Universitetet
i Stavanger

FACULTY OF SCIENCE AND TECHNOLOGY

MASTER'S THESIS

Study programme/specialisation: Industrial Economics / Natural Gas Engineering and Project Management	Spring semester, 2017 Open
Author: Ingrid Katrine Løvbrekke	………………………………………… (signature of author)
Programme coordinator: Atle Øglend, University of Stavanger Supervisor(s):	
Title of master's thesis: An Analysis of how Changes in the Oil Price Influence the Oslo Stock Exchange	
Credits: 30	
Keywords: Oil Market, Brent Crude Oil Price, Oslo Stock Exchange, OSEBX, OSE10GI, Statistical Analysis	Number of pages: 70 + supplemental material/other: 13 Stavanger, June 15, 2017 date/year

Preface

Writing a master thesis is a long process. At the same time, it is strange to see the how the work is materialized on the following pages. All the reading, writing, deleting, and rewriting which lies behind, is not reflected in the final version of the thesis. That is how it is. A thesis is affected by post-rationalization which does not show any side tracks or dead ends that appeared throughout the work. The work has been challenging, interesting, and fun at the same time, and through this process I have learned a lot.

A series of pessimistic and optimistic news about the oil price affecting the Norwegian economy was the motivation behind my decision to take a deeper look at this theme. I wanted to find out whether changes in the oil price influenced the Norwegian economy as the media portrayed it or not. Given this, I chose to study the relation between the oil price and the Oslo Stock Exchange benchmark index, and to see if changes in the price affected the value of the stock index. I hope that the reader find this paper as an interesting contribution to a relevant and important debate.

I want to thank my supervisor Atle Øglend for providing necessary oil price data sets, and for constructive feedback and contribution with guidelines. Your responses have been helpful and quick throughout this semester.

Ingrid Katrine Løvbrekke

Abstract

This master thesis was written at the University of Stavanger (UiS), department of Industrial Economics, Risk Management and Planning, during the spring of 2017. The idea behind stems from interests in oil price changes and how the Norwegian economy is affected by it. The aim for this paper is to study the impact of oil price fluctuations on the Oslo Stock Exchange benchmark index (OSEBX), by investigating the changes in the crude oil price for the period from 2001 to 2016. Since Norway is built on oil richness, it's stock markets are likely to be susceptible to oil price shocks. Regression analysis is used to analyze the relationship among the variables.

It is generally accepted that oil has been vitally important for the global economy, and the world has experienced growth in consumption for the majority of years since the 1900s. The global importance of oil is likely to continue in the years to come as well. Oil is the world's primary fuel, and demand is ever-growing. In 2015, there was about 1.2 billion passenger cars in the world, and over 98% of them relied on oil. This number is expected to grow in the years to come. Increasing number of vehicles has an obvious influence on the demand for gasoline and diesel fuel. Engineers stated in 2015 that only 12% of the 9 trillion barrels of oil in place globally has been extracted yet (Clemente, 2015). Oil is the main reason the world is globalized, and its importance will continue in the following years.

The fact that oil price movements have been a subject of discussion for centuries is one of the factors driving me to write this thesis. Economists and policy makers have shown increasing concerns regarding speculation and extreme oil price movements. Production and exportation of oil and gas are important parts of the Norwegian economy, and should therefore have a strong effect on the stock market. In the long run, we see that there is a strong correlation between the changes in the oil price and the changes in the OSEBX. When studying four different short-run periods, we see that the correlation is low for all periods except the last. Generally, the OSEBX can just to some extent be said to be driven by the oil price. Other external factors are driving the changes. The overall conclusion is that the oil price has a positive effect on the OSEBX index. Only indexes related to the oil market will be significantly influenced by changes in the price of oil.

Table of Contents

List of Figures

1. Introduction

The Norwegian oil adventure started about 50 years ago, and the story is not yet even close to finished. On Christmas Eve 1969, something that no one thought was possible happened: oil was found on the Norwegian continental shelf. The Norwegian authorities was informed by Phillips Petroleum about the discoveries of oil in the North Sea. The discoveries were made in the Ekofisk field, which was the world's largest offshore oil field. Since then, the oil's importance for the Norwegian economy has increased in pace with oil companies' share of the country's exports, gross domestic product, and employment (Løvås, 2014) ("Lille julaften 1969…", 2014).

Norwegian newspapers constantly report from the Oslo Stock Exchange. They highlight that the benchmark index goes up and down as a result of oil price fluctuations. However, this is just one out of many reasons for the change in the benchmark index. The Norwegian economy's dependence on oil has especially been a topic since the oil price fell from $115 the summer of 2014 to under $50 in January 2015. In January 2016, the oil price reached its lowest in thirteen years, reading $27.67, which rapidly rose again to above $28. Now, the oil price is still increasing slowly through small ups and downs (Armstrong, 2016). Simultaneously Oslo Stock Exchange's benchmark index has only been slightly changed since the summer of 2014 (Hovedindeksen, 2017).

Many people believe that the Oslo Stock Exchange benchmark index can be read from the fluctuations in the oil price. Based on assumptions of rational investors and efficient markets, it is difficult to understand why such an attitude has been established. By looking at the graphic relationship between the price of oil and the OSEBX in Figure 1.1, it is however understandable that some are inclined to believe that the Oslo Stock Exchange is mainly driven by the oil price. At the same time, many newspapers write about how the oil price falls in line with the stock markets, and oil traders reposition and sell their shares. Even though Norway experienced painfully low oil prices for the Brent crude oil the last years, stock markets all over the world fell because of the uncertainty related to the trades of oil at that time (Lorch-Falch, 2015). That the reality differs from the theory preconditions should not surprise many, but: is the distance between theory and reality so great that the oil market is a statistically significant leading indicator for the Oslo Stock Exchange? If so, this means that the average investor is less rational than assumed. Articles highlighting the connection between the oil market and several world exchanges came to the same conclusion: the price of oil does not conduct the Oslo Stock Exchange (Gabrielsen & Holtet, 2009). It is therefore interesting to see what results appears in this thesi. In addition, the government has long warned that the Norwegian economy is facing a major restructuring, where the community must become less dependent on oil in the future.

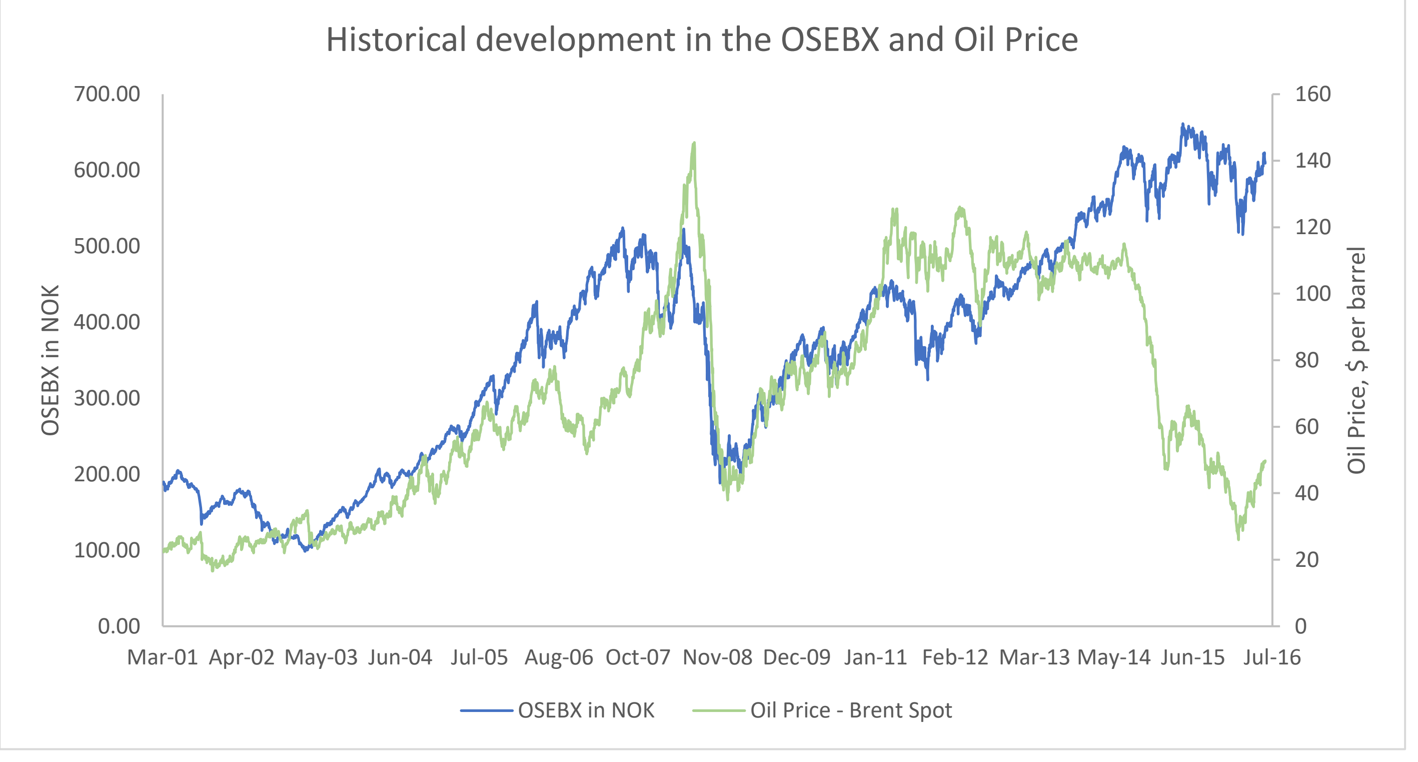


Figure 1.1 The historical development in the oil price and the stock market for the period 2001-2016. The oil price is represented by Brent crude oil in USD, while the benchmark index in NOK represents the stock market.

The main topic for this thesis is to analyze how changes in the oil price influences the Oslo Stock Exchange by looking at the Brent crude oil price and the OSEBX index. The analysis is divided into different periods to get a better image regarding the relation between these two variables. First, the whole period from 2001 to 2016 will be analyzed. Further, this time period is divided into four smaller periods which are of particular interest. This allows us to take a closer look at what happens when the price of oil fluctuates. All regressions will be based on daily data. The main focus will be put on the effects of the downturn in 2014, and the consequences of it.

Throughout the work with this thesis, I found that the Norwegian Economy has become more two folded than perhaps ever before. On one side, the Norwegian petroleum industry is facing major challenges with downsizing and investment failure. While on the other side, the rest of the Norwegian economy is fairly unaffected by the fall in oil prices, and is growing. One can thus say that the Norwegian economy is dependent on the oil in the sense that the energy sector constitutes a large percentage of Norwegian economy and hence its fluctuations. At the same time, I found little evidence that oil price dependence spread wider to other parts of the Norwegian economy, as one gets the impression in by the ongoing debate in the media.

The thesis consists of 6 parts in addition to the introduction. Part 2 presents an introductory overview of the oil market, the petroleum industry in Norway, and the supply and demand of oil.

Part 3 will examine the Oslo Stock Exchange, what the Oslo Stock Exchange Benchmark index is and how it is related to the Norwegian economy, while part 4 will review the applied statistical method. In this part, the underlying theory for the regression analysis will be explained together with different tests for the basic data, including tests for stationarity.

In Part 5, the data approach is presented. Here, the different independent variables used in the regression analysis will be explained. It is then time to study the regression results in part 6. The results from the empirical analysis are analyzed and explained. Part 7 constitutes the discussion of results, and part 8 will constitute a summary and conclusion.

2. Oil Market

This chapter will focus on the oil market. The information provided here is meant to give an understanding of the oil market and the price of oil before conducting the statistical analysis. This information will underpin and give a better understanding of the later analysis. It will review the historical development of the oil market, the Norwegian petroleum industry, and the supply and demand of oil. This chapter will therefore introduce the oil price, and give a basic understanding of it and its contribution to the Norwegian economy.

2.1 The Norwegian Petroleum Industry

The petroleum industry is known to be unpredictable, and factors like the economic conditions in the world economy, production capacity within and outside the organization of petroleum exporting countries (OPEC), as well as the oil price is highly influencing oil companies' profitability. Rising oil prices give a lucrative market and a direct increase in their profitability, while falling oil prices have the opposite effect (Fiskå & Wangswik, 2014).

The oil and gas value chain starts with discovering oil and gas fields and ends with providing products to the end consumers. The different stages are called upstream, downstream, and midstream. The upstream sector involves the exploration and production. It encompasses searching for potential underground and underwater fields, drilling wells for exploration, operating the wells, recovering, and producing crude oil and/or natural gas. The downstream sector involves refining and marketing the crude oil, as well as processing and selling natural gas. The midstream sector often includes elements of both the upstream and downstream sectors. This sector is covering storage, transportation, processing, and distribution operations. The midstream sector also embodies marketing of the different petroleum products. (Avata, n.d.). Norway only has two large oil refineries, and has focused on becoming world leading in upstream activity like exploration and production offshore (EIA, 2012).

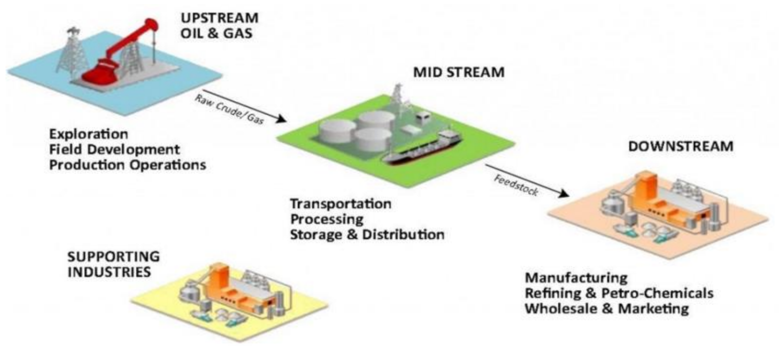


Figure 2.1 The Petroleum Value Chain with its different stages (Avata, n.d).

Ever since oil was found on the Norwegian continental shelf in 1969, the petroleum industry has created huge values for the Norwegian economy. Now, 50 years after the first licenses in the North Sea were given, the petroleum industry has become Norway's most important source when it comes to income to the treasury, investments, and share of total wealth (Olje- og energidepartementet, 2016). A country's wealth can be measured by using the gross domestic product (GDP). In 2014, Norway's GDP was calculated to be 3167 billion NOK (Norsk olje&gass, 2012).

Norway is one of the largest exporters of petroleum products. In 2014, the export of petroleum (crude oil and natural gas) accounted for more than 55% of total Norwegian export, against almost 60% in 2012. The exported volume, on the other hand, increased in 2014 compared to previous years. The drop in the export value is therefore said to be due to a lower crude oil price (SSB, 2015). In 2016, the total value of the exportation of crude oil and natural gas amounted at approximately 350 billion NOK. This corresponds to 47% of total Norwegian export (Eksport av olje og gass, 2017). To keep up these numbers, the petroleum industry requires many employees. In 2016, SSB estimated that 185,300 people or 7% were directly and indirectly employed in the Norwegian petroleum industry. In 2015, the number was 206,000 employees, while in 2013 it was 232,000. These numbers indicate a considerable decrease in employments within the Norwegian petroleum industry since the crack in the oil price in 2014 (Arbeidsplasser, 2017).

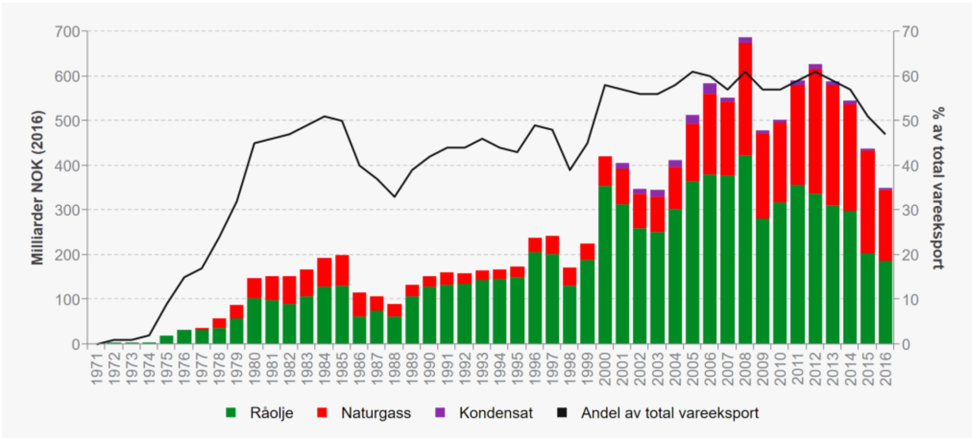


Figure 2.2 Norwegian Export of Petroleum (Eksport av olje og gass, 2017)

The crude oil production increased in 2016 for the third year in a row, after a continuous decrease in production between 2001 and 2013. The production from the oil fields on the Norwegian continental shelf was 230.6 billion Sm^3 oil equivalents (o.e.) in 2016. Although this is a high number, the production record was set in 2004, were 264.2 billion Sm^3 o.e. were produced. Since the trend have changed, it is expected that the industry has passed its highest production year already. The gas production, on the other hand, stayed at approximately the same record high level as in 2015. In 2016, the gas production was 115 billion Sm^3, which accounted for almost 50% of the total petroleum production measured in oil equivalents. The most important reason for the increase in the sale of gas over the recent years is higher demand of gas in Europe. Most of the Norwegian gas is exported in pipes to Europe, which make Norwegian gas export more sensitive to demands from Europe. Natural gas will continuously get more important for the Norwegian petroleum industry, and unlike oil, large gas reserves still remains on the Norwegian continental shelf (Olje- og gassproduksjon, 2017).

