text{EBIT}}{\text{Total Assets}}$$

The reason for adding ROI to the DuPont model was to measure factors affecting profitability that are not in the direct control of company management (Sheela & Karthikeyan, 2012). Additionally, ROI provides a clearer presentation of earnings before interest and taxes (EBIT) over total capital compared to ROE; hence, it is frequently used in evaluating leveraged companies (Inderes, 2023).

According to CFI (2023b) ROIC is nowadays one of the most commonly used return ratios when measuring return on investment. More precisely, ROIC measures the return on invested capital and can be defined as follows: EBIT * (1 – tax rate) / (debt value + equity), where EBIT is earnings before interests and taxes (CFI, 2023b). For long-term investors, ROIC can be one of the most relevant profitability measures since it shows how efficiently the company can generate return after capital reallocation (Inderes, 2023). Thus, the measure is most suitable for evaluating the performance of older companies that have returned and have invested capital, while younger companies' ROIC can not reflect their true capabilities yet.

All return ratios included in DuPont's identity have now been introduced, and one can see that measuring profitability can be done with several different ratios, which all have their strengths and weaknesses.

However, this study will use ROE as a profitability measure since it is expected to provide a sufficient overview of companies' profitability by showing how efficiently a company generates return on invested equity (CFI, 2023b) and considers company debt. Furthermore, ROE has been calculated similarly in related prior literature since the formula is relatively straightforward.

3.2 Performance valuation on the market

Stock-listed companies are continuously under pressure to show they are performing well. In the market, companies' shares are actively followed by several parties, such as analysts, investors, and shareholders. In addition to pure accounting variable-related performance measures, the market also evaluates how the company's share is performing. This chapter introduces a few common measures often used to assess a publicly listed company and its shares.

Publicly listed companies' stocks can be bought by anyone from the stock market. Nowadays, this can be done via different stock exchanges such as the New York Stock Exchange (NYSE), Nasdaq, or London Stock Exchange. Often, a stock exchange provides few valuation ratios to evaluate the stock, which are as follows.

Earnings per share (EPS) shows how much earnings are generated per share, and it can be calculated with the following formula: (net income-preferred dividend) / (weighted average number of shares outstanding) (Accounting For Management, 2023). However, EPS can also be calculated by dividing the end-of-period shares outstanding (CFI, 2023c), which enables, e.g., investors to obtain the value with the most recent amount of shares. Regardless of the computation method, the higher the EPS, the better since it indicates a stronger financial position and higher earnings; thus, an investor may see the company as a reliable investment (Accounting For Management, 2023).

Another commonly seen valuation ratio is the price-earnings ratio (P/E), which is computed by dividing share price by EPS, and it indicates what kind of expectations the market has on the company share (CFI, 2023d). This earnings multiple can be utilized to analyze whether the company is a growth stock or a value stock, but it is most useful when comparing companies with similar characteristics (CFI, 2023d) since there is no universally good or bad P/E applicable for all industries.

The last valuation metric introduced in this chapter is a price-to-book ratio (P/B), which is calculated by dividing share price by company book value, and it is often utilized to define if a company is undervalued or overvalued (Finance Strategists, 2023).

As with the P/E ratio, the P/B ratio is the most useful when it is being compared among similar companies, and together with the P/E ratio, it helps an analyst or an investor to see whether the expected growth is in line with the current share price (Finance Strategists, 2023).

There are numerous other metrics and analysis methods to evaluate company value, but the purpose of this chapter was to give a brief overview of how the market is evaluating listed companies' performance. The valuation metrics EPS, E/P, and P/B are often used together when evaluating a listed company. Since the metrics are relative, they are most useful when comparing them between similar companies or assessing the same company during different periods.

3.3 Hedge accounting

Oil companies are often engaged in hedging activities (Sadorsky, 2001). This means oil companies are investing in non-physical activities; a company successful in hedging might have good performance even if the feedstock costs have significantly increased and the price has not been transferred to the customer.

Hedging is an important part of oil companies' risk management activities since it enables them to cover their losses with another investment. Thus, when the companies engage in hedging, they must enclose them clearly, e.g., according to IFRS 9 in Europe, which refers to the following "IFRS 9 specifies how an entity should classify and measure financial assets, financial liabilities, and some contracts to buy or sell non-financial items." (IFRS, 2023b). The reason for the previous is that it is essential in accounting to recognize whether the activity is hedging or speculation. IFRS 9 was created as a response to accounting problems by replacing IAS 39 after the financial crisis in 2008 to align risk management and hedge accounting in companies (PwC, 2016).

Hedging refers to an activity that aims to cover the losses of another investment (CFI, 2023a), e.g., when an oil company has made a physical deal. It can hedge by investing in derivatives that have a negative relationship to obtaining an optimal hedge (Mercatus Energy, 2023). Hence, the purpose is not to profit when the security's price changes but to reduce the risk. Speculation again causes an additional risk whose goal is to make a profit. Thus, IFRS has strict conditions for hedge accounting and requires detailed documentation of hedging relationships and their effectiveness (Schöndube-Pirchegger, 2006). By hedge effectiveness, IFRS 9 requires having an economic relationship between the investments and having a sufficient hedge ratio according to the company's risk management strategy (PwC, 2016).

3.4 Oil reserves in accounting

When oil companies' activities include upstream processes, such as oil exploration and drilling, they most likely have oil reserves. Regarding accounting, oil reserves refer to the economically recoverable amount of oil (Hammond & Craig, 2020). Oil reserve is a valuable industry-specific item in oil companies' balance sheets with some unique features.

Oil reserves have different confidence levels, which describe the estimated amount of oil to be received, and if the level is below a certain threshold, it is considered an oil resource (Hammond & Craig, 2020). However, estimating certainty is not simple; it requires comprehensive data to be analyzed by geologists and engineers to classify reserves into the following categories (PwC, 2017). Global audit company PwC (2017) introduces in their report proved reserves, including sub-categories of proved developed reserves, which means there is already existing equipment to obtain oil. Proved unreserved refers to a situation where significant investment is needed before extracting the reserves is possible. Furthermore, there are two other sub-categories under unproved reserves, which are probable reserves that mean there are, e.g., technical or geographical uncertainties to recover the reserves, and possible reserves are the least likely reserves to be recovered.

In the EU, the listed companies must follow international financial reporting standards (IFRS) while preparing their financial statements (European Commission, 2023). Additionally, UK-listed companies have to follow the UK-adopted IAS (IFRS, 2021), and Norwegian domestic listed companies must comply with IAS regulations originated from the EU (IFRS, 2018). Thus, the reporting of oil reserves must be according to the related IFRS for most companies included in the sample of this study. One of the most relevant standards that oil companies with extracting activities follow is IFRS 6. The purpose of the standard is to align financial reporting in industries with extraction activities (Abdo, 2016). It demands the following: "requires entities recognising exploration and evaluation assets to perform an impairment test on those assets when facts and circumstances suggest that the carrying amount of the assets may exceed their recoverable amount" (IFRS, 2023a).

3.5 Other factors influencing oil companies' profitability

Oil companies' profitability is impacted by profitability measures described in the previous chapter as any other companies. However, some specific industry-specific factors can be considered when reviewing oil companies' profitability. They are introduced as follows.

Oil companies are often capital-heavy companies, which means they often have high fixed costs. High fixed costs proportionally from a total cost also indicate higher operating leverage for the company (Archer & D'Ambrosio, 1972). Hence, it is not necessarily a bad sign if an oil company has high leverage but also a significant amount of fixed assets.

As Genova and Falola (2005) concluded, politics impacts the oil price. The previous also means oil companies are affected by political decisions made by the governments and the EU. Governments can set new regulations in order to enhance transfer to renewable energy usage and reduce fossil fuel proportion in the market. An example of the previous is "uusiutuvien polttoaineiden jakeluvelvoite" in Finland, which refers to a regulation that forces fuel suppliers to supply at least a certain percentage per year (13.5% in 2023) of fuel that is refined from renewable raw materials (Energiavirasto, 2023). Thus, even if an oil company that distributes fuel in Finland would only prefer to sell refined fuel from crude oil, e.g., due to cheaper production and feedstock costs, this is not possible due to regulation.

The oil industry is not highly competitive (Gupta, 2016), since to enter the industry, one requires considerable capital and the trust of the consumers. The previous is not easily obtained when there are major and strong competitors waiting. Less competition in the industry can be beneficial for oil companies to increase their profitability. Bacon (1991) found in his study that oil companies do "rockets and feathers," i.e., they increase the prices quickly when oil prices increase and decrease prices slowly when they decrease. The previous might not be as easy if the industry was more competitive.

4 HYPOTHESIS DEVELOPMENT

The empirical part of the study starts from this chapter. This chapter familiarizes how the hypothesis was developed and explains the research hypotheses and the objective of this study.

4.1 Observations for hypothesis formulation

Initially, it might appear there are only two options for how oil prices affect oil companies' profitability. In a simplified scenario, they either have a negative relationship, i.e., when oil prices increase, the raw material costs increase, but the refined product price remains the same, which would lower product margin. The other option would be for the oil companies to transfer oil price increases to their product prices for the customers, which could minimize the impact of raw material price increases. However, in reality, it is not as simple. There are several factors, such as the size of a company, hedging, and green energy requirements, which can affect the relationship.

In prior research, the relationship between oil prices and oil companies has been identified (Dayanandan & Donker, 2011; Vătavu et al., 2018; Wattanatorn & Kanchanapoom, 2012). However, there are some differences in the results. A marginally significant positive relationship was captured in studies in which samples included listed Thai oil companies and a marginally negative relationship for UK-listed oil companies.

Wattanatorn and Kanchanapoom's (2012) research on Thai-listed oil companies used ROA as a profitability measure, but they did not consider risk management in their study, which means hedging activities were not considered. As hedging is a common activity among oil companies (Sadorsky, 2001), it might have impacted the relationship between oil prices and their profitability. The impact could have been dependent on how efficient and successful oil companies had been in hedging since hedging could have been one of the reasons why a marginally significant positive relationship had been identified. Furthermore, the study used ROA as a dependent profitability variable, which is one of the most common profitability measures (CFI, 2023b), but this measure does not consider company debt, and the debt was not as a control variable in Wattanatorn & Kanchanapoom's (2012) empirical model. Thus, to consider the debt in a company, this study will use ROE in the final empirical model and debt ratio as a control variable. A profitability measure that considers debt is applied due to the evidence from prior literature showing a negative relationship between company profitability and debt (Muscettola & Naccarato, 2015). Hence, ROE is considered a more comprehensive profitability ratio to value company profitability.

A study conducted by Vătavu et al. (2018) investigated how oil price fluctuation impacted UK-listen companies and came to an opposite conclusion compared to Wattanatorn and Kanchanapoom (2012) by identifying a marginally negative significant relationship. However, the significant relationship was only recognized with the GMM model, and there was no significant relationship between oil price and company profitability with other models. Thus, the authors explain this by oil and gas companies passing oil price increases to the customer. Additionally, Vătavu et al. (2018)) had more control variables in their study, e.g., taxation and asset turnover. The purpose of the taxation variable is to show the level of taxes paid, and the higher the taxes paid, the higher the profit. However, taxation might not be the most suitable variable to describe company profitability since, e.g., capital gains can impact the amount of paid taxes and, therefore, distort the profit expectations if they are significantly higher during the year. Contrary to Vătavu et al. (2018) study, it is challenging to include taxation variables in a model when the sample consists of companies from different countries; consequently, each country has different taxation regulations and policies. The previous would make comparisons among the companies in which taxation is done in different countries difficult, and therefore, taxation is not included as a control variable in this study.

Another notable control variable included in Vătavu et al. (2018) study was the asset turnover ratio, one of the profitability measures. This differs from the previously described study conducted by Wattanatorn & Kanchanapoom (2012), who considered assets in the dependent variable ROA. Vătavu et al. (2018) again used ROE as a dependent variable. As asset turnover is one of the control variables, both debt and efficient use of assets are considered in the study. This combination will also be utilized in this study.

Contrary to previously described studies, Dayanandan & Donker (2011) discovered a significant positive relationship between crude oil prices and ROE. Their study was conducted on North American oil and gas companies; hence, the geographic area might also be the reason for different empirical results. This study considered the effect of three significant crises (the Asian crisis, 9/11, and the financial crisis), gearing variable, and company size. During the crises, oil price shocks arose, impacting economies and companies (Hamilton, 2000; Kilian & Park, 2007). However, different crises had different impacts on companies' profitability, and the reason is that it matters what has caused an oil shock. Prior literature suggests that positive oil shocks have caused the gas and oil industry to perform better (Kilian & Park, 2007), and during negative oil shocks, e.g., during geopolitical crises in 2014, European oil companies performed worse.

However, Sim & Zhou (2015) found that during a negative oil price shock, listed US companies performed better. They also noted that the relationship between oil prices and stock returns is weaker when there is a positive oil price shock. This also raises a question: are there more variables to consider when investigating a relationship between oil price and company profitability in a positive oil price shock? Based on the previous, this study will consider crises during the relevant periods with dummy variables.

Unlike other studies described in this chapter, Dayanandan & Donker (2011) considered a size variable that was calculated by taking a logarithm from total assets. This variable makes sense since although listed oil companies are generally large, there are still differences between their sizes. This can be done by comparing the major European oil companies where the revenues and number of employees among the companies differ substantially. However, oil companies with refining activities, exploration activities, or both often have high amounts of assets, which makes assets a suitable variable to compare the company sizes. Additionally, oil reserves are valuable for oil companies, and they are shown in companies' assets on a balance sheet. Hence, the same total assets control variable will be included in this study.

However, it should be noted that Dayanandan & Donker (2011) study had a lower R-square for their fixed effect model than Vătavu et al. (2018) study, which can indicate a less reliable model due to poorer model fit. Although a lower R-square does not necessarily mean an inferior model, it is one of the ways to measure model reliability.

Bagirov and Mateus (2019) captured a statistically positive relationship between listed oil companies' returns and oil prices. Furthermore, the authors reported a significant negative relationship during the financial crisis in 2008 and 2009. Thus, their results were similar to the ones obtained by Dayanandan and Donker (2011), which shows some consistency within the prior literature. The regression model in previously mentioned studies was very similar, which included ROE as a dependent variable, oil price as the main dependent variable, and control variables for size, debt, dummy variables, and interactive dummy variables. However, the main difference between the studies was geographical areas since Dayanandan and Donker's (2011) study concentrated on North American listed oil companies, and Bagirov and Mateus's (2019) sample included Western European listed oil companies. However, neither of the studies considered inventories or hedging in their model, which might impact oil companies' profitability. Due to the inventory's multicollinearity issue with total assets, the additional control variable is also excluded from this study.

Risk management and, more precisely, hedging in his context has not been one of the central concepts in prior studies on oil prices and company profitability relationships. The previous is surprising since hedging is common in the oil industry (Sadorsky, 2001).

It would seem sensible to consider its impact on profitability since it is to cover possible losses. Some studies related to the topic (Bagirov & Mateus, 2019) mention hedging effectiveness in their literature review, but regardless, it is still not included in their empirical part. The reason for not considering hedging while investigating oil prices and oil companies' profitability relationship can be as follows. The lack of comprehensive and reliable data could be one of the main reasons why hedging as a control variable has not been included. This can be recognized in practice by noticing that one of the large and widely used databases, Compustat Global, does not provide hedging-related accounting variables. The reason for this can be different accounting methods worldwide, which do not require similar reporting for hedging activities, e.g., US GAAP or IFRS. Another reason to exclude hedging can be the assumption that the hedging effectiveness and success are similar among listed oil companies. Hence, it is not expected to differ significantly, and for that, it is excluded from an empirical model. A similar assumption is also made in this study; thus, hedging is not included in the regression model.

4.2 Hypothesis formulation

This study investigates whether there is a relationship between oil prices and oil companies' profitability. More precisely, the purpose is to examine crude oil price changes' effect on listed European oil companies' profitability. This chapter initiates how the hypotheses were formulated and the reasonings behind them.