A typical oilfield has a production cycle with a quick buildup to maximum production followed by the leveling off over some years (plateau production), before the production gradually decreases. Without further investment activity, the oil production will fall quickly. Even with significant actions, it is challenging to keep up the production. In the end, without new fields or greater investments in the existing fields, the production will fall like it did between 2001 and 2013. Due to the high development capacity over the last years it is expected that the production will be relatively stable the next years. The new fields will compensate for the falling production from aging fields. In the long run, exploration of new fields is necessary for the future production (Olje- og gassproduksjon, 2017).

Today, the petroleum industry is more important for the Norwegian economy than ever. The oil price's influence on Oslo Stock Exchange, investment, export, and income in Norway is a good representation for this. According to Olje- & energidepartementet (2016), the activity on the Norwegian Continental Shelf is and will continue to be central for the Norwegian economy, thanks to the large resisting resources and some meaningful development projects like Johan Sverdrup. For each year that passes, oil seems to play an even greater role in the Norwegian economy, but also in the global economy. The Norwegian petroleum industry is especially affected by changes in the oil price because of the large investments needed to produce oil offshore. Higher oil prices lead to more activity and optimism, while low oil prices lead to cuts and pessimism (Norsk olje&gass, n.d).

2.2 Brent Crude Oil

Different types of oil price benchmarks exist. Each of the benchmarks are representing crude oil from particular parts of the globe. The largest and mostly used benchmarks are Brent Blend, Texas Intermediate (WTI), Dubai Crude, and Onam Crude (Kurt, 2015). The difference between the benchmarks are simply the quality and area of delivery. Since they represent different crude oils from different places in the world, the crude oils will have different characteristics. The light (low density) and sweet (low sulfate content) crude oil benchmark has the highest demand since it is easier to refine. This type of crude oil will normally be priced higher than other types (Akram & Holter, 1996).

In this thesis, the focus will be put on the Brent Blend or Brent Crude oil price. This is because Brent crude is the benchmark for all oil produced on the Norwegian continental shelf, but also because this is the reference price for two thirds of all oil trades in the world (Holm, 2015). Brent Crude represents roughly two-thirds of all crude contracts around the world, and is the most widely used marker. "Brent" refers to oil from four different fields in the North Sea, namely Brent, Forties, Oseberg and Ekofisk. The crude oil found here is known for its high quality. The oil is light, with an API gravity of 37.5˚, and sweet, meaning that it has low sulfur content (0.37%). This makes the oil ideal for the refining of diesel fuel, gasoline and other high-demand products (Kurt, 2015) (Råvarehandel, 2017).

The oil prices used in the regression analysis later is based on daily prices for Brent spot (cash). This is the cash settlement price for the ICE Brent Future which is based on the ICE Brent Index on the expiry day for the relevant ICE Brent Futures contract month (ICE, 2016).

2.3 The World's Oil Supply and Demand

When crude oil, or petroleum, has been produced, it is sent to a refinery where the oil is separated into petroleum products. Crude oil is first of all used to produce energy-rich fuel. Petroleum products include transportation fuels like gasoline, diesel fuel, and jet fuel, as well as heating oil, asphalt, lubricating oils, plastic and waxes (EIA, n.d.). Because of its high-energy density, easy transportation, and relatively large reserves, oil has been the world's most important source of energy since the 1950's (IER, n.d.).

Crude oil is a global commodity, and the global oil market is more complicated than most people realize. Given the fact that the market is very dynamic, there are many forces that drive the cost up and down. The oil price is important for the Norwegian petroleum sector, the government revenue, the size of the Petroleum Fund (government pension fund), and thus for the Norwegian economy and the citizens in general. Internationally, oil is an important input in most countries' economies, and is the single-commodity in international trade with the largest turnover. The price of oil is of great importance for the economic development in and the income distribution between the oil importing and oil exporting countries, and is determined in the international market for oil trades (Austvik, 2016). Hence, the price of crude oil is dependent upon many factors.

The oil market can be described and analyzed based on microeconomic theory, and the price of crude oil can be determined by supply and demand, but also several other factors. Here, price elasticity of supply and demand is central. Generally, price elasticity is defined as the percentage change in quantity divided by a one percent change in price (Farnham, 2014).

2.3.1 Global Supply

The ten largest oil producing countries in the world constitutes over 60% of the world's total oil production. In 2015, the average oil production per day was 96.83 million barrels/day, while in 2016 it was 97.17 million barrels/day (EIA, 2017). The three largest oil producing countries are the United States, Saudi-Arabia, and Russia. They have produced approximately the same amounts of oil each day for the last years, lying between 11 and 13 million barrels/day each. With exception of the US, the world's 20^{th} largest oil producing countries are net exporters of oil (Produksjon av olje&gass, 2017).

In Norway, the Norwegian state is significantly more involved in the oil production than in other countries in the west. 67% of Statoil is owned by the Norwegian state after the partial privatization in 2001 (Statoil, 2017). Norway is the 14^{th} largest producer of oil, and covers approximately 2% of the global oil consumption with its production of 1.9 barrels/day. In 2016, export of petroleum constituted 47% of total Norwegian export. Since the global export is less than the production, and Norwegian production is far higher than Norwegian consumption, Norway's share of the world's oil export is higher than the share of production. About 70 million Sm^3 crude oil was directly exported to other countries in Europe, while 16 million Sm^3 was delivered to domestic refineries. Natural gas, on the other hand, is a different case, where Norway is the third largest exporter in the world, covering over 20% of the total European gas consumption (Eksport av olje og gass, 2017).

The Organization of the Petroleum Exporting Countries (OPEC) is a cartel consisting of 12 of the world's major oil exporting countries, mainly from the Middle-east and Africa. This organization aims to manage the supply of oil, and has been one of the defining actors on the supply side of the oil market for the past decade. OPEC aim to find methods to secure oil price stability for the international petroleum industry and in this way, avoid fluctuations that affect involved countries. The reason for this is to secure a stable and predictable income to the oil producing countries, an effective and predictable supply of oil and gas to the international community, and secure high returns for those who invest in the oil and gas industry. They have played an important role in the price and volume regulation in the oil market, even though their role has weakened because of large findings in the North Sea and the Gulf of Mexico, new licenses for oil production in Russia and modification of the market (OPEC, 2005) (Knudsen & Leraand, 2014). In 2015, the OPEC-countries accounted for 30% of the total oil production (Eksport av olje og gass, 2017). Production of oil from the sand in the Middle East is less expensive than producing oil from the bottom of the ocean or from oil sands. In the past years, the United States and Canada have had a severe growth in their oil production, strongly driven by increased production from oil sands in Canada as well as shale oil production in the US. The oil supply has overgone the oil demand, and the storages have been built up, leading to a weaker market share for OPEC. The organization also have weaker role in setting the price of oil (OPEC, 2015).

The supply of oil can be price elastic. The supply is just slightly elastic in the short term due to the fact that the marginal cost by producing one extra barrel of oil from an existing oil field is low. This is because the necessary investments to pump the oil from the field is already done. The supply curve will therefore be steep, which indicated that small volume changes go hand in hand with large price changes (Fiskå & Wangsvik, 2014).

In the long-term, the supply curve changes. A supply shock would not cause long-term changes in consumption, but if the long-term oil price expectations changes, the supply curves change as well. Although crude oil is the world's most important source of energy, it is not unique and irreplaceable. The total warmth giving value from coal, tar, oil sands, methane, and gas hydrates is greater than the value from crude oil. Additionally, there are other alternative energy sources like wind power, biomass, geotherm, atom power, and sun cell power. If the price of these alternative sources fall to a lower level than the crude oil, which have already happened with electricity production, all the alternative energy sources will substitute oil. The point is that the long-term, price of crude oil depends highly on the price of substitutes (Gabrielsen & Holtet, 2009).

2.3.2 Global Demand

About 81% of the global energy demand is covered by fossil energy. In 2015, oil was the largest energy source followed by coal and natural gas. In total, oil is covering approximately 31% of the world's total demand of energy. The most important drivers for the global demand of oil have historically been the population growth, supply and availability, economic activity, consumption patterns, and exploitation effect. This leads to an expected growth in global demand in the future as the emerging economies mature and the global population growth continues. Last year's supply shock and the accompanying fall in oil price have shown how consumption patterns change and oil consumption rises when the price falls. It is estimated that the global oil demand rose 3.3% in the first half of 2015 compared to the corresponding period in 2014 (Silent, n.d.) (Reuters, 2015). Further, during the financial crisis in 2007-2008, we could see how the demand quickly fell as the economic activity in the US fell. In the US, the demand fell 5.4% in 2008, while normally rising a few percentage points (Reuters, 2008).

Oil is traded and sold internationally in US dollars. Dollar depreciation generally tends to increase oil demand and raise the price of oil. Conversely the strengthening of the dollar reduces real income in consumer countries, decreasing the demand for oil and lowering prices. And lastly, oil consumption in developing countries that are not part of the Organization of Economic Cooperation and Development (OECD) has risen sharply in recent years. While oil consumption in the OECD countries declined between 2000 and 2010, non-OECD oil consumption has increased more than 40% (Clover Global Solutions, 2012).

If production exceeds demand, excess supplies can be stored. Non-OPEC countries produce 70% of the world's oil. These suppliers do not have sufficient reserves to be able to control price and can only respond to market fluctuations, although they are 50% larger than OPEC. OPEC, on the other hand, can directly influence market pricing. This is especially the case when the supply of oil produced by non-OPEC countries decreases (Clover Global Solutions, 2012). OPEC is the single largest entity that are impacting the world's oil supplies. The organization is responsible for 30% of the world's oil production (Eksport av olje og gass, 2017). They have the power to set policies among member countries to meet global consumption (Clover Global Solutions, 2012). The oil price can also change because of higher demand. If the demand is higher, the price of the crude oil jumps (Smart Touch Energy, 2016).

Demand can be price elastic. In the short run, the demand for oil is little price elastic. This is because several private persons and companies are very dependent on oil in their daily life, and it is hard to substitute. Cars cannot easily change its source of energy over the night, even though the number of electric cars are increasing. Since the demand is little price elastic, it means that in situations where the oil price is halved, the demand is not doubled (Fiskå & Wangsvik, 2014). The demand curve will be steep, indicating that small volume changes go together with large price changes. In the long-term, the demand curve changes, depending on the long-term price expectations.

2.3.3 Setting the Price

The price of crude oil is primarily impacted by the supply and demand, and the market sentiment. The price is set in the oil futures market, meaning that the price of oil is determined based on supply, demand, and market sentiment toward oil futures contracts (Kosakowski,2016). According to Kosakowski (2016), an oil futures contract is a binding agreement that gives one the right to purchase oil by the barrel at a predefined price on a predefined date in the future. Under a futures contract, both the buyer and the seller are obligated to fulfill their side of the transaction on the specified date. Clients buy futures to hedge against oil price increases that could affect their profitability.

Buyers of oil are mainly the refineries where oil is converted into fuel and other petroleum products. The market where the oil price is determined works in a way that the oil refineries puts out demands for crude oil, and the price of the crude oil is then determined from the refineries margins on their own end products and the market demand for these. The last years, the share of the trades with oil futures have increased significantly since more and more financial market participants eager to be directly exposed of oil (Eksport av olje og gass, 2017).

Other factors that influence the determination of the oil price is war, restrictive legislation, political events and crisis, financial markets, natural disasters, speculative buying, change in the value of the dollar, and non-OECD demand. Since the global oil market is politicized, most of the world’s oil reserves and production are controlled by government-run companies. In Norway, the price of oil is influenced by the energy policies and taxes. Extreme weather conditions can, as well, physically affect production facilities and infrastructure disrupting the supply of oil and induce pricing spikes. Hurricane Katrina in 2005 caused a large price increase when it destroyed hundreds of oil and gas platforms and pipelines (Clover Global Solutions, 2012) (Smart Touch Energy, 2016).

3. Oslo Stock Exchange

The Norwegian economy is heavily dependent on the oil price and the continuous changes in it. The question answered in this thesis is whether or not there is a relation between the oil price and the Oslo Stock Exchange Benchmark Index. To analyze the correlation between them, an overview of the benchmark index and its share indices are presented below.

3.1 The Benchmark Index

The benchmark index at the Oslo Stock Exchange is named The Oslo Stock Exchange Benchmark Index (OSEBX). This index contains a selection of shares which together must be representative for the listed companies on the Stock Exchange. It is an investible index which comprises the most traded shares that are listed on the Oslo Stock Exchange. The index is used to measure the return for the Norwegian stock market, and is adjusted every six months, December 1st and June 1st. Per December 1$^{st.}$ 2016, the OSEBX index constituted of 62 shares. The market value of the companies listed on the OSEBX per December 2016 was 2,208 million NOK. Through the lifetime of the index, the number of shares which have been included in the index have varied between 52 and 81 (Hovedindeksen, 2017).

Figure 3.1 The Oslo Stock Exchange Benchmark Index (OSEBX) over the last 5 years (Hovedindeksen, 2017).

In 2009, oil and gas related businesses was one of the largest branches on the stock market, making up 54.9% of the market value of the benchmark index. Today, the market shares of the OSEBX is slightly different. Per January 2017, oil and gas related businesses makes up 14.52% of the market value of the benchmark index, which means 9 oil and gas related companies. The largest sector on the OSEBX is OSE20GI Industrials, which made up 22.58% of the index, followed by the OSE10GI Energy Sector and the OSE45GI Information Technology sector which each make up 14.52% (Hovedindeksen, 2017). The rest of the share indices can be seen in the sector diagram in figure 3.2, put together by information from Oslo Børs.

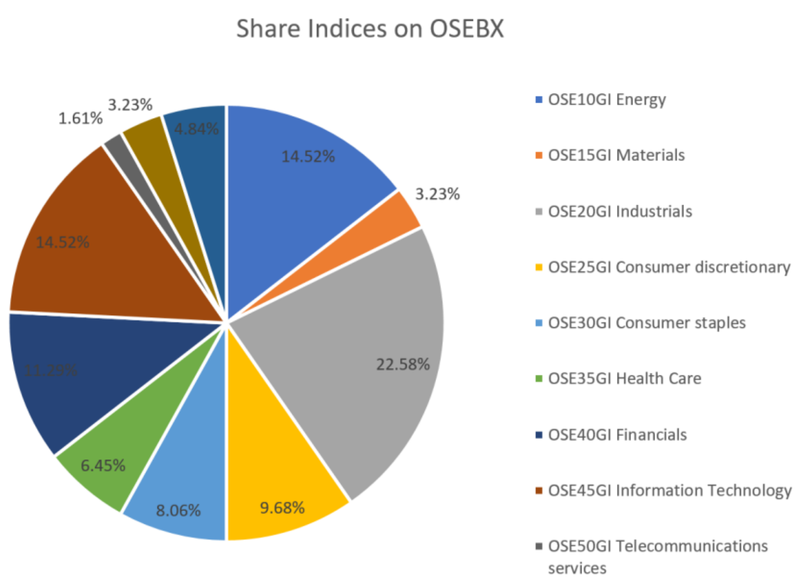


Figure 3.2 Share Indices on the Oslo Stock Exchange, measured in number of companies.

3.2 Owners Distribution on the Oslo Stock Exchange

When performing an empirical analysis of the fluctuations in the oil price and its influence on the Oslo Stock Exchange, it is important to have some understanding about the owner's distribution. The proportion of foreign investors increased from 2003 till the summer of 2008 because of increasing oil prices. When the stock market decline started in the fall of 2008, the proportion decreased as an effect. This gives an understanding that the Oslo Stock Exchange is a spot for foreign investors who wants to be exposed to oil and its richness. A consequence of this is that the Oslo Stock Exchange have gotten more conjuncture cyclical than before. The statistics below gives an overview over the ownership distribution of companies listed on the stock market in Norway (Oslo VPS, 2017). In the graph, it is clear that foreign investors and public administration constitute the largest part, while all the other groups are represented low on this scale.