The crude oil price used in this study is based on the crude oil prices published for one of the most followed oil benchmark indexes, Brent Spot Price (S&P Global Platts, 2021). Brent spot price was chosen as an oil price indicator since it is based on trading activities in the North Sea (Frino et al., 2016), hence often followed in European markets.

Companies' profitability is measured with profitability measure ROE, one of the ratios in the widely recognized DuPont identity. The return ratio ROE was chosen as a performance measurement in this study since it shows how efficiently a company generates a return on the invested equity by the owners and also considers the debt (CFI, 2023b).

The null hypothesis implies that there would not be a significant relationship between oil prices and oil companies' profitability. There can be various reasons for this result, but this study assumes they could be as follows. Wattanatorn and Kanchanapoom (2012) introduced the possibility that oil companies could easily increase the oil price to customer prices. This could be shown as an insignificant relationship, but this conclusion would be difficult to prove with the empirical model used in this study. Another reason for not identifying a significant relationship could be the decreased use of crude oil as a raw material. This would imply that oil prices would not impact the oil companies' profitability significantly and could show the use of alternative raw materials, such as renewable source usage, has increased.

However, this assumption should be interpreted with high caution since this study does not focus on investigating whether renewable raw material usage in refining has increased. Efficient hedging can also prevent significant relationships from appearing since it could mean the company has successfully covered its losses against oil price fluctuation. Hence, the oil price would not be identified to impact companies' profitability. Lastly, the size of the company's inventories can enable it to sell products refined from cheaper crude oil with a higher price if the product price is more expensive on the market at the time.

The study's second hypothesis expects a negative significant relationship between oil prices and oil companies' profitability. This relationship was captured by Wattanatorn and Kanchanapoom (2012) and is also considered a possibility in this study. However, a negative significant relationship is also expected in a crisis. The crises are expected to increase oil prices, disturb consumer behavior, and negatively affect companies' profitability, e.g., by reducing sales and increasing other costs in addition to raw materials. Furthermore, three crises from the research period, which have all caused negative oil price shocks, are assumed to provide similar results as in prior literature (Bagirov & Mateus, 2019; Dayanandan & Donker, 2011).

The third hypothesis expects the results from the regression model are expected to be in line with prior literature (Bagirov & Mateus, 2019; Dayanandan & Donker, 2011), which means a positive significant relationship between oil prices and oil companies is expected. The reasoning for the hypothesis is the assumption that when oil prices increase, the oil companies react fast to the raw material cost increase. Furthermore, at the same time, improving their margins since customers are not as sensitive to price increases since the products sold to them, such as petroleum, kerosene, or other fuels, are necessities.

The EU regulates the oil industry in Europe, and the non-EU countries in Europe can also have their regulations on it. The regulations can impact oil companies' profitability since, e.g., tax reductions on petroleum or diesel can bring higher profits if they do not decrease prices to customers in the same relationship. Furthermore, the EU and some non-EU countries have ambitious sustainability and renewable energy goals to drive oil companies to renewable feedstock usage. This can also happen on the country level; e.g., in Finland, fuel distributers must sell a certain percentage of products refined from renewable raw materials. However, the regulation might differ among countries since Russia, especially nowadays after the war in Ukraine, does not comply, e.g., with similar regulations related to renewable energy utilization and climate change reduction. Thus, the Russian companies included in this study are likely to have different characteristics in terms of regulation.

Regardless, the previous Russian-listed oil companies that have refining activities are included in the sample since their relationship between oil prices and profitability is still expected to be similar to other major European oil companies. Moreover, most European oil companies have at least had business with the Russian oil giants; hence, they have also had activities on the Russian market and operated according to Russian regulations.

Numerous factors can affect the relationship between oil prices and oil companies' profitability, and this study might not consider all of them. But, regardless of the previous, the purpose of this study is to identify whether the statistical relationship exists in Europe. Additionally, the oil prices in this study rather describe crude oil prices during different periods and should not be confused with oil price volatility.

4.3 Hypotheses

The main goal of this study is to examine whether there is a relationship between oil prices and oil companies' profitability. Furthermore, the purpose is to answer the research question: *Do oil price changes impact oil companies' profitability?* And identify what kind of relationship and whether it is statistically significant.

The first hypothesis, i.e., the null hypothesis, expects no statistically significant relationship at all between the dependent company profitability variable and the independent oil price variable. The primary purpose of the study is to reject the null hypothesis.

H0 – A significant relationship does not exist between oil prices and oil companies' profitability

The second hypothesis expects a negative relationship and also investigates how strong the existing relationship is.

H1 – Oil prices have a negative relationship with oil companies' profitability

The third hypothesis expects a positive relationship and also examines the relationship's significance level.

H2 –Oil prices have a positive relationship with oil companies' profitability

5 METHODOLOGY

This chapter introduces the research methodology, data, and variables with descriptive statistics and shows how the research model is formulated.

5.1 Quantitative research methodology

This study is conducted with a quantitative research method. More precisely, the applied research method is pooled data regression analysis using the ordinary least squares (OLS) model.

OLS is a nearly 200-year-old research method often used for multivariate analysis, which is suitable for testing a hypothesis where the relationship between dependent and explanatory variables is investigated (Chumney & Simpson, 2006). Multivariate analysis means that there is more than one independent variable (Chumney & Simpson, 2006), which allows a researcher to consider variables that can impact the tested relationship.

However, when utilizing OLS, certain assumptions should be met to receive the most precise results from the regression. Frost (2023) introduces the assumptions as such as follows. The regression is expected to be linear, which means the model fits on some level to the linear pattern, i.e., the variables in the equation are summed up. Additionally, it considers a random error term. The error term should not be correlated with any of the independent variables or the observations, and it should have a constant variance, i.e., heteroscedasticity should not exist. Lastly, multicollinearity should be minimized, which means the independent variables should not be strongly correlated with each other.

5.2 Model estimation

The main idea of this study is an assumption that oil prices affect oil companies' profitability since oil is an essential raw material for oil companies that have refining activities. Hence, in short, the initial estimation of the model is as follows.

$$ROE_\tau = \beta_0 + \beta_1 OP_\tau + \varepsilon_\tau \tag{1}$$

ROE_τ = Return on equity in year t

OP_τ = Crude oil price (Brent spot price) for year t

ROE is one of the most followed profitability variables and return ratios (CFI, 2023b); hence, it is used as a dependent variable to reflect a company's profitability. It shows net profit over equity. Oil price variable OP shows the Brent spot price FOB yearly in USD per barrel. The Brent oil benchmark index was chosen to reflect oil price fluctuations since it is the most commonly followed in European oil markets (S&P Global Platts, 2021).

The reason for using yearly data, e.g., instead of daily or monthly data, is that, unlike the oil price, the accounting variables can not be obtained from public databases daily or monthly.

The next version of the model, which includes the control variables, is shown as follows.

$$ROE_\tau = \beta_0 + \beta_1 OP_\tau + \beta_2 SIZE_\tau + \beta_3 GEAR_\tau + \beta_4 CR_\tau + \beta_5 AT_\tau + \varepsilon_\tau \quad (2)$$

The model includes control variables that are expected to affect the relationship between the dependent variable ROEt and the main independent variable OP_t. Company is assumed to impact company profitability; hence, SIZE. It is included in the model as a natural logarithm to lower heteroscedasticity. Debt variable GEAR is calculated by dividing long-term and short-term debt by total assets. The current ratio CR shows how well the company manages its short-term outflows by dividing current assets by current liabilities. The debt and current ratio are expected to impact the company's profitability in the long and short term. Additionally, asset turnover AT is expected to affect the company's profitability since oil companies tend to have high amounts of assets. It shows how efficiently the company generates revenue relative to its assets (Nariswari & Nugraha, 2020) and is calculated by dividing revenue by total assets.

The final version of the model also includes two dummy variables for three global crises affecting Europe, which were the financial crisis (2008-2009), COVID-19 (2020-2021), and The Russian war in Ukraine (2022).

$$ROE_\tau = \beta_0 + \beta_1 OP_\tau + \beta_2 SIZE_\tau + \beta_3 GEAR_\tau + \beta_4 CR_\tau + \beta_5 AT_\tau + \beta_6 D_1 + \beta_7 D_2 + \beta_8 D_3 + \varepsilon_\tau \quad (3)$$

The purpose of dummy variables D_1, D_2, and D_3 is to consider the impact of three major global crises that have caused oil price shocks during different periods. The previous can be seen in Figure 1, which shows significant oil price drops and increases in the crisis years. During the crisis years, the variables are 1 and 0 for the other years.

5.3 Data and variables

The accounting data for this study was gathered from the Compustat database maintained by Wharton Research Data Services. The oil companies included in the sample of this study were European listed oil companies, i.e., their head offices are located in Europe. Their data was obtained based on the Standard Industry Classification (SIC) code 2911, which covers Petroleum Refining companies, and 5172 is for Petroleum and Petroleum Products Wholesalers. The initial sample included 574 observations from 27 companies.

The companies that did not have headquarters in Europe were removed from the sample. Moreover, fuel distributors and oil companies with only oil extraction activities were excluded.

Accounting data was obtained from 2000 to 2022, including observations that had data for each variable in regression, such as net income, assets and liabilities, and others were excluded. Additionally, outliers were also removed from the data. Furthermore, companies with negative equity were removed from the sample since this would have resulted in ROE with different characteristics than those with positive equity. Thus, the final sample included 26 companies in total and 467 observations.

As the sample included accounting variables from different European countries, the annual report figures in Compustat for some companies were in local currency or euros instead of USD. For most variables in the regression, such as ROE, oil price (OP), debt (GEAR), current ratio (QR), and assets turnover (AT), this was not an issue since the variables are ratios. However, size (SIZE) is not a ratio; hence, to match the currency to the oil price currency, the value of the total assets was converted from the initial currency to USD with applicable exchange rates obtained from Investing.com. Exchange rate risk can impact company figures during different periods, e.g., the RUB was significantly weaker than the USD after Russia started its invasion of Ukraine. However, this risk is not considered since it is out of the scope of this study.

The oil price variable used in this study is equivalent to the yearly Brent spot price. The yearly prices for 2000 to 2022 were obtained from Thomson Reuters and are published in USD per barrel. The yearly Brent spot price is the average daily values published during one year. Hence, the oil price data was received yearly without adjustments and removals.

The variables included in the regression model are shown below in Table 3. It shows raw data in panel A, which has been used to compute the dependent variable ROE and control variables. Panel B includes regression variables and how they were calculated.

Variable	Definition	Description
Panel A	*Raw data*	
NICON	Return	Net Income (Loss) - Consolidated
CEQ	Total equity	Common/Ordinary Equity - Total
DLTT	Long term debt	Long-Term Debt - Total
DLC	Short term debt	Debt in Current Liabilities - Total
LCT	Total current liabilities	Current Liabilities - Total
REVT	Total revenue	Revenue - Total
AT	Total assets	Assets - Total
ACT	Total current assets	Current Assets - Total
Panel B	*Regression model data*	
ROEt	Return on equity	Net Income (Loss) - Consolidated / Common Equity
OPt	Oil price	Dated Brent Spot Price FOB yearly
GEARt	Debt variable	(Long-Term Debt + Short term Debt) / Assets
SIZEt	Size variable	Ln(Assets)
CRt	Current ratio	Current Assets / Current Liabilities
ATt	Asset turnover	Revenue / Assets
D1	Dummy variable	Dummy variable for financial crisis in 2008-2009
D2	Dummy variable	Dummy varable for COVID-19 2020-2022
D3	Dummy variable	Dummy variable for Russian war in Ukraine 2022

Table 3: Raw data and regression variables

5.3.1 Descriptive statistics

Descriptive statistics based on 467 observations are presented in Table 4 for each variable included in the regression.

Descriptive Statistics

N =467	Mean Statistic	Std. Deviation Statistic	Minimum Statistic	Median Statistic	Maximum Statistic
ROEt	0.124	0.151	-0.495	0.127	0.772
OPt (USD/barrels)	70.885	26.368	24.460	70.860	111.630
SIZEt (LN)	9.830	1.902	1.478	9.586	12.947
GEARt	0.209	0.108	0.000	0.201	0.646
CRt	1.340	0.431	0.332	1.290	5.162
ATt	1.423	1.370	0.271	1.142	17.546

Table 4: Descriptive statistics

The above table shows the dependent variable ROE obtains values between -0.495 and 0.772. The lowest value, -0.495, represents the worst profitability and means the net income is negative since observations with negative equity were excluded. In general, negative ROE is not comparable with positive ROEs; however, this study focuses on changes level in ROE.

Hence, negative ROE in this study indicates poor profitability. Additionally, median 0.127 and median 0.124 are close to each other; thus, the skewness of the data is close to zero.

The oil price variable OPt has a notable difference between its minimum value of 24.46 USD per barrel and maximum value of 111.63 USD per barrel, and the obtained standard deviation is 26.37 USD per barrel. This shows how significantly oil prices can vary between different years. Additionally, the data for OP is not likely to be much skewed since the median 70.86 and mean 70.885 are relatively close to each other.

The company size is shown in the table as a natural logarithm of total assets. Variable SIZE, based on total assets value, differs significantly between different companies and periods. The lowest value is 1.478 (equivalent to 4.38 million USD), while the highest is 12.947 (equivalent to 419658.44 million USD). Hence, the variation between companies is notable, and the large and successful have had the resources to purchase assets for a long time and increase their size. However, the median of 9.586 compared to the maximum value of 12.947 shows that most companies included in the sample have relatively high assets, which supports the idea of the oil industry being capital-intensive.

Debt variable GEAR, a ratio calculated by dividing short-term and long-term debt with total assets, differs among companies. The lower the value, the less the company has debt relative to its assets. The lowest GEAR value in Table 4 is 0; thus, some companies included in the sample did not have debt since all companies owned assets. There is no universally agreed good value for the ratio since the company may have more debt than other companies with similar characteristics. Still, it might be able to generate high profits. However, prior research suggests that debt and profitability have a negative relationship (Muscettola & Naccarato, 2015).

The current ratio CR is one of the liquidity ratios that shows how a company manages its short-term liabilities. But similar to the GEAR ratio, there is no particular value that all companies would desire; instead, it is more relevant compared to peers in the industry. Table 4 shows the lowest value for CR is 0.332, and the highest is 5.162. In general, a company with a lower CR can be assumed to manage its daily obligations worse than a company with a higher CR. However, if the ratio is notably high, it may indicate the company resources are not utilized efficiently, e.g., if a large amount of cash is left in the company account. The previous can be the case, with the observation having the highest value of 5.16 since the data median is 1.29. Additionally, the data has a high kurtosis value (data not shown) and is slightly positively skewed since the mean of 1.34 is higher than the median of 1.29.

Asset turnover ratio AT shows how efficiently a company uses its assets relative to its generated revenue. Essentially, the higher the value, the better since this indicates a relative lower amount of assets have been utilized to generate revenue. The lowest value for AT is 0.271, and the ratios below 1 mean that the companies have not been able to generate as much revenue as they have assets. In the long run, this will not likely be a favorable outcome. The highest value in the data is 17.55, which means the company has generated more than 17 times its revenue relative to its assets. However, the median of AT is 1.142, which means that most of the companies included in the sample have been able to generate more revenue than they have assets. Nevertheless, this ratio is also industry-specific as CR; hence, the ratios should be compared between similar companies. Lastly, the data is positively skewed since the mean of 1.423 is notably higher than the median of 1.142 and has a high kurtosis value (data not shown).

Companies included in the sample have similar characteristics, which means, in principle, ratios in Table 4 are comparable among the companies during different years. Nevertheless, it should be noted that OLS assumptions have not been fully satisfied since some data included in the regression is notably skewed, which means it is not normally distributed. However, in practice, it is difficult to fulfill all OLS assumptions; nevertheless, the impact should be considered when interpreting the regression results' reliability.