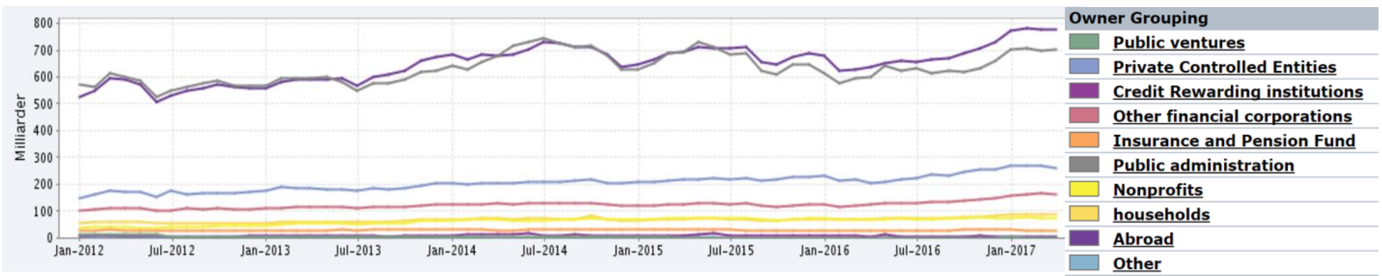


Figure 3.3 Owners distribution of companies listed on the stock market in Norway (Oslo VPS, 2017)

4. Statistical Method

In this thesis, I have used a regression model to elucidate whether oil prices are affecting the Norwegian stock market or not. A deeper dive into the theory behind the statistical method used will therefore be necessary. To provide the reader an overview of the statistical method used, the method for estimation and testing will be explained. The results from the regression analysis of treated data will constitute the main basis for discussion and conclusions. It is important that the reader is critical to the methods used, since different approaches could potentially determine the results.

4.1 Regression Analysis

Regression analysis is the most important tool when it comes to the field of econometric statistics. It is a statistical tool which consists of techniques for modeling the relationship between variables. Generally, regression describes and evaluates the relationship between a given dependent variable and one or more independent variables. The dependent variable, y, can be explained by one or more independent variables, x. This can be written as:

$$y_t = \alpha + \beta x_t + \varepsilon_t$$

where α is constant, β is the regression coefficient for the independent variable x, which measures the effect on the y variable, and u is the error term which represent variation in the dependent variable unexplained by the function of the dependent variable and coefficient at time t (Bacon, 2013). In the equation, y is the variable whose movements the regression seeks to explain, while the x-variables that are used to explain those variations.

4.1.1 Regression Versus Correlation

"The correlation between two variables measure the degree of linear association between them" (Brooks, 2008). If two variables, y and x, is stated to be correlated, there is evidence for a linear relationship between the two, and that the magnitude of changes are measured by a correlation coefficient. Because they are correlated, the variables are being treated in a symmetrical way.

When it comes to regression, the two variables are treated very differently. The dependent variable, y, is assumed to be random, i.e. to have a probability distribution, while the independent variables, x_t, are assumed to be fixed values. This gives reason to state that regression is a more flexible and powerful tool than correlation (Brooks, 2008).

4.1.2 The Simple Linear Regression (SLR) Model

Regression analysis with a single explanatory variable is called simple regression. Simple regression means that one variable, y, is explained only based on one other variable, x. This sub-chapter deals with the topic of simple linear regression, treating the case of a single dependent variable y and an independent variable x, in which the relationship between y and x is linear (Yan & Su, 2009).

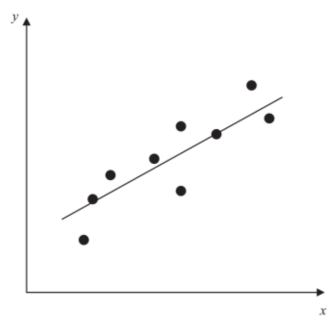


Figure 4.1 Simple Linear Regression Plot (Brooks, 2008).

The first stage to go about solving this would be to plot the variables using a scatter plot, and then analyze whether there is a relation between the variables. To find a line that best fits the data given in the scatter plot, the general equation for a straight line is used:

$$y_t = \alpha + \beta x_t$$

To account for any error or random disturbance, the term u_t can be added to the above equation. The first step is then to find the values of the parameters α and β, which will place the regression line as close as possible to all the data points. The parameters are chosen so that the vertical distances from the data points to the fitted lines are minimized (Brooks, 2008).

There exist different methods to estimate the value of the regression coefficient. The most common method that are used to fit a line to data points in a scatter plot is known as ordinary least squares (OLS). "The method entails taking each vertical distance from the point to the line, squaring it and then minimizing the total sum of the areas of squares" (Brooks, 2008). The point is to minimize the sum of the squared residuals. Some of the plotted dots will lie above and some below the fitted line, and to avoid the problem of positive and negative values, the distances are squared and then summed after.

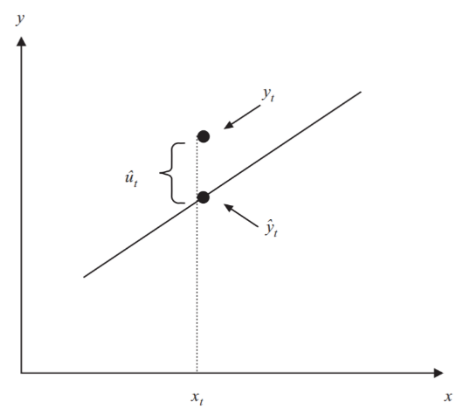


Figure 4.2 Single observation plotted together with the line of best fit, the residual and the fitted value (Brooks, 2008).

Further, let $\widehat{y_t}$ denote the fitted value from the regression line (same as y_t). Then, the equation for the residual sum of squares (RSS), denoted by L, is given as:

$$\hat{\varepsilon} = (y_t - \widehat{y_t}),$$

$$L = \sum_{t=1}^{T} \hat{\varepsilon}_t^2 = \sum_{t=1}^{T} (y_t - \widehat{y_t}) = \sum_{t=1}^{T} (y_t - \hat{\alpha} - \hat{\beta} x_t)^2.$$

To find the values for α and β that minimize the residual sum of squares, the coefficient estimators can be calculated using the below equations.

$$\hat{\beta} = \frac{\sum x_t y_t - T\overline{xy}}{\sum x_t^2 - T\bar{x}^2}$$

$$\hat{\alpha} = \bar{y} - \hat{\beta}\bar{x}.$$

These equations state that it is always possible to calculate the values of the two coefficients that best fits the data given only the observations x_t and y_t (Brooks, 2008).

4.1.3 Assumptions for the OLS Method

There are different prerequisites for the OLS method. Before we can use a linear regression model to perform statistical tests, the following assumptions concerning disturbance terms and their interpretation must be held:

(1) $E(u_t) = 0$. The expected value of the error term must be 0.
(2) $Var(u_t) = \sigma^2 < \infty$. The variance of the errors is constant and finite.
(3) $Cov(u_i, u_j) = 0$. The error terms are not correlated, meaning that they are linearly independent.
(4) $Cov(u_t, x_t) = 0$. The explanatory variables are non-stochastic. There is no relationship between the error and corresponding x variate.
(5) $u_t \sim N(0, \sigma^2)$. The error terms are normally distributed.

The estimated values $\hat{\alpha}$ and $\hat{\beta}$, and the OLS will have the desirable properties if it can be proved that the above assumptions number 1-4 holds. The desirable properties are known as the Best Linear Unbiased Estimators (BLUE) (Brooks, 2008).

4.1.4 Precision and Standard Errors

α and β are specific to the sample used in their estimation in any set of regression estimates. If another data sample was selected, the data points would be different, leading to other values of the OLS estimates. It is consequently desirable to check the reliability or precision of the estimators. Thus, it is useful to know whether one can have confidence in the estimates, and if they are likely to vary much within the given population. Valid estimators of the standard errors are given by the equations below, based on the above assumptions 1-4 (Brooks, 2008):

$$SE(\hat{\alpha}) = s\sqrt{\frac{\sum x_t^2}{T\sum(x_t - \bar{x})^2}},$$

$$SE(\hat{\beta}) = s\sqrt{\frac{1}{\sum(x_t - \bar{x})^2}},$$

where s is the estimated standard deviation of the residuals, given by the equation:

$$s = \sqrt{\frac{\sum \hat{\varepsilon}_t^2}{T-2}}.$$

4.1.5 Statistical Interference

Hypothesis Testing

It is often necessary to determine whether certain coefficients stay within limitations concerning financial theory when performing a regression analysis. Hypothesis testing is derived to check if financial theory can be right. A selection of the population, that the theory is supposed to apply to, are then compared with what is originally stated in the theory.

There are primarily two approaches when it comes to hypothesis testing, namely the Significance Approach and the Confidence Interval. Both of the approaches starts off with formulating a null hypothesis (H_0) and an alternative hypothesis (H_1), continued by estimating the parameters α, β, SE($\hat{\alpha}$), and SE($\hat{\beta}$) as explained above. After these steps, the two approaches are slightly different (Brooks, 2008):

Method 1: Significance Approach. The next step when using the significance approach is to calculate the test statistic, which is given by the equation:

$$test\ statistic = \frac{\hat{\beta} - \beta^*}{SE(\hat{\beta})},$$

where $H_0 = \beta$ and $H_1 = \beta^*$. The test statistics derived by this formula follow a t-distribution with T-2 degrees of freedom. A significance level, α, should then be chosen, which is usually sat at 5%. The significance level allows for a rejection and non-rejection region to be determined. Then, t-tables are used to obtain a critical value or values with which to compare the test statistic. The final step is formerly to perform the test. If the test statistics lies in the rejection region, the null hypothesis should be rejected. Otherwise, do not reject (Brooks, 2008).

Method 2: Confidence Interval. After choosing a null hypothesis and an alternative hypothesis, and estimating the different parameters, the next step in carrying out a hypothesis test using confidence interval, is to choose a significance interval, α. Choosing a significance interval equal to 5% is equivalent to choosing a (1 – α) * 100% = 95% confidence interval. In this method, one must use t-tables to find the critical values. The confidence interval for β is then given by:

$$\left(\hat{\beta} - t_{crit} \cdot SE\left(\hat{\beta}\right), \hat{\beta} + t_{crit} \cdot SE(\hat{\beta})\right)$$

The next step is then to perform the test. If the hypothesized value of β lies outside the confidence interval, reject the null hypothesis. Otherwise, keep it (Brooks, 2008).

Goodness of Fit Statistics, R^2

After conducting a regression analysis, it is desirable to have a measure of how good the regression model fits the data. The goodness of fit statistics test how close the fitted regression line is to all the data points taken together. The most common goodness of fit statistic is known as R^2. R^2 is the square of the correlation coefficient between y and $\hat{y}$. The correlation coefficient of R^2 must lie between 0 and 1. If the correlation is high (close or equal to 1), the model fits the data well, while if the correlation is low (close or equal to 0), the model is not providing a good fit. The goodness of fit statistics is given by the ratio:

$$R^2 = \frac{ESS}{TSS},$$

where TSS is the total sum of squares, given by

$$TSS = \sum_t (y_t - \bar{y})^2.$$

The TSS can be split into two parts: the part that has been explained by the model (ESS) and the part that the model was not able to explain (RSS). That is

$$TSS = ESS + RSS$$

$$\sum_t (y_t - \bar{y})^2 = \sum_t (\hat{y}_t - \bar{y})^2 + \sum_t \hat{\varepsilon}_t^2.$$

The goodness of fit statistics using R^2 is a simple way to calculate and get an answer on how the regression line fits the data. But, this method also comes with some problems related to the squared value as a goodness of fit measure. These problems are related to the fact that R^2 is defined so that if the dependent variable changes, R^2 will also change. Another problem is that the value of R^2 never falls if more regressors are added. R^2 can take values of 0.9 and above for time series regressions. To account for this, an adjusted R^2 can be used (Brooks, 2008).

4.2 Stationarity

To make statistical interferences of time series data, the data must be stationary. A time series is stationary if its mean and variance do not vary systematically over time, i.e. are time invariant, and the covariance between the time periods depends only on the distance between the periods and not the actual time. If that is not the case, then the time series is non-stationary. Thus, a non-stationary time series has a time-varying mean and/or a time-varying variance (Gujarati, 2004).

If the variables in a regression model is non-stationary, the normal t-states will not follow a t-distribution, and the F-states will not be F-distributed. The conclusion is that it is not possible to derive hypothesis tests in a regression with non-stationary regression parameters. Time series data should therefore be examined by using yield figures instead of the absolute value of a parameter.

If a time series is non-stationary, its behavior can only be studied for the time period under consideration. The consequence is that it is not possible to generalize it to other time periods. It is therefore necessary to transform a non-stationary time series to stationary. A non-stationary variable can be transformed to a stationary variable by differencing:

$$y_t - y_{t-1} = \alpha + \varepsilon_t$$

The time series will thus be stationary for all *n* time intervals since every error term, u_t, is identical and independently distributed. Stationarity has been induced by differencing once, which can be written I(1) (Brooks, 2008).

Stationarity can be examined in three different ways; examine stationarity by plotting the data in a graph and then interpret them, do an autocorrelation test or a by performing a Dickey-Fuller unit root test. The Dickey-Fuller unit root test is used to examine stationarity by running the regression:

$$Y_t = \varphi Y_{t-1} + \varepsilon_t$$

where $\varphi = 1$ is non-stationary.

$$Y_t - Y_{t-1} = \varphi Y_{t-1} - Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = (\varphi - 1) Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = \rho Y_{t-1} + \varepsilon_t$$

where ρ is a coefficient of autocorrelation. If $\rho = 0\ so\ that\ \varphi = 1$, the test concludes with the existence of a unit root, meaning there is non-stationarity (Gujarati, 2004).

However, stationarity will not be tested here as we assume the values to be stationary when using logarithmic return values instead of the price from day to day. Using the logarithmic functions will assure the stationarity we need to perform the regression analysis and to neglect meaningful errors.

5. Statistical Approach

5.1 Data Handling and Independent Variables

This thesis explores the dynamic relationship between the oil price and the Oslo Stock Exchange Benchmark Index (OSEBX). The data are retrieved from the Oslo Stock Exchange, Professor Atle Øglend, Norges Bank, Federal Reserve Bank of St. Louis, and from Yahoo Finance. The data set analyzed is based on daily observations in the time period from 2001 to 2016. The reason for this is to be able to analyze the impact of oil price changes from day to day, and what it has to say for the running development in the Norwegian stock market. This correspondingly give an insight into the long-term effects from the fluctuations in the oil price. In addition to analyzing the whole period as one, I will also divide the it into four smaller periods of interest because of the up- and downturns in the oil market:

- The upturn in the oil market before the international financial crisis in 2008 (2007-2008)
- Downturn in the oil market after the international financial crisis in 2008 (2008-2009)
- Stable period with ups and downs in the oil price (2009-2014)
- The period from 2014 and until today; rapid decrease followed by a slow increase in the price of oil (2014-2016)

To ensure stationarity, I have calculated the logarithmic return on all variables. Further, all regressions are done for the Brent Crude oil price since this is the price used for the oil found in the North Sea. The oil price is expressed in dollars while the benchmark index is expressed in Norwegian kroner. The currency exchange rates are retrieved from Norges Bank, and are included in the regressions. Additionally, for all variables, days with no listings, e.g. weekends and other days with no trading, are eliminated from the regression analysis. The data is then analyzed in excel, using the built-in regression analysis program.

The regression model used (e.g for the OSEBX) is as follows:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\,price_t} + \varepsilon_t$$

The graph presented below will give an overview over the development in oil price (in NOK) and the changes in the Oslo Stock Exchange Benchmark Index over the period from 2000 to 2016. The two main events influencing the changes are marked; The international financial crisis in 2008 and the crack in the oil price in 2014 due to overproduction. Before the international financial crisis took place in 2008, we can see that the oil price was to some extent continuously increasing, followed by several ups and downs the next years.

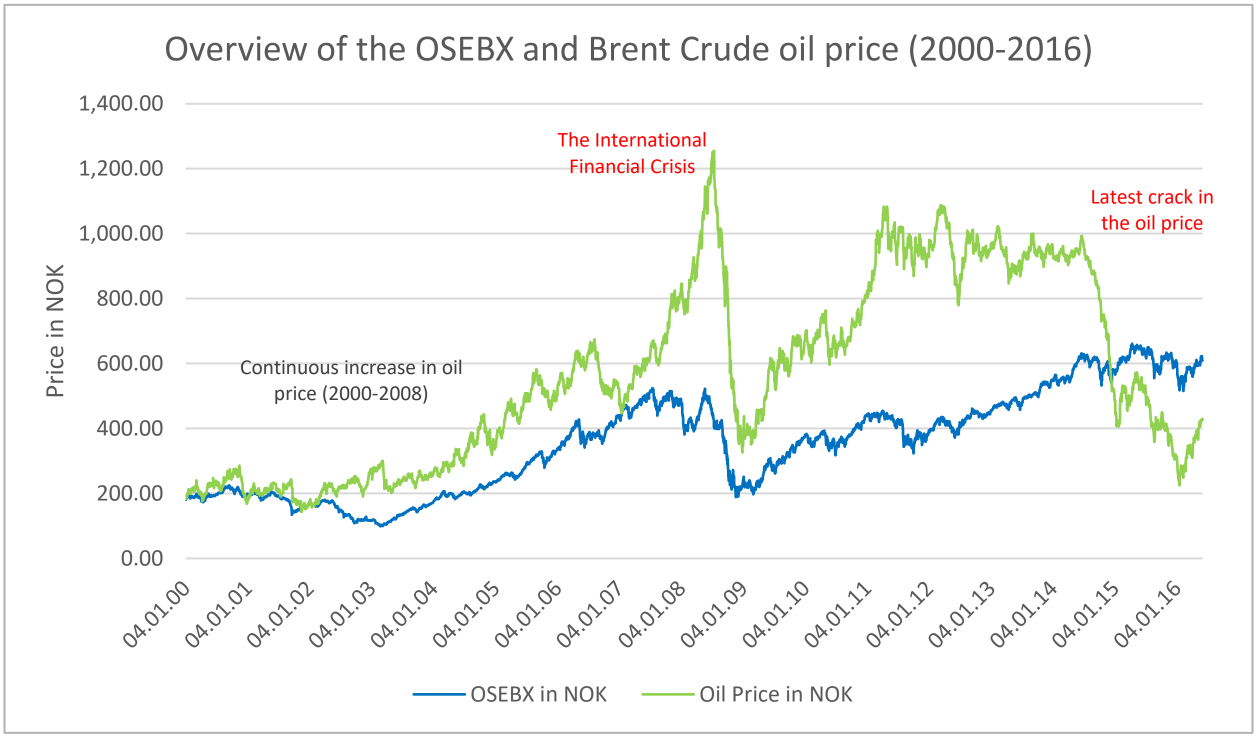


Figure 5.1 Graphical representation of the relation between the OSEBX and the Brent Crude oil price (prices in NOK).

The focus will mainly be put on analyzing the effect of the different up- and downturns in the oil price, and see how it affected and affects the stock market in Norway, reflected by the OSEBX. The price of oil is not the only variable that affects the stock market, and to avoid wrong estimation or overestimation of the influence of the oil prices in the regression analysis, it is therefore necessary to include other independent variables that are expected to have explanatory powers, like Nibor, S&P500, the currency exchange factor. Before conducting the statistical regression analysis, the different independent variables will be presented below.

5.1.1 Nibor 3M

Nibor (Norwegian Interbank Offered Rate) is a collective term for Norwegian money market rates at different maturities. Nibor is intended to reflect the interest rate level lenders require for unsecured money market lending in NOK. Nibor have different maturities, and is published for one week, 1 month, 2 months, 3 months, and 6 months. The interest rate is calculated as a simple average of interest rates published by the Nibor panel banks for each maturity. The interest rates published by the panel shall reflect which interest rate the bank charges on lending NOK to a leading bank that is active in the Norwegian money and foreign exchange markets. The rates are to be regarded as best possible estimates, not binding offers. In this thesis, the 3-month nominal Nibor is used as it is the most common Nibor-parameter used in these contexts (3 Month Nibor Rate, 2017).

5.1.2 S&P500

The S&P 500 is an American stock market index. This index is based on the market capitalization of 500 large leading companies in leading industries of the U.S. economy, which are publicly held on either NYSE or NASDAQ. The index covers 75% of U.S. equities. Examples of the largest companies in this index are Apple, Microsoft and Exxon Mobile. The index is seen as a common indicator for the total stock market and the economy. Since the S&P 500 is a price index and not a total return index, it does not contain dividends (Economic Research, n.d.). This index is included to catch the general economic climate in the global market. The stocks on the Oslo Stock Exchange is exposed to the world economy, and by including this variable, it will pick up some of the exposure that the other variables do not catch.

5.1.3 Currency Exchange Rate

Approximately all oil contracts are traded in USD. It is therefore natural to include the NOK/USD as an independent variable in the model. Many of the Norwegian oil companies on the Oslo Stock Exchange also has its income in USD because of the listed price for oil. It is therefore expected that the economy is affected by changes in the currency (Olsen & Velgaard, 2015).

5.1.4 OSE10GI Energy

This sector index of the OSEBX comprises companies whose businesses are dominated by oil and gas related businesses. Companies engaged in the exploration, production, marketing, refining and/or transportation of oil and gas products, coal and other consumable fuels are to be found in this section (OSE10GI, 2017). The reason that this sector index is included in the regression analysis of the market is that this sector constitutes the oil related businesses of the OSEBX, and it is interesting to see how the OSEBX is affected by it.

5.2 Time Difference Problematics

When data retrieved from different time zones are compared, problems related to time difference appears. The Brent Crude oil is noted on the Intercontinental Exchange stock in London. The end notation for the London-stock, and hence the ICE, is one hour after the Oslo Stock Exchange closes. This means that fluctuations in the oil price will appear for one hour after the market in Norway is closed. The price of the North Sea oil can therefore be said to change most of hours of the day. When Oslo Stock Exchange is opened for trade the day after, new information is usually available about the oil price which can affect the stock market. Also, since the S&P 500 is calculated by the end of the stock market in the US, time difference makes sure that the Norwegian market only gets the first hours of the American stock market before the stock market in Norway closes. The time difference can be adjusted to calculate relative return for both zero and one day lagged return.

5.3 Effects of Oil Price Shocks

Oil Price Shocks in Oil Importing Countries

Increasing oil prices lead to a fall in net quantity of energy used in production. Thus, an increase in the oil price will lead to an increase in the production costs, and a decrease in companies' production. This reduction in production and revenue force the consumers in oil importing countries to hold back on the consumption and investments, and reduce the overall demand and production (Hamilton, 2005).

Even though increasing oil prices lead to a restriction within production and economic activity for oil importing countries, the expected opposite effect by a fall in the oil price is not present (Baumeister & Peersman, 2008). Normally, one would expect that a fall in the oil price would lead to a fall in production costs and therefore increased production. This makes it natural to adapt differently during oil price falls than rise (Kilian, 2009).

Oil Price Shocks in Oil Exporting Countries

An increased oil price can affect an oil exporting country in two ways. It is easy to imagine that the Norwegian economy will get positive revenue- and fortune-effects when the oil price is high. A high oil price will lead to increased activity in Norwegian economy and increases welfare, in the short-run. On the other side, a high oil price will lead to negative trade effects through that Norwegian export also becomes more expensives. A high activity level in the economy will normally push inflation and domestic currency up. Thus, leading to the fact that Norwegian export is weaker in the competition with foreign competitors. Increased oil price will also lead to a fall in the production for oil importing countries, which again means that these countries will demand less of the export goods (Bjørnland, 2008).

The effect of an oil price shock depends on what causes the change. If the increase in oil price is due to a positive demand shock, it is because of high activity in the world economy. It is natural to expect that high activity in the world economy will give positive effects to both oil importing and oil exporting countries (Kilian, 2009). On the other hand, if a fall in the oil price appears due to a negative demand shock, it can oppositely be caused by fundamental weaknesses in the world economy. This would hurt Norway hard, since the country's economy would be affected by two negative effects, namely a fall in the oil price and lower activity in the world economy (Cappelen et. al., 2014).

When a fall in the oil price is caused by a positive supply shock, that more oil than what is demanded is produced, and the rest of the world economy is like normal, one can expect that the effects mainly will hit the oil sector in the oil exporting countries in the short run (Cappelen et. al., 2014).

6. Statistical Analysis

When studying the oil price' influence on the Norwegian economy, an important precondition would be that the market actually responds to changes in the oil price.

6.1 Calculation of Absolute Return

The two most common ways to calculate the return for an index is simple arithmetic return or logarithmic continuous return. When working with time series data and empirical finance, logarithmic return is most common. This also eliminate problems related to autocorrelation (Olsen & Velgaard, 2015).

Logarithmic return measures continuous interest rate return from period to period. For financial data, it is expected to be normally distributed (Brooks, 2008). If calculating the return over a longer period, arithmetic return should be used. In the regression analysis performed here, the variables have been defined as follows by absolute return:

$$Return\ Index_t = \ln\left(\frac{P_t}{P_{t-1}}\right) = \ln(P_t) - \ln(P_{t-1})$$

where P is the absolute value of the index at time t (Olsen & Velgaard, 2015).

The interpretation of the coefficients for the logarithmic return is as follows: if a change in the return of an independent (explaining) variable goes up 1%, the change in the return of the OSEBX goes up/down equal the value of the coefficient in percent.

6.2 Data Approach

The general equation for the linear regression model can be written:

$$y_t = \alpha + \beta_1 x_{t1} + \beta_2 x_{t2} + \cdots + \beta_k x_{tk} + \varepsilon_t$$

The model examines how much the oil price and the other given independent variables are affecting the Oslo Stock Exchange Benchmark Index. First, I will look at how the oil price affects the OSEBX, using the single regression equation:

Model 1:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\,price_t} + \varepsilon_t$$

Further, I will expand the equation by adding more and more of the independent variables. This will give different regression models that can be compared later, and it will give an indication of how the different variables are affecting the OSEBX. The three other regression equations are listed below. I will use these for the whole period of time from 2001 to 2016, and then discuss the results before conducting regression analysis for several different periods within these years.

Model 2:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\,price} + \ \beta_1 \cdot Return_{Currency} + \varepsilon_t$$

Model 3:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\,price} + \ \beta_1 \cdot Return_{Currency} + \ \beta_2 \cdot Return_{Nibor} + \varepsilon_t$$

Model 4:

$$Return\ OSEB = \alpha + \beta_0 \cdot Return_{Oil\,price} + \ \beta_1 \cdot Return_{Currency} + \beta_2 \cdot Return_{Nibor} + \beta_3 \cdot Return_{S\&P500} + \varepsilon_t$$

Formulating the Hypothesis

For the regression analysis, a null and an alternative hypothesis needs to be set and tested. The hypothesis chosen here are:

- Null hypothesis, H_0; states that a change in the oil price would not influence the OSEBX.
- Alternative hypothesis, H_1; Stated that the oil price is influencing the OSEBX.

Then the oil coefficient must deviate from zero. Thus, the following hypothesis will be tested, with a significance level of 5%:

$$H_0: \beta_0 = 0 \text{ and } H_1: \beta_0 \neq 0$$

6.3 Descriptive Statistics

The tables below show the average, standard deviation, minimum and maximum values for absolute data and for the logarithmic data (absolute return) for the period 2001 to 2016.

Descriptive Statistics Absolute Values

	OSEBX	OSE10GI	Oil Price	Currency	Nibor	S&P 500
Mean	367.160	466.870	68.800	6.628	3.310	1344.012
Std dev	152.261	198.053	32.213	1.041	1.931	347.706
Max	661.318	868.730	145.490	9.456	7.910	2130.820
Min	98.570	111.180	16.570	4.959	0.940	676.530
N	3719	3719	3719	3719	3719	3719

Descriptive Statistics Absolute Logarithmic Return

	OSEBX	OSE10GI	Oil Price	Currency	Nibor	S&P 500
Mean	0.000318	0.000325	0.000208	-1.93E-05	-0.000530	0.000158
Std dev	0.015370	0.017892	0.021508	0.007923	0.013301	0.012695
Max	0.101388	0.115625	0.103678	0.044155	0.190000	0.109572
Min	-0.104778	-0.115512	-0.223644	-0.059176	-0.140000	-0.094695
N	3718	3718	3718	3718	3718	3718

6.4 Analysis of the Whole Period (Year 2001 to 2016)

To get a proper answer on how the different variables affect the logarithmic return on the OSEBX, I have decided to divide the analysis in four different regression models. All variables used in the analysis have been presented in chapter 5.

The main focus area of this thesis is the oil price influence on the Oslo Stock Exchange, and therefore the oil price coefficient and its influence will be the main area of discussion in this part.

6.4.1 Model 1

This model examines how the oil price as a single regressor influence the Oslo Stock Exchange benchmark index. Model 1 is given by the equation below:

$$Return_{OSEBX} = \alpha + \beta_{0_t} \cdot Return_{Oil\ price_t} + \varepsilon_t$$

The regression results are given in table 6.1. The results show that the OSEBX is positively influenced by an increase in the price of oil. The model confirms that if the return in the price of oil increases by 1%, the return on the OSEBX will increase by 0.0596%. It is expected that an increase in the oil price will influence the index positively because the companies listed on the stock exchange will give ripple effects to other oil related business that are listed on the OSEBX.

The greater the magnitude of the t-statistic, the greater the evidence against the null hypothesis that there is no significant difference. The closer t is to 0, the more likely there is not a significant difference. The t-value here is 5.099, which indicate that the value is significant. The oil price changes are strong positively correlated with the changes in the benchmark index. The result give reason to state that the oil price can be seen to lead the benchmark index on the Oslo Stock Exchange.

After conducting a regression analysis, it is desirable to have a measure of how good the regression model fits the data. Based on the goodness of fit statistics, there is low correlation between the data and the fitted line. R^2 is 0.00695 in this case, which indicates that the linear regression line given by the model does not provide a good fit to the data. This makes sense given the large spread in the data sets and e.g. due to omitted variables.

Putting the regression results into the above equation for model 1, we get the following equation:

$$Return_{OSEBX} = \quad 0.000301 + 0.059585 \ \cdot Return_{Oil\ price_t} + \varepsilon_t$$

Regression Statistics	
Multiple R	0.08337
R Square	0.00695
Adjusted R Square	0.00668
Standard Error	0.01532
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000301	0.000251	1.196355
Ln_Oilprice	0.059585	0.011685	5.099323

Table 6.1 Regression Results for the period 2001-2016, using model 1.

6.4.2 Model 2

This model examines how the oil price together with the currency exchange factor influence the Oslo Stock Exchange benchmark index. Model 2 is then explained by the equation below:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\ price} + \ \beta_1 \cdot Return_{Currency} + \varepsilon_t$$

The regression results are given in table 6.2. The results show that the OSEBX is positively influenced by an increase in the oil price. If the price of oil increases by 1%, the return on the OSEBX will increase by 0.0435%. By looking at the results from the previous model, the effect from the oil price change is slightly less in this case. The currency exchange factor lowers the beta value for the oil price. The beta value for the currency exchange factor is -0.4477, meaning that a 1% increase in the currency exchange factor will lead to a decrease of 0.4477% in the OSEBX return. This indicates that the currency exchange factor is negatively influencing the benchmark index return.

For this model, the t-value for the oil price is 3.808, which indicate that the value is significant. The oil price change is positively correlated with the changes in the benchmark index. This result give reason to say that the price of oil is a slightly leading indicator on the OSEBX.

The goodness of fit statistics, represented by R^2 is low (0.0592), meaning that the linear regression line does not fit the plotted data well. There is low correlation between the data and the fitted line. In this model, the R^2-value is significantly greater than for the first model, indicating that the model gives a better explanatory power of the OSEBX index.

Using the regression results, this model's equation can be written:

$$Return_{OSEBX} = 0.000294 + 0.043513 \cdot Return_{Oil\ price} - 0.447697 \ \cdot Return_{Currency} + \varepsilon_t$$

Regression Statistics	
Multiple R	0.24433
R Square	0.05970
Adjusted R Square	0.05919
Standard Error	0.01491
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000294	0.000245	1.203463
Ln_Oilprice	0.043513	0.011426	3.808203
Ln_Currency	-0.447697	0.031018	-14.433644

Table 6.2 Regression results for the period 2001-2016, using model 2.

6.4.3 Model 3

This model examines how the oil price together with the currency exchange factor and the 3 month Nibor rate influence the Oslo Stock Exchange benchmark index. Model 3 can then be explained by the following equation:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\ price} + \ \beta_1 \cdot Return_{Currency} + \ \beta_2 \cdot Return_{NIBOR} + \varepsilon_t$$

The regression results are given in table 6.3. The results show that the OSEBX is positively influenced by an increase in the oil price. If the price of oil increases by 1%, the return on the OSEBX will increase by 0.0434%. By looking at the results from the previous model, model 2, there is barely no change here. The beta value for the currency exchange factor is still negative (-0.4417), meaning that a 1% increase in the currency exchange factor will lead to a decrease of 0.4477% in the OSEBX return. The beta value for the Nibor rate is 0.0187, which means that a 1% increase in the Nibor rate will lead to an 0.0187% increase in the OSEBX index.

For this model, the t-value for the oil price is 3.798, which indicate that the value is significant. The oil price change is positively correlated with the changes in the benchmark index. On the other hand, the goodness of fit statistics, represented by R^2 is low (0.0599), meaning that the linear regression line does not fit the plotted data well. In this model, the R^2-value is significantly greater than for the first model, indicating that the model gives a better analysis of the OSEBX index.

In comparison to model 2, model 3 with the Nibor rate included exhibits only small differences. We can see that the influence of the oil price on the OSEBX is almost unchanged. The goodness of fit statistics is also approximately the same as it was in the previous model. This indicate that the Nibor rate does not change the results significantly when studying the oil price's influence on the OSEBX.