5.3.2 Correlation analysis

A correlation analysis was conducted by creating a correlation matrix with Pearson's correlations. Pearson correlations were chosen for the data since it is suitable for measuring linear relationships between two continuous variables (Sedgwick, 2012). The correlation matrix in Table 5 shows the correlations between the regression model variables.

Correlations (Pearson correlation)

N = 467	ROE	OP	SIZE	GEAR	CR	AT
ROE	1.00					
OP	0.01	1.00				
SIZE	-.109*	0.07	1.00			
GEAR	-0.07	-0.02	-.124**	1.00		
CR	.198**	.138**	-0.04	-.242**	1.00	
AT	.297**	.151**	-.602**	.105*	0.04	1.00

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5: Correlation matrix

The oil price variable OP is not notably correlated with other variables since all the correlation values are below 0.3, which is relatively close to zero. This was expected since a correlation is not likely between oil price and, e.g., company size or debt. Hence, there is no evidence to support the idea that when oil prices increase, the companies would start buying more assets or increase their debt relative to their assets.

Profitability variable ROE has the highest correlation with asset turnover AT. This can be explained by the fact that AT is computed with company revenue value and ROE with company return. Although the correlation is low, only 0.297, in general, when company revenue increases, there is a potential for the income to increase.

Company size SIZE has a notable negative correlation of -0.602 with AT. This can be explained by the fact that when the assets amount increases and the revenue does not, the AT variable will decrease due to relatively lower revenue to assets. The previous causes a minor multicollinearity problem for the regression and violates the OLS assumptions.

The current ratio variable CR has the highest negative correlation, -0.242, with GEAR, and as the correlation is lower than -0.3, there is only a low degree correlation. However, this finding may suggest that when companies have higher CR, i.e., they manage their short-term obligations better, they are likely to have lower amounts of debt relative to their assets. However, the correlation matrix can not be used to support the previous claim; it only provides an idea of the possible relationship.

5.4 Analysis of variance

Analysis of variance (ANOVA) was compiled to examine the robustness of regression results. Table 6 below shows F(10, 456) = 18.935, and this F score has a p-value of lower than 0.001, a statistically significant value; thus, the likelihood of chance is less than 0.1%. Furthermore, the null hypothesis can be rejected; hence, the results support the alternative hypothesis.

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.129	10.000	0.313	18.935	<.001[b]
	Residual	7.534	456.000	0.017		
	Total	10.663	466.000			

a. Dependent Variable: ROE

b. Predictors: (Constant), OP, SIZE, GEAR, CR, AT, F_crisis_dummy_2008, F_crisis_dummy_2009, COVID_dummy_2020, COVID_dummy_2021, War_dummy_2022

Table 6: ANOVA

6 RESULTS

This chapter introduces the results obtained from the OLS regression by analyzing the effect of the variables on the dependent variable ROE and discusses the limitations of this study.

6.1 Relationship between oil prices and oil companies' profitability

This study aims to identify whether there is a statistical relationship between oil prices and oil companies’ profitability. Most of the prior studies instead focused on oil price changes or oil price shocks' impact on stock returns and macroeconomic consequences (Bhaskar & Biswajit, 2023; Gupta, 2016; Hamilton, 1983, 2000; Still, 2007). Additionally, many of them have North America as their geographic area. However, this study focuses specifically on the relationship between oil prices and the European listed oil companies that have refining activities.

The final regression model (3) used in this study included the following variables. The dependent variable is the profitability variable ROE, and the main independent variable is the Brent spot oil price OP. Control variables included in the regression are company size SIZE, the natural logarithm of company assets; current ratio CR, which shows how well the company manages its daily outflows; and asset turnover AT, which shows how efficiently it generates profits on its assets. Additionally, the model includes three dummy variables for each year when the three major global crises were present: the Financial crisis in 2009 and 2009, COVID-19 in 2020 and 2021, and the Russian war in Ukraine in 2022.

The Regression results for the empirical model are displayed in Table 7 on the next page. The first column shows all the variables included in the model. The second column indicates unstandardized coefficients’ betas and standard errors. Unstandardized coefficients’ betas are crucial to recognize whether the possible relationship between the dependent variable is positive or negative (Statistics Solutions, 2023). Furthermore, it displays the line slope between the dependent variable ROE and the independent variable. The standard error shows how much the observations are spread from the regression line; hence, the lower the value, the better the opportunity to discover the significance (Statistics Solutions, 2023). The third column displays standardized coefficients, which enables one to compare how much each dependent variable impacts the dependent variable since the value will only range between 0 and 1 or 0 and -1.

The following columns are related to statistical significance; the fourth one shows the t value from the t-statistic test. If the value is over 1.677 or below -1.677, it indicates at least a 5% significance level exists (RED SPOTS Econometrics, 2023).

The last column is computed with a t-value from the previous column and shows a p-value, which describes a statistical significance level. P value has different levels of statistical significance: the threshold for rejecting the null hypothesis is 0.05, which means there is a 95% probability that the result is a true finding and a 5% possibility of a chance, and similarly, when the value is less than 0.001 the possibility of a chance is lower (Andrade, 2019).

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-0.040	0.052		-0.76	0.449
	OP	-0.001	0.000	-0.225	-5.01	<0.001***
	SIZE	0.012	0.004	0.152	2.99	0.003**
	GEAR	-0.023	0.058	-0.017	-0.40	0.689
	CR	0.068	0.015	0.192	4.65	<0.001***
	AT	0.041	0.006	0.372	7.27	<0.001***
	F_crisis_dummy_2008	0.007	0.044	0.009	0.17	0.866
	F_crisis_dummy_2009	0.000	0.000	-0.026	-0.47	0.642
	COVID_dummy_2020	-0.243	0.028	-0.363	-8.79	<0.001***
	COVID_dummy_2021	0.002	0.027	0.003	0.08	0.938
	War_dummy_2022	0.140	0.030	0.192	4.68	<0.001***
	N = 467					
		R	R Square	Adjusted R Square	Std. Error of the Estimate	
		.542[b]	0.293	0.278	0.129	

a. Dependent Variable: ROE

** and *** indicate statistical significance at 1% and 0.1% level

b. Predictors: (Constant), OP, SIZE, GEAR, CR, AT, F_crisis_dummy_2008, F_crisis_dummy_2009, COVID_dummy_2020, COVID_dummy_2021, War_dummy_2022

Table 7: Regression results

In the above table, the R square for the regression model is 0.293, which is the proportion of the variance in ROE explained by the independent variables in the model. R square is always between 0 and 1, and the higher the value, the better the fit. However, R square may increase only for the reason of adding more independent variables to the regression (Frost, 2023a). The adjusted R square, which is 0.278 for the regression model, increases only when the model fit improves after adding another independent variable (Frost, 2023a). However, R square and adjusted R square can still be considered relative measures, although they can differ among different methods, and some models are more difficult to form than others.

The reported R square of 0.293 is close to the prior studies (Bagirov & Mateus, 2019; Dayanandan & Donker, 2011; Vătavu et al., 2018), which includes OLS in their empirical study.

A slightly higher R square of 0.31 was obtained with OLS by Vătavu et al. (2018), which can be, e.g., due to a different model that includes more variables or more robust data. Still, on average, it appeared R squares with OLS in previous studies were close to 0.3, which is close to 0.293. This relatively low R square can indicate that OLS might not be the best method for measuring the relationship between oil prices and companies' profitability since other authors had introduced other models with methods such as GMM as their main models. However, the reason can also be that the relationship is challenging to investigate, which means some relevant variables impacting the relationship have not been identified or are difficult to include in the regression model.

The regression results in Table 7 show the slope coefficient value for oil price OP is less than 0.001, which indicates a strong statistical significance; thus, the significance level is less than 0.1%. As the P value is below the threshold, the negative slope coefficient shows an existing negative relationship between OP and ROE. Hence, the null hypothesis H0 can be rejected since a statistically significant relationship is identified between oil prices and company profitability.