Using the regression results, this model's equation can be written:

$$Return_{OSEBX} = 0.000304 + 0.043393 \cdot Return_{Oil\ price} - 0.441713 \cdot Return_{Currency} + \ 0.018657 \cdot Return_{NIBOR} + \varepsilon_t$$

Regression Statistics	
Multiple R	0.24484
R Square	0.05995
Adjusted R Square	0.05919
Standard Error	0.01491
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000304	0.000245	1.243841
Ln_Oilprice	0.043393	0.011427	3.797506
Ln_Currency	-0.441713	0.031594	-13.980856
Ln_Nibor	0.018657	0.018735	0.995860

Table 6.3 Regression results for the period 2001-2016, using model 2.

6.4.4 Model 4

This model examines how the oil price together with the currency exchange factor, the 3 month Nibor rate and the S&P500 Index influence the Oslo Stock Exchange benchmark index. Model 4 can then be explained by the following equation:

$$Return_{OSEBX} = \alpha + \beta_0 \cdot Return_{Oil\ price} + \ \beta_1 \cdot Return_{Currency} + \ \beta_2 \cdot Return_{Nibor} + \beta_3 \cdot Return_{S\&P500} \ + \varepsilon_t$$

In the regression analysis, the benchmark index was used as the dependent variable. The regression results are given in Table 6.4. The results show that the OSEBX is positively influenced by an increase in the oil price. If the price of oil increases by 1%, the return on the OSEBX will increase by 0.0452%. The beta value for the currency exchange factor is still negative (-0.3219). The beta value for the Nibor rate is 0.0212, which means that a 1% increase in the Nibor rate will lead to an 0.0212% increase in the OSEBX index. Lastly, the beta value for the S&P500 index is 0.5653, meaning that the OSEBX return will increase by 0.5653% by a 1% increase in the index. This seems natural since the S&P500 index is an index that more than other regressors is driven by the general demand in the world economy.

After conducting a regression analysis, it is desirable to have a measure of how good the regression model fits the data. The goodness of fit statistics, by using R^2, is a simple way to calculate and get an answer on how the regression line fits the data. In this case, the goodness of fit statistics is $R^2 = 0.274$. This usually means that the correlation is low, and that the model does not provide the best fit to the given data. Given that we are testing real empirical data, a value of 0.274 is not that low. Actually, it provides a good fit and is a good result compared to models 1-3.

For this model, the t-value for the oil price is 4.499, which indicate that the value is significant. The oil price change is positively correlated with the changes in the benchmark index. In comparison to the other models, this is the best correlation result so far. The result indicates that the model works better with all the independent variables (oil price, currency exchange factor, Nibor rate, and the S&P500 index) included in the regression, especially including the S&P index.

Regression Statistics	
Multiple R	0.52367
R Square	0.27423
Adjusted R Square	0.27345
Standard Error	0.01310
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept, α	0.000220	0.000215	1.021068
Ln_Oilprice	0.045176	0.010042	4.498811
Ln_Currency	-0.321921	0.027999	-11.497496
Ln_Nibor	0.021246	0.016464	1.290439
Ln_S&P500	0.565271	0.017075	33.105532

Table 6.4 Regression results for the period 2001-2016, using model 4.

Based on the regression results, the equation for the return on the benchmark index can be written as follows:

$$Return_{OSEBX} = 0.000220 + 0.045176 \cdot Return_{Brent} - 0.321921 \cdot Return_{Currency} + 0.021246 \cdot \mathrm{Return}_{Nibor} + 0.565271 \cdot Return_{\mathrm{S\&P500}}$$

The most interesting in this part of the analysis is *how* the oil market affects the benchmark index, since this gives an image of the whole Oslo Stock Exchange. Over the period of time from 2000 to 2016, it is possible to see some similar patterns in the movements of the OSEBX and the oil price (i.e. Figure 1.1 and Figure 5.1). Hence, there has never been a doubt that there is a relation between the oil price and the benchmark index. The interesting aspect here will therefore be to see whether or not it can be said that the oil market is leading the benchmark index. This is where there are some doubts. Does it hold that the OSEBX is led by the oil market, even though it is a contrast to what we would believe based on economic theory? Going through the results, the beta value here is 0.0452, with the corresponding fitness of good statistics of 0.274 and t-value of 4.499. With one day lag, the R^2 value is 0.275 and the t-value is 4.502, which is just slightly better. Data from this period indicate that the oil market leads the benchmark index both with and without a one day lag. Except this, the oil market cannot predict the development in the benchmark index. The short answer is that the oil price is a leading indicator on the Stock Exchange with one day lag. That the oil market is a leading indicator on the stock market development does not necessary mean that it is the changes in the oil price that makes the return on the stock change. It can be a third factor that affects both the oil market and the stock market. Thus, the oil market reacts more rapidly to this factor than the stock market, and is therefore a leading indicator for the stock market development.

The regression results for the OSEBX index with one day lag in the oil price is given below:

Regression Statistics	
Multiple R	0.52413
R Square	0.27471
Adjusted R Square	0.27373
Standard Error	0.01310
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000217	0.000215	1.006826
ln_Oilprice	0.045195	0.010040	4.501571
ln_Oilprice_lag	0.015610	0.009992	1.562253
ln_Currency	-0.320919	0.028001	-11.460928
ln_Nibor	0.021412	0.016461	1.300766
ln_S&P500	0.565209	0.017072	33.108221

Table 6.5 Regression results for the period 2001-2016 with one day lag in the oil price, using model 4.

6.4.5 Model 4 used for the OSE10GI Index

This model examines how the oil price together with the currency exchange factor, the 3 month Nibor rate and the S&P500 index influence the OSE10GI index. Model 4 can then be explained by the following equation:

$$Return_{OSE10GI} = \alpha + \beta_0 \cdot Return_{Oil\ price} + \beta_1 \cdot Return_{Currency} + \beta_2 \cdot Return_{Nibor} + \beta_3 \cdot Return_{S\&P500} + \varepsilon_t$$

For the OSE10GI index, the results with respect to the oil price are better than for the OSEBX. Here, with a 1% increase in the oil price, the OSE10GI will increase by 0.1183%. The t-value is also higher, reading 9.641, while the R^2 is 0.1997. This tells us that the OSE10GI index is highly influenced by the change in oil price, and at the same time not as influenced by the other factors. The t-value indicated a strong positive correlation between the oil price and the OSE10GI index, which was expected. The results from the regression with the OSE10GI is given in Table 6.6. Following, the equation for the return in the OSE10GI index can be written:

$$Return_{OSE10GI} = 0.000217 + 0.118315 * Return_{Oil\ price} - 0.398132 * Return_{Currency} + 0.022280 * Return_{Nibor} + 0.497515 * Return_{\text{S\&P 500}}$$

Regression Statistics	
Multiple R	0.44690
R Square	0.19972
Adjusted R Square	0.19885
Standard Error	0.01601
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept,α	0.000217	0.000263	0.823788
ln_Oilprice	0.118315	0.012272	9.641069
ln_Currency	-0.398132	0.034217	-11.635405
ln_Nibor	0.022280	0.020120	1.107352
ln_S&P500	0.497515	0.020867	23.842374

Table 6.6 Regression results for the OSE10GI index over the period 2001-2016, using model 4.

Based on the regression results for models 1-4 above, I have chosen to use Model 4 for the four smaller periods of interest in the next sections. Model 4 includes all the independent variables included in this thesis, and it gives the best regression results. Both the t-value and R squared give better values when using this method compared to method 1-3. Before continuing to the first period of interest.

6.5 Analysis of Period 1 (2007-2008)

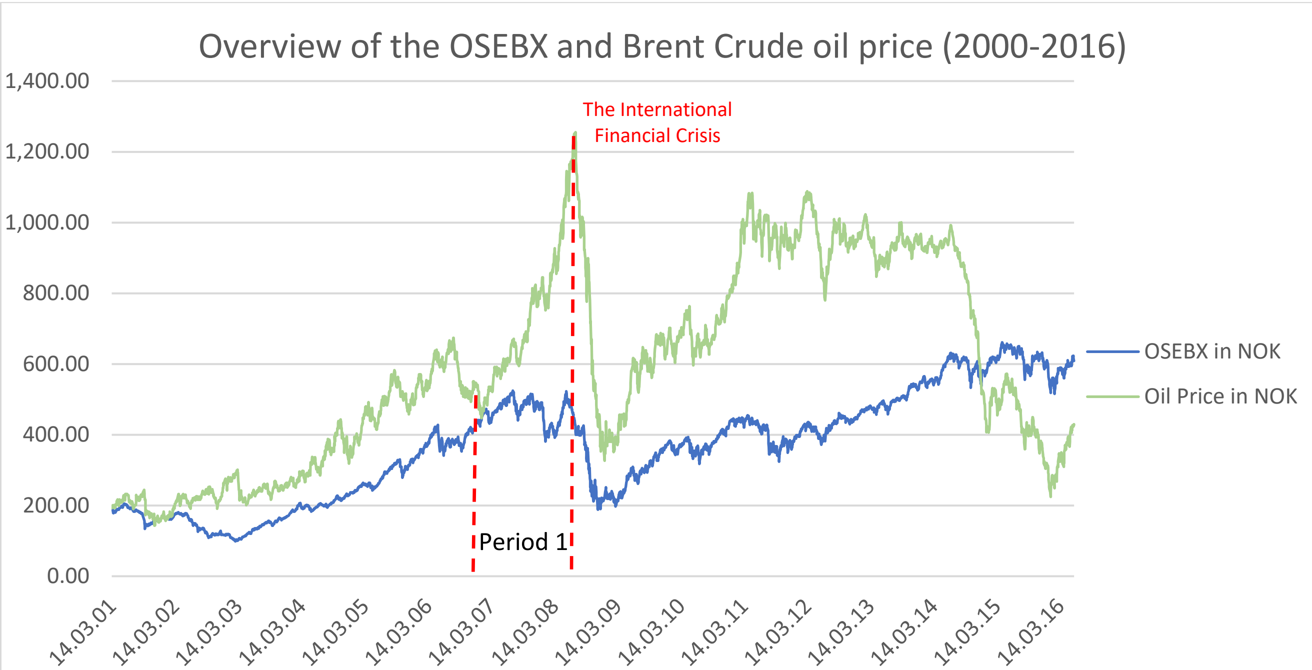


Figure 6.1 Plotted values for the OSEBX and the Brent Crude Oil price. The period of interest, period 1, is marked in the graph.

Regression Statistics	
Multiple R	0.45292
R Square	0.20514
Adjusted R Square	0.19628
Standard Error	0.01305
Observations	364

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000332	0.000700	0.473988
Ln_Oilprice	0.004028	0.042650	0.094452
Ln_Currency	-0.692004	0.108625	-6.370560
Ln_Nibor	-0.339210	0.083152	-4.079378
Ln_S&P500	0.374878	0.059558	6.294289

Table 6.7 Regression results for the OSEBX for Period 1, using model 4.

$$Return_{OSEBX} = 0.000332 + 0.004028 \cdot Return_{Brent} - 0.692004 \cdot Return_{Currency} - 0.339210 \cdot \mathrm{Return}_{Nibor} + 0.374878 \cdot Return_{\mathrm{S\&P500}}$$

In Period 1, 03.01.07 – 30.06.2008, there was a positive oil price shock. The increase in the oil price was driven by an unexpected growth in consumption and low supplies because of weather conditions, a break in the oil recovery in the American part of the Gulf of Mexico and because of political unrest in the Middle East (Hamilton, 2009). This can be seen as the build-up period before the international financial crisis hit the world in the summer of 2008.

The regression results are given in table 6.7. The regression results show that the return in the OSEBX increases by 0.00403% by a 1% increase in the oil price. The OSEBX is positively influenced by an increase in the price of oil. The result, however, is low compared to the result we received from the regression analysis of the whole period. By looking at the graph in figure 6.1, it is easy to see the explanation of this. The OSEBX index does not follow the same pattern as the oil price. This means that there is just a slight relation between the two variables in this short period of time. Hence, there is no reason to expect better results from this period compared to the results from the whole period.

The beta value for the currency exchange factor is negative (-0.6920), meaning that a 1% increase in the currency exchange factor will lead to a decrease of 0.6920% in the OSEBX return. Also, the OSEBX reacts greatly to the S&P500 index compared to the other regressors. Here a 1% increase in the S&P500 index will lead to a 0.3749% increase in the OSEBX index, which also seems natural since this index are more driven by the general demand in the world economy than others. For the lagged values of the oil price in this case, the R^2 will be lower and the model would fit less (see. Table 10.2 in the Appendix).

An interesting result from the regression analysis is the rate. The return of the 3 month Nibor rate is significant for the OSEBX index. The interpretation of the coefficient is that when the return in Nibor increases, then the rate will go up. The sign of the coefficient is negative, which has a natural explanation. When the rate goes up, a company's loan costs will increase. Increasing rate has a depressant effect on the growth in the economy and will normally send the stock markets down. So, if the return in the Nibor rate increases by 1%, the return in the OSEBX will decrease by 0.3392%.

After conducting a regression analysis, it is desirable to have a measure of how good the regression model fits the data. Based on the goodness of fit statistics, there is low correlation between the data and the fitted line. R^2 is 0.205 in this case, which indicates that the model does not provide the best fit to the given data. This makes sense given the large spread in the data sets, and will therefore be considered a relatively good fit.

For this model, the t-value for the oil price is 0.0944, which indicate that the value is not significant. The oil price change is not correlated with the changes in the benchmark index, and one cannot say that the oil price drives the benchmark index. For Period 1, it can hence be concluded that the correlation between the oil price and the benchmark index is low. This relation was expected based on the graphical representation in Figure 6.1. In this case, it is thus not possible to say that the oil price is leading the stock market in Norway.

The OSE10GI index is representing the energy sector. It is the sector that best can be explained by the oil market and changes in the oil price. The regression results for the OSE10GI index (Table 10.3 in Appendix), says that the OSE10GI index increases by 0.0796% by a 1 % increase in the oil price return. The t-value equals 1.653, which indicates that the value is not significant. The oil price change is not correlated with the OSE10GI index, and the price can therefore not be said to lead the OSE10GI index. The correlation is higher for the OSE10GI index than for the OSEBX index, but still not significant. In this case, neither the OSEBX nor the OSE10GI index can be said to be led by the changes in the oil price.

6.6 Analysis of Period 2 (2008-2009)

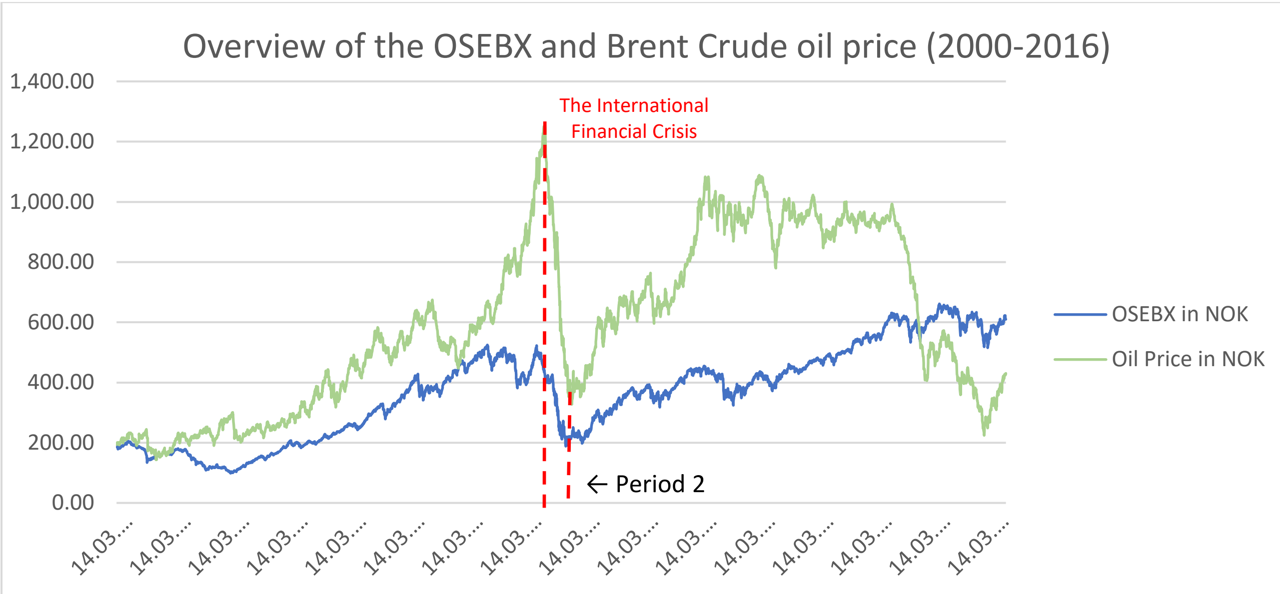


Figure 6.2 Plotted values for the OSEBX and the Brent Crude Oil price. The period of interest, Period 2, is marked in the graph.

Regression Statistics	
Multiple R	0.60352
R Square	0.36424
Adjusted R Square	0.34322
Standard Error	0.03330
Observations	126

	Coefficients	*Standard Error*	*t Stat*
Intercept	-0.001492	0.003145	-0.474478
Ln_Oilprice	-0.049104	0.089508	-0.548604
Ln_Currency	-0.892556	0.233793	-3.817721
Ln_Nibor	0.160483	0.098578	1.627971
Ln_S&P500	0.538662	0.089413	6.024428

Table 6.8 Regression results for the OSEBX for Period 2, using model 4.

$$Return_{OSEBX} = 0.000332 + 0.004028 \cdot Return_{Brent} - 0.692004 \cdot Return_{Currency} - 0.339210 \cdot \mathrm{Return}_{Nibor} + 0.374878 \cdot Return_{S\&P500}$$

In the second period, 30.06.2008 – 02.01.2009, the oil price experienced a negative shock (demand shock) due to the international financial crisis that hit the world the summer of 2008. During the financial crisis, economic growth slowed down. Demand declined, which had a negative impact on oil prices. The financial crisis led to a steep decline in oil and gas prices. This decline resulted in falling revenues for oil and gas companies, which again led to a decline in the stock markets (Investopedia, 2015). This can all be seen in the graph presented above.

Figure 6.2 indicates that there is a better correlation between the oil price and the OSEBX index in Period 2 compared to Period 1. During the financial crisis, both the oil price and the benchmark index fell, and a positive relation between them can be spotted. The pattern we can see in the graph is also present in the regression result. For this period, the goodness of fit statistics is represented by an R^2 equal 0.364, which is higher than before. This indicates that the relation between the two variables is better than we have seen before, which was expected based on the graphical representation. The result tells us that the model provides a good fit to the given data for Period 2.

The regression results are given in table 6.8. The regression results show that the return in the OSEBX decreases by 0.0491% by a 1% decrease in the oil price. The OSEBX is negatively influenced by a decrease in the price of oil. The interpretation of the coefficient is that when the return in the oil price decreases, the oil price will decrease. The coefficients sign is negative, which means that when the price of oil goes up, a company's production as well as Norwegian export will decrease. For the lagged values of the oil price in this case, the R^2 will be higher and the model would fit better. In this case, the R^2 equals 0.374 (Table 10.5 in the Appendix). These values also indicate a better correlation between the oil price and the OSEBX, which can also be seen in the figure above.

The beta value for the currency exchange factor is negative (-0.8926), meaning that a 1% increase in the currency exchange factor will lead to a decrease of 0.8926% in the OSEBX return. The beta value for the Nibor rate is 0.1605, which means that a 1% increase in the Nibor rate will lead to an 0.1605% increase in the OSEBX index. Also, the OSEBX reacts greatly to the S&P500 index. Here a 1% increase in the S&P500 index will lead to a 0.5387% increase in the OSEBX index.

The t-value for the oil price is low, reading 0.5486. The low t-value indicate that it is not significant. The change in the oil price is not correlated with the change in the benchmark index. By looking at Figure 6.2, one would expect the parameters to be stronger correlated than the results indicate. This might be because of the sudden drop in economic growth during the financial crisis. The drop can be seen as the common factor which led to the decline in both the price of oil and the benchmark index on the Norwegian stock exchange, giving a high R squared value and a low t-value.

The regression results for the OSE10GI index (Table 10.6 in Appendix), says that the OSE10GI index decreases by 0.1349% by a 1 % decrease in the oil price return. The t-value equals 1.412, which indicates that the value is not significant. The oil price change is not correlated with the OSE10GI index, and the price can therefore not be said to lead the OSE10GI index. The correlation is higher for the OSE10GI index than for the OSEBX index, which was -0.5486, and not significant. In this case, neither the OSEBX nor the OSE10GI index can be said to be led by the changes in the oil price.

For Period 2, it can hence be concluded that the correlation between the oil price and the benchmark index is low, and it is thus not possible to say that the oil price is leading the stock market in Norway. It can neither be said that the oil price leads the OSE10GI index.

6.7 Analysis of Period 3 (2009-2014)

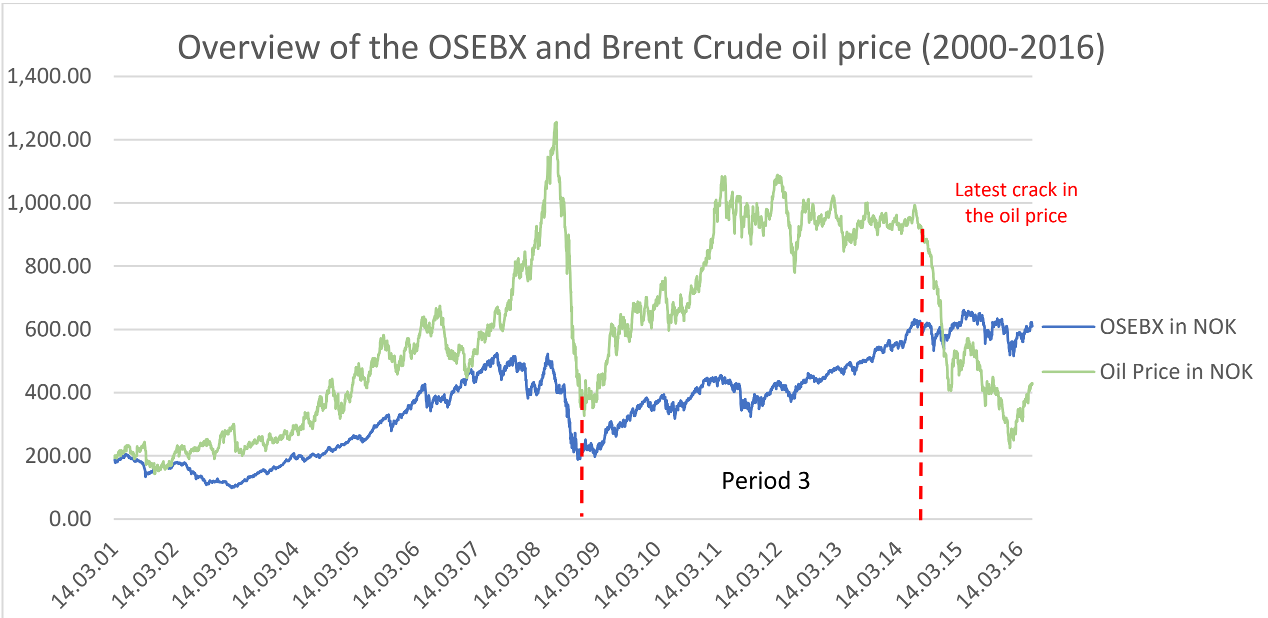


Figure 6.3 Plotted values for the OSEBX and the Brent Crude Oil price. The period of interest, Period 3, is marked in the graph.

Regression Statistics	
Multiple R	0.70597
R Square	0.49839
Adjusted R Square	0.49692
Standard Error	0.01040
Observations	1367

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000237	0.000282	0.838737
Ln_Oilprice	0.018638	0.018130	1.028009
Ln_Currency	-0.506869	0.035533	-14.264891
Ln_Nibor	-0.034765	0.021754	-1.598111
Ln_S&P500	0.696513	0.024425	28.51678282

Table 6.9 Regression results for the OSEBX for Period 3, using model 4.

$$Return_{OSEBX} = 0.000237 + 0.018638 \cdot Return_{Brent} - 0.506869 \cdot Return_{Currency} - 0.034765 \cdot \mathrm{Return}_{Nibor} + 0.696513 \cdot Return_{S\&P500}$$

In Period 3, 02.01.09 – 01.08.2014, the oil price is trying to recover and build up after the financial crisis, with just a few small downs. From the graph in figure 6.3, we can see that the oil price and the OSEBX is following the same pattern. Increasing prices for oil and gas, together with increasing demand and new economic growth, contributed to get back on track. Higher prices of oil increase companies' revenues and increase production. The correlation between the oil price and the OSEBX index seems to be higher here than in the previous periods. The pattern we can see in the graphical representation can also be seen in the regression results. For the first time, the goodness of fit statistics is high (0.498), which in our case is a very good match. The model therefore provides a good fit to the given data here, which was expected.

The regression results, in Table 6.9, show that the return in the OSEBX increases by 0.0186% by a 1% increase in the oil price. This is a somehow low result. The t-value is also low, 1.028, which indicate that the value is not significant. The oil price change is not correlated with the changes in the benchmark index, and one cannot say that the oil price drives the benchmark index on the Oslo Stock Exchange. The market is trying to build up after the financial crisis, and both the price of oil and the OSEBX index is slowly increasing to the better before reaching an approximately constant level.

Again, an interesting result from the regression analysis, is the interest rate. The return of the 3 month Nibor rate is significant for the OSEBX index. The interpretation of the coefficient is that when the return in Nibor increases, then the rate will go up. The sign of the coefficient is negative, which has a natural explanation. When the rate goes up, a company's loan costs will increase. Increasing rate has a depressant effect on the growth in the economy and will normally send the stock markets down. So, if the return in the Nibor rate increases by 1%, the return in the OSEBX will decrease by 0.0348%.

The beta value for the currency exchange factor is negative (-0.6920), meaning that a 1% increase in the currency exchange factor will lead to a decrease of 0.6920% in the OSEBX return. Also, the OSEBX reacts greatly to the S&P500 index. Here a 1% increase in the S&P500 index will lead to a 0.3749% increase in the OSEBX index.

Looking at the regression results (Table 10.9 in Appendix) for the OSE10GI index, we see a better correlation between the return in oil price and the OSE10GI index. Here, the index increases by 0.0587% by a 1 % increase in the oil price return. The t-value equals 2.901, which indicates that the value is to some extent significant. The oil price change is positively correlated with the changes in the OSE10GI index. This is also an indication that the oil price can be said to lead the OSE10GI index. The correlation is higher for the OSE10GI index than for the OSEBX index, which was 1.028, and not significant. The beta coefficient for the S&P500 index is 0.6228 and significant at a 5% level. This is showed to be one of the most important variables that affects the development for the OSE10GI. The coefficient is strongly positively correlated with the OSE10GI index.

For Period 3, it can hence be concluded that the correlation between the oil price and the benchmark index is low. This relation was both expected and unexpected based on the graphical representation in Figure 6.3. In this case, it is thus not possible to say that the oil price is leading the stock market in Norway. On the other side, the correlation between the oil price and the OSE10GI index was better, and the changes in the oil price can be said to have a better effect on the OSE10GI index.

6.8 Period 4 (2014-2016)

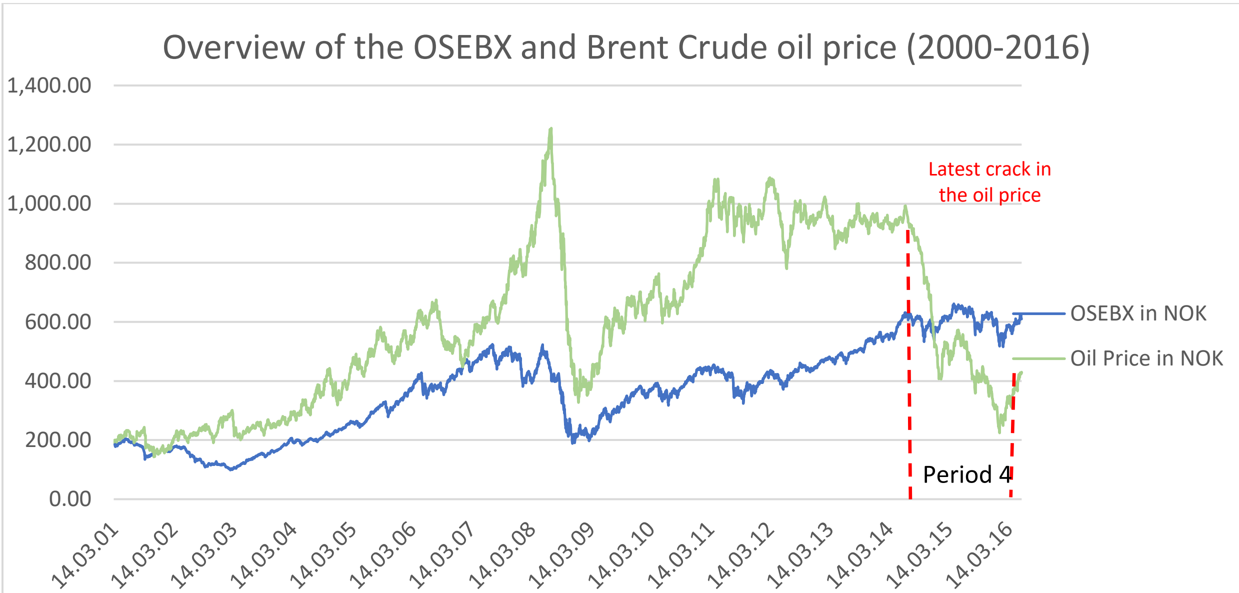


Figure 6.4 Plotted values for the OSEBX and the Brent Crude Oil price. The period of interest, Period 4, is marked in the graph.

Regression Statistics	
Multiple R	0.56658
R Square	0.32101
Adjusted R Square	0.31495
Standard Error	0.01039
Observations	453

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000210	0.000491	0.428438
Ln_Oilprice	0.144602	0.020138	7.180551
Ln_Currency	-0.106892	0.064665	-1.652995
Ln_Nibor	-0.006684	0.029239	-0.228598
Ln_S&P500	0.510059	0.054139	9.421220

Table 6.10 Regression results for the OSEBX for Period 4, using model 4.

$$Return_{OSEBX} = 0.000210 + 0.144602 \cdot Return_{Brent} - 0.106892 \cdot Return_{Currency} - 0.006684 \cdot \mathrm{Return}_{Nibor} + 0.510059 \cdot Return_{S\&P500}$$

The last period, 01.08.14 – 03.06.16, is characterized by a crack in the oil price, followed by a slow recovery of the world economic growth. The reason for the crack was overproduction compared to demand. In this period, we can see that the OSEBX index follows the same pattern as the oil price. There are some similarities through the crucial ups and downs.

The price of the Brent Crude oil has fluctuated heavily the last two years. In the summer of 2014, the oil price was above 115 dollars per barrel, before it fell to under 40 dollars in December 2015, and rose to above 55 dollars in December 2016 (NRK, 2017). The main cause of the crack in the oil price was low demand together with high production, as well as increased shale oil production in the US. One of the only reasons that the oil price kept low over a longer period of time is that the producers in the Middle East wanted to keep up the high production, even though it meant low prices in the world. This led to the fact that the supply increased while the demand for crude oil decreased, lowering the prices of oil. Because of the low oil prices, the exploration and development on the Norwegian continental shelf were no longer profitable. It led to a recession in the petroleum industry all over the world. And, the result of the permanently low oil price was lower investments, lower employment, reduced salaries, and a weaker stock market. Given the slow recovery after the crack, we still see a slow increasing trend in the price of oil (NRK, 2017).

The regression results are given in table 6.10. They show that the return in the OSEBX increases by 0.1446 % by a 1 % increase in the oil price. The OSEBX is positively influenced by an increase in the price of oil. The goodness of fit statistics, by using R^2, is 0.321. This means that the correlation is good related to the large spread in our data. The model can therefore be said to provide a good fit to the data.

For this model, the t-value for the oil price is 7.181, which indicate that the value is significant. The oil price change is strong positively correlated with the changes in the benchmark index. In comparison to the other models, this is the best correlation result. It indicates that the oil price is leading the Oslo Stock Exchange benchmark index. With increasing prices for oil and gas, together with slightly increasing demand and new economic growth, we can see that the industry is trying to get back on track. The market is trying to rebuild after a low period, and both the OSEBX and the price is influenced by many different factors.

The OSE10GI index is representing the energy sector, and is the sector that best can be explained by the oil market and changes in the oil price. Looking at the regression results (Table 10.12 in Appendix) for the OSE10GI index, we see a better correlation between the return in oil price and the OSE10GI index. Here, the index increases by 0.3086% by a 1 % increase in the oil price return. The t-value equals 8.98, which indicates that the value is significant. The oil price change is positively correlated with the changes in the OSE10GI index. This is also an indication that the oil price leads the OSE10GI index. The correlation is higher for the OSE10GI index than for the OSEBX index, which was expected beforehand. The beta coefficient for the S&P500 index is 0.5585 and significant at a 5% level. This is showed to be one of the most important variables that affects the development for the OSE10GI. The coefficient is strongly positively correlated with the OSE10GI index, but not stronger than the oil price.