A negative relationship between OP and ROE suggests that when oil prices increase, the company's profitability decreases. Hence, the answer to the research question: *Do oil prices affect oil companies' profitability?* Is yes. This result aligns with a general assumption that the raw material price increase can impact profitability negatively. This finding also suggests that the price increase is not transferred to the customers.

Furthermore, the results of this study are on some level similar to results obtained by Vătavu et al. (2018), who discovered a marginally negative significant relationship between oil prices and UK-listed companies' profitability. However, the level of significance can be impacted by several different factors. Firstly, the number of observations was roughly half the number in this study and included only UK oil and gas companies. Secondly, the model in Vătavu et al. (2018) study included more control variables such as stock turnover, oil volume turnover, and tax variable.

Contrary to this study, the narrow geographical area perhaps enabled them to consider the impact of taxes since it is more convenient to consider taxes for one country with one regulation than for a dozen European countries. Thirdly, the regression method where a marginally statistically negative relationship was obtained was GMM instead of OLS. The authors also utilized OLS, but it did not capture a significant relationship between oil price and profitability; hence, this study provides a new result with OLS.

No other prior study related to oil prices and company profitability (Dayanandan & Donker, 2011; Vătavu et al., 2018; Wattanatorn & Kanchanapoom, 2012) than Vătavu et al. (2018) utilized OLS as a linear regression method to investigate the relationship.

This makes the statistically significant finding of this study unique since it shows a possibility of a linear relationship between the variables. The possible reasons for the result can be as follows.

This study shows that the profitability of listed European companies is negatively associated with oil price increases. The reason for this might be the fact that crude oil has been an essential raw material for oil companies with refining activities during years 2000 to 2022. Furthermore, green energy requirements from the EU and customers do not seem to be reflected in this result. The EU has an ambitious goal of receiving 32% of energy from renewables in 2030 and reaching carbon neutrality by 2050 (European Parliament, 2023); hence, prompt changes would also be needed from the oil industry. The previous supports Bukold's (2023) claim that major oil companies still have high oil production and are focused less on green energy solutions than their annual reports would indicate. Hence, the result of this study can also be held as an argument against oil companies not considering green energy and sustainability requirements sufficiently and supports the idea of "greenwashing" in the companies' press releases and annual reports.

OPEC has a wide impact on oil prices worldwide since the countries in the organization obtain most of the world's known oil resources. As a result of the study indicating a negative relationship, it can mean that OPEC also has a role in fluctuating oil prices. OPEC aims to ensure a sufficient return for its member countries, and when the oil supply is too high and the demand too low, it can reduce oil production to increase the oil prices. For refining oil companies, this can cause adjustment issues with the higher oil price, which necessarily can not be transferred to the customer. However, for the previous reason, crude oil and petroleum product prices are often tied to benchmark indexes such as Brent, which is used as an oil price indicator. This should help the oil companies to receive the market price of their product. Still, there can be exceptions such as certain price threshold clauses, discounts included, or the customers' inability to manage the higher prices. Hence, the profitability can be impacted negatively.

Hedging has been mentioned in this study to be common in the oil and gas industry, and the purpose of it is to cover the possible losses. Profits and losses impact the company's net income, and net income in this study impacts ROE, which is a profitability measure. Regardless of the previous, this study does not consider any risk management impact on company profitability.

However, hedging might still impact the relationship between oil price and company profitability. Furthermore, if one focuses on only results from this study, the negative relationship may suggest poor hedging since increasing oil prices are associated with lower profitability. The second option could be the idea of irrelevant hedging activities (Modigliani & Miller, 1958) since financial decisions would not impact the firm value. However, the previous ideas should be interpreted very cautiously since hedging impact was not empirically investigated in this study but would be relevant additions to further research on the topic.

A negative relationship between oil price and profitability can also indicate something about the oil companies' products' price elasticity. If the companies do not transfer the raw material price increase to their end customers, it might show that they are afraid that demand will drop. This possible finding is interesting since, e.g., petroleum products and fuel can be considered as utilities, meaning their price would be inelastic. However, as the demand and oil volume are out of the scope of this study, the price elasticity interpretation should be considered with extreme caution. Nevertheless, research on oil prices and volume turnover, demand, and company profitability is an idea for further research.

6.2 Relationships between other control variables and profitability

The control variables included in the regression model were SIZE, GEAR CR, and AT, and some had a statistically significant impact on the dependent ROE, while others did not. This chapter analyses the results of relationships between the previously mentioned control variables and ROE.

Company size control variable SIZE in Table 7 captured a statistically significant relationship with a p-value of 0.003 at a 1% significance level. The sign for the coefficient is positive; hence, the regression results indicate a positive relationship between company size and profitability. This finding aligns with the prior studies (Bagirov & Mateus, 2019; Dayanandan & Donker, 2011), which also discovered SIZE and ROE to have a statistically significant positive relationship. The company size in this study refers to the total value of assets, and the more refining oil companies have, the larger their production capacity can be. Thus, economies of scale can be one of the reasons for the positive relationship. However, as the company size and profitability are not the main focus of the study, further research would be needed to draw more reliable conclusions on the relationship.

Company debt variable GEAR shows a high p-value of 0.689 in Table 7, which means there is no statistical relationship between GEAR and ROE. This result is similar to the one obtained from a study on listed Western European oil and gas companies by Bagirov and Mateus (2019), who did not discover a statistically significant relationship between debt variable and ROE in their regression model.

The reason for this can be that the companies included in the sample are partly the same since this study includes European listed oil companies, which also cover major Western European oil companies.

However, Dayanandan and Donker (2011) captured a negative relationship between debt variable and ROE; hence, the results vary in prior research. Nevertheless, it should be noted that Dayanandan and Donker (2011) had North America as their geographic area, and their sample included more observations due to a higher number of oil companies. However, it can still be possible that the relationship between debt and profitability is weaker in European listed companies. However, as this idea is out of the scope of this study, it should be interpreted with caution.

The current ratio CR has a positive statistically significant relationship with the dependent variable ROE with less than 0.001 p-value in Table 7. As the result suggests, the chance of being wrong is less than one in a thousand; the relationship is statistically highly significant. This means that when the liquidity ratio CR increases, ROE is also higher. These results differ from Vătavu et al. (2018) study, where a statistically significant relationship was not captured between the current ratio and ROE, while other relevant studies did not include CR in their regression model. The current ratio is not directly related to profitability. However, a poor CR of less than one can indicate the company has difficulties managing its less than one-year debts and obligations. If this continues, the increasing debts and interest on them will increase company expenses, eventually reflecting on company profit. Additionally, if external stakeholders know the company's difficulties in managing short-term liabilities, they might reconsider engaging in a customer relationship since it can be too risky for them. Thus, CR appears to indirectly impact ROE in this study since a sufficient CR can be a sign of a company that will manage its short-term liabilities properly.

The last control variable, asset turnover AT, has a strong statistically significant relationship with ROE based on the captured p-value of less than 0.001. The result aligns with the prior research, which includes asset turnover in the regression model and indicates that profitable companies efficiently generate revenue on their assets (Vătavu et al., 2018). This result was expected since a higher AT requires a higher revenue relative to company assets, and the purpose of the oil companies is to create more profit with the assets they have invested in. Nonetheless, company net profit or loss is different from company revenue. Still, in general, the higher the revenue, the higher the profit is expected if the relationship to expenses remains the same. However, it should be noted that AT had the highest correlation of 0.297, with ROE, which is significant at 0.01 level and is not desired for OLS. Nevertheless, the control variable is included in the regression since, as seen in Table 7, it impacts company profitability ROE.

Furthermore, the reason for the correlation is that company profit or loss is calculated by deducting costs from revenue, which is used for calculating AT.

6.3 Relationship between crisis dummy variables and company profitability

This study included three different dummy variables in the regression for global crisis years, and this chapter introduces the impact of dummies on ROE. The reason for adding dummies in the regression is that oil price shocks have an impact on economies and companies (Hamilton, 2000; Kilian & Park, 2007; Still, 2007); hence, they reflect the crisis impact for different years. The global crises included in this study are the financial crisis, COVID-19, and the Russian war in Ukraine.

The global financial crisis was expected to impact oil prices in 2008 and 2009. This can also be noticed in Figure 1, wherein in 2008, the oil price was significantly higher compared to previous years, and in 2009, a significant drop happened. Hence, dummy variables for the financial crisis were added for those years. The dummy years compared to the prior study by Dayanandan & Donker (2011) differ since their study on North American oil companies considers the financial crisis years to be 2007 and 2008. Furthermore, this study uses dummies for 2008 and 2009, as did Bagirov & Mateus (2019), since these years appear more relevant for the crisis period in Europe. However, no statistically significant relationship was captured in either of the dummy years, as seen in Table 7. This differs from prior studies (Bagirov & Mateus, 2019; Dayanandan & Donker, 2011), which identified a negative relationship between the financial crisis dummy variable and ROE. The difference can be due to another research method, such as GMM, and the prior research used interactive dummy variables. Interactive dummy variables were equivalent to oil prices during the crisis years and otherwise zero. However, this study used 1 for crisis years but was otherwise zero since this was suitable for OLS.

The second dummy variable included in the study was the COVID-19 dummy for 2020 and 2021 when the pandemic was aggressively spreading and impacting economies, companies, and consumers. The impact of the previous can be identified as an oil price shock during the years 2020 and 2021, when the yearly average price changed significantly. This can be seen in Figure 1, which shows a notable drop in oil prices in 2020. A statistically significant negative relationship can be seen for the COVID-19 dummy 2020 in Table 7, which shows a less than 0.001 p-value. This means that COVID-19 has negatively impacted companies' profitability and indicates that companies have suffered during the first year of the pandemic. There are several possible reasons why the pandemic impacted oil prices, and this study suggests the following.

A dramatic drop in oil demand in 2020 (International Energy Agency, 2020) caused the Brent spot oil price to decrease to a meager daily oil price of 9.12 USD per barrel (Thompson Reuters, 2020). The previous price is extremely low even for a daily oil price since the 2020 average oil price of 41.96 USD (Thompson Reuters, 2020) per barrel was already nearly 35% lower (Thompson Reuters, 2020) than the 2019 oil price. The previous was a consequence of worldwide lockdowns and fear of getting infected, and most governments instructed or legally forced people to stay home. When this happened, people who could work from home did not use their cars or public transport to get to their workplaces, and as the number of these people was significant, this impacted fuel demand negatively. Furthermore, the traveling and tourism industry suffered since restrictions were set on numerous of them; thus, fuel and energy demand was reduced.

Additionally, the "high-contact" industries suffered the most, such as the accommodation and food industry, the entertainment industry, and the wholesale and transportation industry (Dey-Chowdhury et al., 2022). In most European countries, businesses had to comply with strict measures such as having a limited number of customers or even being closed during lockdown periods. The previous negatively affected the businesses, and as a consequence, several businesses went bankrupt. Hence, the profitability of different businesses was highly impacted, including the oil industry.

Regardless of finding a negative relationship between the COVID-19 dummy for 2020 and profitability, a similar result was not captured with the COVID-19 dummy for the year 2021. The possible reason for this is that the major and the widest of the negative impacts of COVID-19 happened in 2020 since the market changes happened unexpectedly. But in 2021, the economies, companies, and consumers have had time to adjust some of their activities to a changed global environment. As this study considers oil companies' ROE, the previous assumption suggests that perhaps they had found solutions to continue their businesses more successfully in 2021 compared to 2020, regardless of the pandemic's presence.

The last dummy variable included in the regression was a war dummy for 2022, which represents Russia's war in Ukraine in 2022. The reason for adding a war dummy for 2022 instead of a COVID dummy is that this study assumes the war has a higher impact on oil prices and oil companies' profitability than COVID-19, which was also ongoing globally in 2022. This conclusion was also drawn from the finding that COVID-19 did not significantly impact oil companies' profitability in 2021; hence, a similar assumption was made regarding 2022.

The war dummy for 2022 has a statistically significant relationship with ROE, with its less than 0.001 p-value as seen in Table 7. Furthermore, the coefficient for the dummy is higher than zero, which means the relationship between the variables is positive.

This finding suggests that the European-listed oil companies' profitability improved during the ongoing Russian war in Ukraine. The finding also supports the news regarding the record-high profits reached by oil majors in 2022 (Visual Capitalist, 2023). There are numerous reasons for the discovered relationship, but the ones introduced in this study are as follows.

Russia has been an essential oil importer for the EU (Eurostat, 2023). As mentioned earlier in the study, the EU set numerous economic sanctions on Russia as an action against its war in Ukraine. One of them was a ban on Russian-origin crude oil and petroleum; however, it should be noted that the restrictions did not become applicable immediately. The ban on Russian crude oil became applicable on the 5th of December in 2022 and on petroleum products on the 5th of February in 2023 (Eurostat, 2023). Before the ban, G7 countries and the EU agreed on a price cap on Russian oil barrels (Bruegel, 2022); this enabled the oil companies to buy discounted Russian oil until the end of 2022. The previous can explain the record high profits in 2022 if the companies more or less kept the prices the same for their customers.

Other reasons for companies' profitability and ROE having a positive relationship are fossil fuel subsidies and reductions in fuel taxes. Fossil fuel subsidies in the EU in 2022 were 123 billion euros, while in prior years, from 2015 to 2021, the amount was close to 56 billion euros (European Environment Agency, 2023). Thus, subsidies have increased by 120%, a significant increase compared to the previous year. However, it is plausible the subsidies are related to not only the war but also the COVID-19 period, and the inflation should also be considered. Nevertheless, these fossil fuel subsidies are still likely to impact oil companies' profitability due to their huge amount.

Similarly to subsidies, the fuel tax reductions can explain the companies' positive performance in 2022. More than 13 European countries, such as the UK, Germany, Italy, and the Netherlands, reduced the fuel tax in 2022 (FleetNews, 2022). Thus, some of the oil companies included in the sample of this study benefited from the reduction and might not have lowered their fuel prices to their customers accordingly. However, as fossil fuel oil subsidies and fuel tax reductions are not the main focus of the study and are not included in the empirical section, the elaborated reasons should be considered with caution.

Adding dummy variables for the regression was crucial in this study, and the crisis years are essential to recognize since they can impact oil prices and the oil prices affect oil companies' profitability (Bagirov & Mateus, 2019; Dayanandan & Donker, 2011; Vătavu et al., 2018; Wattanatorn & Kanchanapoom, 2012). Although not all dummy variables had a statistically significant relationship with the ROE, it is essential to consider the possibility of this complex relationship.

6.4 Sensitivity analysis

The sensitivity of regression results was tested by replacing the dependent profitability variable ROE with another common profitability measure, ROA. The main difference between ROE and ROA is that the first one considers the company debt, but the second one considers the amount of assets without the impact of debt.

The regression results with ROA (data not shown) give a higher model fit with an R square of 0.364 than 0.293 obtained with ROE; however, a higher R square does not necessarily mean a better model. The results were robust with control variables OP, CR, AT, and crisis dummy variables; thus, the signs of coefficients and the significance levels were similar to regression with ROE. However, a statistically significant negative relationship was also captured with GEAR and ROA. This result is aligned with prior research suggesting that debt negatively affects profitability (Muscettola & Naccarato, 2015). Regardless of the previous, it should be noted that ROA and GEAR had higher correlation coefficients (data not shown) since both variables were calculated using total assets as a divider. Hence, the regression results could have been impacted by the higher multicollinearity. Nevertheless, most of the variables gave similar results with ROA; therefore, the results of this study are considered robust based on the sensitivity test.

6.5 Limitations

This study has several limitations due to different reasons. The limitations are related to the sample, regression model, and researcher's abilities. This chapter introduces the limitations and possible alternatives to improve future research on the topic.