7. Discussion of results

It is interesting how Norway is stamped as an oil nation where a fall in the price of oil break the economy. Much seems over-dramatized as one has seldom seen a more two-divided economy than today. On one side, the Norwegian petroleum industry is facing major challenges with downsizing and investment failure. While on the other side, the rest of the Norwegian economy is fairly unaffected by the fall in oil prices, and is growing. One can thus say that the Norwegian economy is dependent on the oil in the sense that the energy sector constitutes a large percentage of Norwegian economy and hence its fluctuations. At the same time, I found little evidence that oil price dependence spread wider to other parts of the Norwegian economy, as one gets the impression of by the ongoing debate in the media. Stock market indexes are a good way to analyze this since they reflect all available information in the market. In this thesis, the Oslo Stock Exchange Benchmark index and also the OSE10GI index have been analyzed.

For the whole period (2001 – 2016), different models were used to analyze the influence. Model 1 examined how the oil price alone influenced the Oslo Stock Exchange benchmark index. The results show that the oil price was positively influencing the OSEBX index. A 1% increase in the oil price led to a 0.0596% increase in the OSEBX. In this model, the t-value was 5.099, which indicated that the oil price is leading the stock market.

Model 2 examined how the benchmark index was influenced by the oil price together with the currency exchange factor. Here, the OSEBX return would increase by 0.0435% by a 1% increase in the oil price. The t-value was a bit lower in this model, reading 3.808. The oil price can still be said to lead the benchmark index, to some extent.

Model 3 also included the Nibor rate. By using this model, the OSEBX return would increase by 0.0434% by a 1% increase in the oil price. As for the two other models, the oil price can be said to lead the stock market here as well. Then in model 4, all independent variables were included. Here, the OSEBX return would increase by 0.0452% by a 1% increase in the oil price. The t-value is 4.4988, which indicated that the value is significant. It can therefore be said that the oil price is a leading factor for the OSEBX. Although these results show that the oil price can be seen as leading the OSEBX, there are many other external factors that play an important role in this relation, and that drives the two parameters in a similar way.

Model 4 was also used for the OSE10GI index. In this case, the results were expected to be better given that the index represents the energy sector, and that it is the sector that best can be explained by the oil market and the changes in the oil price. A 1% increase in the oil price gives a 0.1183% increase in the OSE10GI index. The t-value is 9.641, which tells us that the OSE10GI index is highly influenced by the changes in the price of oil, and that there is a strong correlation between these two variables.

Through the regression analysis of the whole period using Methods 1-4, it was clear that the best results were given when all the independent variables included in this thesis were included in the model. For all four models, the results showed that in the long run, the oil price can be viewed as a leading indicator for the OSEBX.

The whole period was then divided into four smaller periods of interest (short run), and then analyzed using model 4. The main focus was put on the OSEBX, but the OSE10GI index was also analyzed. In the first period, 2007-2008, there was a positive oil price shock. Here, the return in the OSEBX index would increase by 0.00403% by a 1% increase in the oil price. The t-value was low, only 0.0944, indicating that the oil price could not drive the benchmark index. For the OSE10GI, the t-value is a little bit higher, 1.653, but it could not be said that the oil price drove this index either.

In period 2, 2008-2009, the oil price experienced a negative price demand shock which led to decreasing oil prices. This crisis hit the economy much wider than the crack in the oil price in 2014/15. In this period, the OSEBX return would decrease by 0.0491% by a 1% decrease in the price of oil. The t-value was low in this period too, and it is therefore not possible to say that the oil price is leading the OSEBX. The same conclusion can be given for the OSE10GI index.

Period 3, 2009-2014, was characterized by an almost continuous build up after the financial crisis. The regression results for this period says that the OSEBX return would increase by 0.0186% by a 1% increase in the oil price. The t-value was 1.028, which indicate that the value is not significant. The oil price change is not correlated with the change in the OSEBX index, and it cannot be said that the oil price leads the benchmark index. An interesting result in this analysis is the Nibor rate. If the Nibor rate increases by 1%, the OSEBX return would decrease by 0.0348%. When the rate goes up it has a depressant effect on the economic growth, and it will normally send the stock markets down. For the OSE10GI index, the t-value equals 2.91. It can therefore be said that the oil price leads the OSE10GI index to some extent.

During a supply driven price shock, as we experienced in 2014, it can be expected that the effects mainly influence the oil sector in oil exporting countries. This is consistent with the regression results. The last period of interest was thus the time from 2014 – 2016. This period was impacted by a crack in the oil price due to overproduction and low demand. The regression results show that the OSEBX index is positively influenced by an increase in the price of oil. The OSEBX return will increase by 0.1446% by a 1% increase in the oil price. In this period, the t-value was relatively high (7.181). The high t-value indicates that the oil price change is positively correlated with the changes in the benchmark index, and it can be said that the oil price is leading the benchmark index. The crack in the oil price led to fall on stock markets all over the world and it is therefore easy to see this relation. For the OSE10GI, the values are even better. The OSE10GI return will increase by 0.3086% by a 1% increase in the oil price, and the t-value is 8.98, which is significant. The oil price can therefore be said to lead the OSE10GI index. In this last period, the return on the Oslo Stock Exchange benchmark index was more influenced by the oil price than what we saw in the results for the whole period. The energy sector is leading this.

Norwegian economy seen through the eyes of an investor is negatively influenced by a decreasing oil price. The reason is not that the economy is bad, the reason is rather that the energy index is doing bad. The OSEBX index is also affected, but not as much as the OSE10GI index. There is no reason to state that the Norwegian economy as a whole is oil dependent. The economy is divided and the energy industry and its economy are affected more than the rest of the Norwegian economy.

The expectation and hypothesis that the stock return in Norway as an oil exporting nation increases by an increase in the price of oil is confirmed by the results in the model. What seems to have a stronger effect on the index is the development in the world economy and especially the American economy expressed through the S&P500 index. The hypothesis that the Oslo Stock Exchange return is influenced positively by an increase in the oil price is therefore confirmed.

8. Summary and Conclusion

The purpose of this thesis was to examine what effect the oil price has on the Oslo Stock Exchange benchmark index. The analysis was performed for the period between year 2001 and 2016, given that this was the period with the most data available for all variables. The hypothesis examined is whether or not there is a positive effect from oil price fluctuations in Norway. This is reasonable since Norway is one of the large oil exporting countries in the global energy market. Production and exportation of oil and gas are important parts of the economy, and should therefore have a strong effect on the stock market. This gave the following issue to solve: How do changes in the oil price influence the Oslo Stock Exchange benchmark index?

To answer the question, four different models were constructed. These four models included increasing amounts of independent variables. The first model examined how the oil price alone influenced the OSEBX, while model 2 included the currency exchange factor as well. Model 3 examined how the oil price, the currency exchange factor and the Nibor rate influenced the OSEBX return, while model 4 also included the S&P500 index. These models were used to analyze the whole period, and the results showed that the more variables included in the expression for the OSEBX, the better results. For Model 4, the OSEBX index would increase by 0.1446% by a 1% increase in the oil price. This model also gave the highest t-value (7.181). The high t-value meant that there was a strong positive correlation between the oil price changes and the OSEBX changes, and it was therefore possible to say that the oil price could be leading the OSEBX. This model also gave good results for the OSE10GI, with a t-value of 8.98, and a 0.3086% change in the OSE10GI by a 1% change in the oil price.

In the long run, we see that there is a correlation between the changes in the oil price and the changes in the OSEBX. When studying the different short-run periods, we see that the correlation is low for all periods except Period 4. Generally, the OSEBX is just to some extent driven by the oil price. Other external factors are driving the changes in both variables. The overall conclusion of this thesis is that the oil price has a positive effect on the OSEBX index. A positive and significant relation between the return on the OSEBX, the OSE10GI and the oil price was found for the whole period between 2001 and 2016 using model 4. The effect of the oil price became stronger towards the end of the period (see results for Period 4), for both the

OSEBX and the OSE10GI. The OSE10GI index is clearly more affected by the changes in the oil price than the OSEBX, which is understandable since the OSEBX includes different sectors, including OSE10GI. Weaker results for the OSEBX gave an understanding of the stock market in Norway, and how not all indexes are influenced by the fluctuations in the oil price. Only indexes related to the oil market will be significantly influenced by changes in the price of oil.

Stock market prices, and hence the Oslo Stock Exchange benchmark index and its sector indices, provide insight in the market expectations for the Norwegian economy – seen through the eyes of domestic and foreign investors. This is possibly the best estimate one can get on how the economy will be in the foreseeable future. By using the stock price as a window to study the economy, we find that the Norwegian economy is more twofold than ever before, and that the question about oil dependence depends on what is added in the term. On one hand, we have the oil industry, Norway's largest industry, with a direct oil impact. By using model 4 for the whole period, the return in the OSEBX will change 0.1446% by a 1% change in oil price. The t-value was 7.181, which indicated that the oil price is leading the OSEBX. On the other hand, other sector indices except the OSEBX and the OSE10GI, will not be significantly affected by the oil price return because of the low oil industry dependence.

How oil dependent Norway is therefore becoming – like the economy otherwise – two divided: Norway is oil dependent in the sense that our largest industry and our largest sector index on the Oslo Stock Exchange is very oil dependent. Not surprisingly, there is a direct correlation between how well it turns out for the energy index, and how high the oil price is. As the industry, and hence the index is large, the Norwegian economy is affected to a relatively large degree by changes here. On the other hand, we can say that Norway is not an oil dependent economy, as the Oslo Stock Exchange indices other than the energy index is not significantly affected by oil prices. Today, the effects of oil prices do not seem to spread from the energy sector to other economies as the social debate suggests.

9. References

Akram, Q. F., og Holter, J. P., (1996). Dollarkursens effekt på oljeprisene – En empirisk analyse. Norges Bank Penger og Kreditt 3/1996, 195-206.

Arbeidsplasser, (n.d). Norsk Petroleum. Retrieved from: http://www.norskpetroleum.no/okonomi/arbeidsplasser/#samlet-sysselsetting

Armstrong, V. (2016, March 7). Nå er oljeprisen på sitt årsbeste for 2016. e24. Retrieved from http://e24.no/energi/oljebremsen/naa-er-oljeprisen-paa-sitt-aarsbeste-for-2016/23632839

Austvik, O. J., (2016). Hva bestemmer oljeprisen? Retrieved from: http://www.nupi.no/Skole/HHD-Artikler/2016/Hva-bestemmer-oljeprisen

Avata, (n.d.). The Oil & Gas Industry. Retrieved 23.04.17 from: http://avata.com/oil-gas

Bacon, Carl R., (2013). Practical Risk-Adjusted Performance Measurement, Chapter 4, p.69-96. Retrieved from Oria (Dawsonera). Universitetet i Stavanger.

Baumeister, C., & Peersman, G. (2008). Time-Varying effects of Oil Supply Shocks on the US Economy. Working Papers of Faculty of Economics and Business Administration, Ghent University, Belgium.

Bjørnland, H. (2008). Oil price shocks and stock market booms in an oil exporting country. Norges Bank. Retrieved from: http://www.norges-bank.no/globalassets/upload/english/publications/working-papers/2008/norges_bank_working_paper_2008_16.pdf

Brooks, C., (2008). Introductory Econometrics for Finance. 3rd edition. Cambridge University Press. NY, USA.

Cappelen, Å., Eika, T., & Prestmo, J. B. (2014). Virkninger på norsk økonomi av et kraftig fall i oljeprisen. Retrieved from: https://www.ssb.no/nasjonalregnskap-og-konjunkturer/artikler-og-publikasjoner/_attachment/180823?_ts=14662dc53a8

Clemente, J., (2015). Three Reasons Oil Will Continue to Run the World. Forbes. Retrieved from: https://www.forbes.com/sites/judeclemente/2015/04/19/three-reasons-oil-will-continue-to-run-the-world/

Clover Global Solutions, (2012). Ten factors that affect the price of oil. Retrieved from:

https://c1wsolutions.wordpress.com/2012/04/30/factors-affect-price-of-oil/

Eksport av olje og gass, (2017). Norsk Petroleum. Retrieved from: http://www.norskpetroleum.no/produksjon-og-eksport/eksport-av-olje-og-gass/#samlet-eksport

Faktorer som påvirker oljeprisen, (n.d). Retrieved 26.04.17 from: http://www.silent7.com/faktorer-som-pavirker-oljeprisen/

Farnham, P. G., (2014). Economics for Managers. United States, US: Pearson Education

Fiskå, K., and Wangsvik, K. E., (2014). Effekten av oljepris og ande makroøkonomiske variable på aksjeavkastning i oljeeksporterende økonomier. Retrieved from Oria. Universitetet i Stavanger.

Gabrielsen, H. B., and Holtet, M. T., (2009). Oljeprisens påvirkning på Oslo Børs. Har oljeprisen historisk sett vært en ledende indikator på det norske aksjemarkedet? Retrieved from: https://brage.bibsys.no/xmlui/bitstream/handle/11250/168393/Gabrielsen%20og%20Holtet%202009.pdf?sequence=1

Gujarati, D. N., (2004). Basic Econometrics, Fourth Edition. The McGraw-Hill Companies, NY, USA.

Hamilton, J. D., (2005). Oil and the Macroeconomy. Department of Economics. University of California, San Diego, USA. Retrieved from: http://econweb.ucsd.edu/~jhamilton/JDH_palgrave_oil.pdf

Holm, R., (2015). Oljeprisens påvirkning på norske boligpriser – effekten av oljeprisfallet høsten 2014. Retrieved from Brage Bibsys, Universitetet i Stavanger.

Hovedindeksen, (n.d). Oslo Børs. Retrieved 28.02.2016 from https://www.oslobors.no/markedsaktivitet/#/details/OSEBX.OSE/overview

ICE, (2016). The ICE Brent Index. Retrieved from: https://www.theice.com/publicdocs/futures/ICE_Futures_Europe_Brent_Index.pdf

Institute for Energy Research (IER), (n.d). Petroleum (Oil). Retrieved 15.05.16 from: http://instituteforenergyresearch.org/topics/encyclopedia/petroleum/

Investopedia, (2015). How did the financial crisis affect the oil and gas sector? Retrieved from: http://www.investopedia.com/articles/economics/09/financial-crisis-review.asp

Investopedia, (n.d.). Organization of Petroleum Exporting Countries - OPEC. Retrieved 24.04.17 from: https://snl.no/OPEC

Kilian, L. (2009, June 13th). Not All Oil Price Shocks are Alike: Disentangling Demand and Supply Shocks in the Crude Oil Market. American Economic Review , 1053-1069

Knudsen, O. F., and Leraand, D., (2014). OPEC. Retrieved from: https://snl.no/OPEC

Kosakowski, P., (2016). What Determines Oil Prices? Retrieved from Investopedia:

http://www.investopedia.com/articles/economics/08/determining-oil-prices.asp

Kurt, D., (2015). Understanding Benchmark Oils: Brent Blend, WTI and Dubai. Retrieved from Investopedia: http://www.investopedia.com/articles/investing/102314/understanding-benchmark-oils-brent-blend-wti-and-dubai.asp

"Lille julaften 1969 forandret livene våre". (2014, February 7). Dagens næringsliv. Retrieved from: http://www.dn.no/nyheter/energi/2009/12/22/lille-julaften-1969-forandret-livene-vare

Lorch-Falch, S., (2015). Oljeprisen faller til finanskrisenivå. Retrieved from E24: http://e24.no/energi/oljeprisen-faller-til-finanskrisenivaa/23510011

Løvås, J., (2004, December 23). Oljejulegaven. Dagens Næringsliv. Retrieved from http://www.dn.no/meninger/kommentarer/2004/12/23/oljejulegaven

Norsk Olje&Gass, (2012, September 16). Norges mest verdiskapende næring. Retrieved from: https://www.norskoljeoggass.no/no/Faktasider/Verdiskapning1/

Norsk Olje&Gass, (n.d). Hva olje og gass betyr for det norske samfunnet. Retrieved 20.03.17 from: http://www.verdensklasse.no/fakta/?id=765&t=Betydningen-for-samfunnet

NRK, (2017). Oljeprisen. Retrieved from: https://www.nrk.no/nyheter/oljeprisen-1.11196113

Olje- og energidepartementet. (2016, February 29). Norsk oljehistorie på 5 minutter. Regjeringen. Retrieved from https://www.regjeringen.no/no/tema/energi/olje-og-gass/norskoljehistorie-pa-5-minutter/id440538/

Olje- og gassproduksjon, (2017). Norsk petroleum. Retrieved from: http://www.norskpetroleum.no/produksjon-og-eksport/olje-og-gassproduksjon/

Olsen, M. O., and Velgaard, O., (2015). Oljeprisends påvirkning på norsk økonomi – med utgangspunkt i avkastning på Oslo Børs. Retrieved from Oria. Universitetet i Stavanger.