The sample size was relatively small in this study since the final sample included only 467 observations. However, the reason for the small sample size is that the companies included in the study were highly targeted, and only European-listed companies with refining activities were included to have the companies that can directly impact the choice of raw materials. Furthermore, Europe has fewer listed oil companies compared, e.g., to the US. Nevertheless, more observations could have improved the model fit since the R square for the final model was 29.3%, and the adjusted R square was 27.8%. Although R-square is not the only way to judge the goodness of a model, it gives an idea of it. Hence, more observations would have increased the data points, which could have improved the model fit if the model otherwise served the purpose.

The study's results suggest that during the period 2000-2022, the increases in oil prices negatively impacted the companies' profitability. However, this does not necessarily mean the identified negative relationship is present for each year. Additionally, this study included only the yearly oil price. However, the impact of oil price changes on the companies' profitability could also be delayed. Thus, to investigate the previous one could add a lagged oil price variable to an empirical model.

The companies included in the sample were assumed to have similar characteristics. Russian companies that passed the main criteria were included, and the final sample included 11.5% of observations from Russian companies. This proportion is notable since, in reality, Russian companies have some different characteristics than European companies. The legislation in Russia is not as aligned with the EU as other non-EU countries. The previous is reflected in how Russia is not planning to make heavy investments and regulations to enhance the transition to green energy (Earth.Org, 2021) as the EU. Thus, the Russian oil companies are likely to depend more on global oil prices since they do not consider other alternatives ambitiously. Additionally, 2022 may have impacted Russian oil companies' profitability by selling crude oil to European markets at a significant discount. However, if Russian companies had been excluded, the small sample would had even fewer observations.

Hedging, which is relevant for oil companies, was not considered in the empirical model. This study assumed the hedging characteristics are similar between the companies included in the sample. However, in practice, the risk management among the different companies can vary, and some companies may be more efficient and successful in hedging than others. Thus, in future research, if suitable and comprehensive data on hedging is available for listed European companies, it might be interesting to see whether it impacts companies' profitability.

This study introduced the possibility of green energy transition as one of the reasons why oil companies' profitability would not capture a statistically significant relationship with oil prices. However, no variable represented the use of green energy in the regression model. Hence, this study can not empirically support the idea of oil companies being less dependent on oil prices nowadays due to the EU's ambitions for carbon neutrality and enhancing the use of renewables. However, some major oil companies in the sample utilize renewable sources. Hence, for future research, it could be valuable to recognize these companies and see if their ROE also has a negative relationship with oil prices. The previous idea could provide helpful information for, e.g., the EU on how their regulations related to renewables have been implemented in the oil companies during the transfer periods.

The study used linear regression analysis and, more precisely, the ordinary least square method (OLS). OLS has several assumptions to be satisfied as well as possible by the data to obtain more reliable results from the regression. However, the data in this study did not meet all the assumptions, which negatively impacted the reliability of the results.

Some variables had minor correlations with the others. However, the highest correlation was initially identified between company assets and inventory, and to lower multicollinearity, the inventory variable was excluded from the model. Additionally, the current ratio and assets turnover variables had high positive kurtosis values, which breaks the normal distribution assumption for the data. Lastly, the predicted variable ROE did not have a constant variance, meaning heteroscedasticity was present instead of a desired homoscedasticity.

However, to minimize the heteroscedasticity, the size variable in the model was in natural logarithm; other variables, except oil prices, were ratios, and the outliers were removed from the sample. The previous can refer to the idea that perhaps linear regression is not the most suitable method to investigate the topic; this can be why most prior studies used GMM as their primary method. Future research, other than linear methods and GMM, could provide more accurate results if the model fit can be improved by adding more significant control variables.

The study used data from the period 2000-2022. The considered crisis years were the financial crisis in 2008-2009, COVID-19 in 2020-2020, and the Russian war in Ukraine in 2022. The previous crises were considered the most notable global crises that impacted oil prices. However, depending on the geographic area, there can also be other crises present that can impact oil prices. The geopolitical crisis in 2014, which was included in Bagirov and Mateus's (2019) study, was excluded from this study since this study focused more on recent crises and included the financial crisis due to its major impacts globally. Furthermore, identifying the significant crises can be subjective, but if relevant to the chosen geographic area, they can provide valuable insights related to oil price changes. However, to avoid too broad a scope for future studies, the specific crisis years could be the main focus of the research.

The data for profitability measure ROE included positive and negative values—a negative ROE results from either return or equity being negative for a company. This study excluded companies with negative equity but had negative ROEs since the research focused on the level of ROE, and these companies also increased the number of observations. However, a negative ROE is not entirely comparable to companies with a positive ROE. The reason for the previous is that a negative ROE does not necessarily mean the company is doomed; instead, other factors should also be considered to define whether the company can still have a sustainable future (Nasdaq, 2016). However, interpreting negative ROE in more detail is out of the scope of this study, but the impact should be noted when interpreting the results.

7 CONCLUSION

Companies' profitability is a timeless accounting topic that interests business-wide and academically. Profitability is a large part of functional economies, and any significantly affecting variables, such as oil price, provide valuable information on how it can be impacted. Furthermore, the oil industry, one of the critical industries and a vast amount of money-generating industry, draws special attention from governments and investors. Hence, relevant and consistent information on the relationship between oil prices and oil companies' profitability is highly valuable.

This study investigated company profitability with return ratio ROE, and most of the independent control variables were accounting variables. However, the main independent variable included in the regression was oil price, which is an economic determinant. Oil price possesses unique features, and it has far-reaching and varying impacts on different industries and companies. Although the oil price is publicly available, it is still difficult to identify all the factors that influence it, and even more challenging to consider these determinants empirically. The previous can explain why there is not much prior research on oil companies' profitability and oil prices since combining accounting information and economic data is not straightforward.

The study results reveal a negative relationship between oil prices and oil companies' profitability in the European oil industry. Thus, oil companies' profitability suffered while oil prices increased. The final sample included 467 observations from 2000-2022 from 26 listed oil companies whose headquarters are located in Europe and have refining activities. The accounting variable data was obtained from the Compustat database, and the yearly Brent spot price represented an oil price in this study.

The company's profitability was positively associated with company size, but no relationship was identified with the debt variable. Furthermore, the current ratio and asset turnover had a positive statistically significant relationship with company profitability. Additionally, crisis dummy variables added in the model show that the financial crisis (2008-2009) and the second year of covid-19 (2021) did not impact the relationship. However, the dummy for the first COVID-19 (2020) negatively affected the profitability, which shows that sudden changes in oil prices do have far-reaching impacts as prior research (Bhaskar & Biswajit, 2023; Hamilton, 2000; Kilian & Park, 2007; Still, 2007) on oil price shocks suggests. In contrast, the dummy variable for 2022, representing the Russian war in Ukraine, showed a positive association between oil prices and oil companies' profitability. The last finding indicates that the European listed oil companies benefited from the war regardless of the drastic oil price increase in 2022.

This study rejected the null hypothesis since a statistically significant relationship was identified between oil prices and oil companies' profitability. Furthermore, the results suggest that European oil companies still depend on oil prices regardless of the EU's regulations on renewable energy and sustainability awareness. Although several oil majors (e.g., Shell, BP, and TotalEnergies) in Europe state that they heavily invest in renewables, based on this study, it is not yet seen on their annual reports, as Bukold (2023) argued. This raises a question about companies' greenwashing. If the companies are emphasizing and claiming to be looking for new solutions from renewables, why is their profitability still significantly impacted by crude oil prices? Moreover, the European oil majors reaching record high profits in 2022 (Visual Capitalist, 2023) can also be explained by the finding that the war improved the oil companies' profitability in 2022.

In conclusion, this study provided recent and relevant information on oil prices' impact on oil companies' profitability. Regardless of the limitations, the study's results can help regulators, management, shareholders, and academics understand the complex relationship between a commonly used profitability variable and a unique commodity price. Additionally, the study also demonstrates the challenges that one encounters while investigating oil prices' impact on the company level and emphasizes crisis impact. It also shows that the relationship is not straightforward since the results vary among prior research. Furthermore, this study provides ideas for further research on the topic, including factors such as hedging, renewables impact, and other notable crises in the chosen geographic area.

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