OPEC, (2005). Oil and Development: The role of OPEC: A historical perspective and outlook to the future. Retrieved from: http://www.opec.org/opec_web/en/894.htm

OPEC, (2015). Annual Report 2015. Retrieved from: http://www.opec.org/opec_web/static_files_project/media/downloads/publications/AR%202015.pdf

Oslo VPS (2017). Ownership structure of listed companies. Retrieved from http://vpsinfo.manamind.com/sectorstats/stockListsInvestorLists.do;jsessionid=46B9FD2B616DFA8D42B01F99F4D9BC5D?f=m&l=no

Reuters, (2008, November 12). U.S. 2008 oil demand to drop most since 1980: EIA. Retrieved from: http://www.reuters.com/article/us-eia-oil-economy-idUSTRE4AB76220081112

Reuters, (2015, September 14). UPDATE 3-OPEC says the world will want more of its oil next year. Retrieved from: http://www.reuters.com/article/opec-oil-idUSL5N11K1Z320150914

Råvarehandel, (2017). Dette må du vite om brent olje (Nordsjøolje). Retrieved from: http://www.xn--rvarehandel-x8a.com/raavarer/brentolje

Smart Touch Energy, (2016). Top 5 Factors Affecting Oil Prices. Retrieved from: http://blog.smarttouchenergy.com/factors-affecting-oil-prices

Statistisk Sentralbyrå (SSB), (2015). Utenrikshandel med varer, 2014, endelige tall. Retrieved from: https://www.ssb.no/utenriksokonomi/statistikker/muh/aar-endelige/2015-05-15

Statoil, (n.d.). About us. Retrieved 26.05.17 from: https://www.statoil.com/en/about-us.html#get-to-know-us

U.S. Energy Information Administration (EIA), (2017, March 7). Short-Term Energy Outlook. Retrieved from: https://www.eia.gov/outlooks/steo/report/global_oil.cfm

U.S. Energy Information Administration (EIA), (2012). Country Report: Norway. Retrieved from: http://www.eia.gov/countries/cab.cfm?fips=NO

U.S. Energy Information Administration (EIA), (n.d). Oil: Crude and Petroleum Products Explained. Retrieved 27.03.17 from: https://www.eia.gov/energyexplained/index.cfm?page=oil_home

Yan, X., and Su, X. G., (2009). Linear Regression Analysis. Theory and computing. Published by World Scientific Publishing Co. Pte. Ltd. Printed in Singapore.

References for the Data:

Brent Crude Oil price: Spot prices. Retrieved from Professor Atle Øglend.

Economic Research, Federal Reserve Bank of St. Louis, (n.d). S&P500. Retrieved 05.05.16 from: https://fred.stlouisfed.org/series/SP500/downloaddata

Norges Bank, (2017). Exchange Rate for US Dollar (USD). Daily exchange rates (from 1981). Retrieved from: http://www.norges-bank.no/en/Statistics/exchange_rates/currency/USD

Norges Bank, (2017). 3 Month Nibor Rate (from 1982-2013). Retrieved from: http://www.norges-bank.no/en/Statistics/Historical-monetary-statistics/Short-term-interest-rates/

OSE10GI, (2017). Oslo Børs. Retrieved from: https://www.oslobors.no/markedsaktivitet/#/details/OSE10GI.OSE/overview

3 Month Nibor Rate, (2017). Oslo Børs. Retrieved from: https://www.oslobors.no/markedsaktivitet/#/details/NIBOR3M.NIBOR/overview

Yahoo! Finance, (2017). OSE10 ENERGY GI (OSE10GI.OL). Retrieved from: https://finance.yahoo.com/quote/OSE10GI.OL/history?period1=984524400&period2=1495231200&interval=1d&filter=history&frequency=1d

Yahoo! Finance, (2017). S&P500 (^GSPC). Retrieved from: https://finance.yahoo.com/quote/%5EGSPC/history?period1=946681200&period2=1465164000&interval=1d&filter=history&frequency=1d

10. Appendix

10.1 Absolute Return and Logarithmic Return with no time lag

	OSEBX	Oil Price	Currency	Nibor	S&P 500
Mean	354.89303	65.6682174	6.7876	3.57	1348.59679
Std. dev.	153.0389823	32.98079071	1.157339836	2.082377219	335.7617844
Max.	661.3184	145.49	9.6062	7.91	2130.820068
Min.	98.57	16.57	4.9589	0.94	676.530029
N	4011	4011	4011	4011	4011

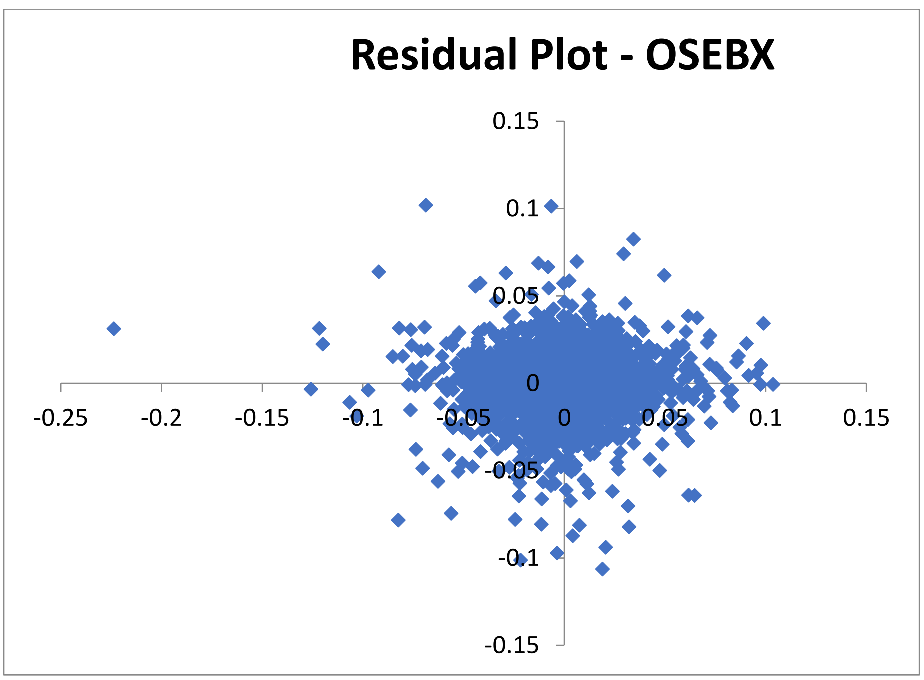
	OSEBX	Oil Price	Currency	Nibor	S&P 500
Mean	0.00029629	0.000199625	1.27778E-05	-0.00044	0.000101113
Std dev	0.015200453	0.022190871	0.007882286	0.012866444	0.012821141
Max	0.101387679	0.103678429	0.044154756	0.19	0.109571968
Min	-0.104777961	-0.223643676	-0.059176148	-0.14	-0.094695125
N	4010	4010	4010	4010	4010

10.2 Regression Results for the Whole Period (2001 – 2016) with Increasing Number of Independent Variables

1. Regression Results for the OSEBX with the Oil Price as the independent variable

Regression Statistics	
Multiple R	0.083371662
R Square	0.006950834
Adjusted R Square	0.006683526
Standard Error	0.015320526
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000300649	0.000251304	1.196354773
Ln_Oilprice	0.059584664	0.011684819	5.099322678



2. Regression Results for the OSEBX with the Oil Price and USD as independent variables

Regression Statistics	
Multiple R	0.244326643
R Square	0.059695508
Adjusted R Square	0.059189152
Standard Error	0.014910116
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000294334	0.000244572	1.203462725
Ln_Oilprice	0.043513231	0.011426186	3.808202566
Ln_Currency	-0.447696634	0.031017574	-14.43364443

3. Regression Results for the OSEBX, with the Oil Price, USD, and the Nibor rate as Independent variables

Regression Statistics	
Multiple R	0.244839939
R Square	0.059946596
Adjusted R Square	0.059187059
Standard Error	0.014910133
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000304473	0.000244784	1.243840697
Ln_Oilprice	0.043393458	0.011426832	3.797505721
Ln_Currency	-0.441713304	0.031594153	-13.98085584
Ln_Nibor	0.018657036	0.018734592	0.995860291

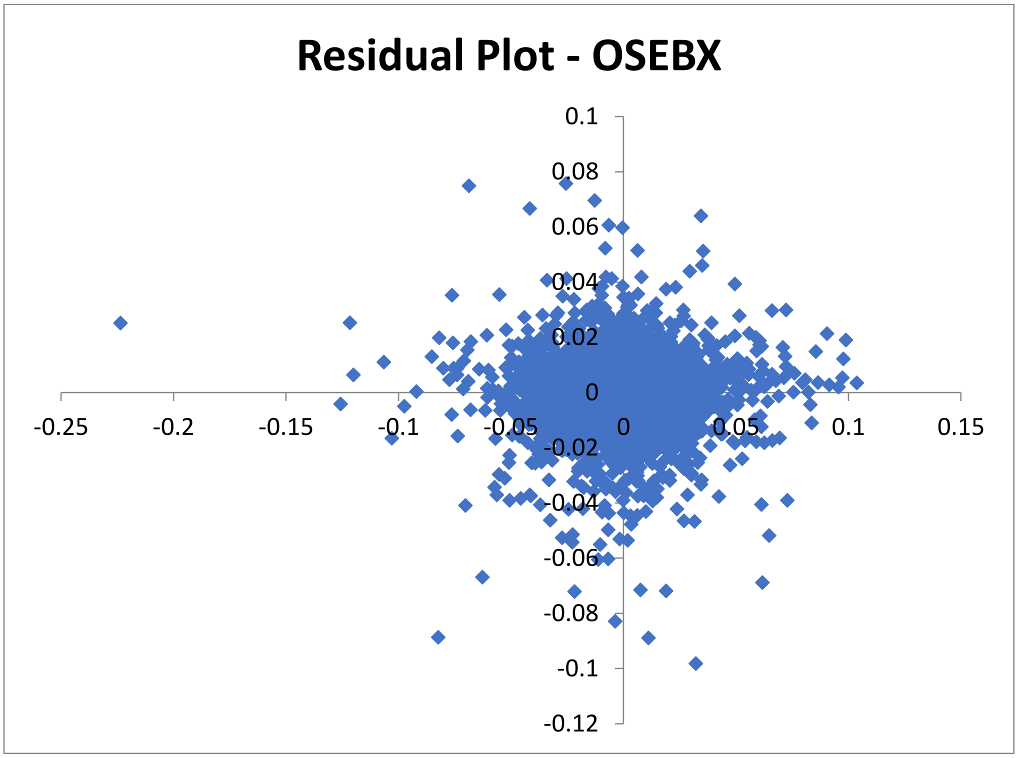
4. Regression results for the OSEBX, with the Oil price, USD, Nibor rate, and the S&P500 as the Independent Variables

Regression Statistics	
Multiple R	0.52367107
R Square	0.27423139
Adjusted R Square	0.273449312
Standard Error	0.013102761
Observations	3717

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.00021966	0.000215127	1.021068903
Ln_Oilprice	0.045176354	0.010041842	4.498811355
Ln_Currency	-0.321920561	0.02799919	-11.49749554
Ln_Nibor	0.021245545	0.016463814	1.290438864
Ln_S&P500	0.565271155	0.017074825	33.10553194

10.3 Residual Plot

Residual plot for the OSEBX index when all independent variables are included in the regression analysis.



10.4 Regression Results for Period 1 (2007 – 2008)

Results for the OSEBX

Regression Statistics	
Multiple R	0.45292367
R Square	0.205139851
Adjusted R Square	0.196283471
Standard Error	0.013050947
Observations	364

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000331869	0.000700163	0.473988371
Ln_Oilprice	0.004028333	0.042649707	0.0944516
Ln_Currency	-0.692003594	0.108625242	-6.370559748
Ln_Nibor	-0.33921023	0.083152438	-4.079378054
Ln_S&P500	0.374878144	0.059558455	6.294289284

Table 10.1 Regression results for the OSEBX for Period 1, using model 4.

Results for the OSEBX with 1 day lag in the Oil Price

Regression Statistics	
Multiple R	0.452980898
R Square	0.205191694
Adjusted R Square	0.194091019
Standard Error	0.013068736
Observations	364

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.00034771	0.00070874	0.490603031
ln_Oilprice	0.004330376	0.042753555	0.10128693
ln_Lagprice	-0.00644961	0.042206607	-0.152810428
ln_Currency	-0.691277002	0.108877176	-6.349145228
ln_Nibor	-0.340497788	0.083691006	-4.068511128
ln_S&P500	0.374534058	0.059682126	6.275481161

Table 10.2 Regression results for the OSEBX for Period 1 with a one day lag in the Oil Price.

Results for the OSE10GI Index

Regression Statistics	
Multiple R	0.409620017
R Square	0.167788558
Adjusted R Square	0.158516007
Standard Error	0.014723277
Observations	364

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.00036187	0.000789881	0.458131456
ln_Oilprice	0.079557594	0.04811478	1.653495939
ln_Currency	-0.797154412	0.122544326	-6.505029162
ln_Nibor	-0.33556639	0.093807473	-3.577181861
ln_S&P500	0.275096423	0.06719019	4.094294444

Table 10.3 Regression results for the OSE10GI Index for Period 1, using model 4.

10.5 Regression Results for Period 2 (2008-2009)

Results for the OSEBX

Regression Statistics	
Multiple R	0.603520668
R Square	0.364237197
Adjusted R Square	0.343220245
Standard Error	0.033296646
Observations	126

	Coefficients	*Standard Error*	*t Stat*
Intercept	-0.00149207	0.003144655	-0.474478177
Ln_Oilprice	-0.049104397	0.089507964	-0.548603666
Ln_Currency	-0.892555799	0.23379281	-3.817721334
Ln_Nibor	0.160482548	0.09857828	1.627970655
Ln_S&P500	0.53866161	0.089412909	6.024427769

Table 10.4 Regression results for the OSEBX for Period 2, using model 4.

Results for the OSEBX with one day lag in the Oil Price

Regression Statistics	
Multiple R	0.611842229
R Square	0.374350914
Adjusted R Square	0.348282202
Standard Error	0.033168085
Observations	126

	Coefficients	*Standard Error*	*t Stat*
Intercept	-0.000156111	0.003276083	-0.047651648
ln_Oilprice	-0.038264339	0.089501418	-0.427527739
ln_Lagprice	0.124407189	0.089323322	1.392773867
ln_Currency	-0.929772144	0.234418047	-3.966299334
ln_Nibor	0.13732265	0.099595641	1.378801816
ln_S&P500	0.542906957	0.089119821	6.091876654

Table 10.5 Regression results for the OSEBX for Period 2, with a one day lag in the Oil Price.

Results for the OSE10GI Index

Regression Statistics	
Multiple R	0.565197423
R Square	0.319448127
Adjusted R Square	0.296950545
Standard Error	0.035559607
Observations	126

	Coefficients	*Standard Error*	*t Stat*
Intercept	-0.001593835	0.003358377	-0.47458482
Ln_Oilprice	-0.134958038	0.09559125	-1.41182418
Ln_Currency	-0.982590688	0.249682218	-3.935365103
Ln_Nibor	0.217958432	0.105278018	2.07031284
Ln_S&P500	0.45755228	0.095489734	4.791638423

Table 10.6 Regression results for the OSE10GI Index for Period 2, using model 4.

10.6 Period 3 (2009-2014)

Results for the OSEBX

Regression Statistics	
Multiple R	0.705967629
R Square	0.498390293
Adjusted R Square	0.496917137
Standard Error	0.010395531
Observations	1367

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000236566	0.000282051	0.838737254
Ln_Oilprice	0.018638222	0.018130413	1.028008675
Ln_Currency	-0.506869228	0.03553264	-14.26489062
Ln_Nibor	-0.034765409	0.021754067	-1.598110767
Ln_S&P500	0.696513184	0.024424676	28.51678282

Table 10.7 Regression results for the OSEBX for Period 3, using model 4.

Results for the OSEBX with one day lag in the Oil Price

Regression Statistics	
Multiple R	0.705970347
R Square	0.498394131
Adjusted R Square	0.496551346
Standard Error	0.01039931
Observations	1367

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000237627	0.000282345	0.841621799
ln_Oilprice	0.0189265	0.018355703	1.031096458
ln_Lagprice	-0.00187067	0.018332114	-0.102043351
ln_Currency	-0.506924798	0.035549727	-14.25959743
ln_Nibor	-0.03486687	0.021784677	-1.600522705
ln_S&P500	0.696537921	0.024434757	28.50603068

Table 10.8 Regression results for the OSEBX for Period 3, with a one day lag in the Oil Price.

Results for the OSE10GI Index

Regression Statistics	
Multiple R	0.616905964
R Square	0.380572969
Adjusted R Square	0.3787538
Standard Error	0.011798462
Observations	1367

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000126768	0.000320115	0.396007372
Ln_Oilprice	0.059702693	0.020577206	2.901399362
Ln_Currency	-0.43348305	0.040327954	-10.74894732
Ln_Nibor	-0.017468839	0.024689891	-0.707530005
Ln_S&P500	0.622762701	0.027720912	22.46544751

Table 10.9 Regression results for the OSE10GI Index for Period 3, using model 4.

10.7 Period 4 (2014-2016)

Results for the OSEBX

Regression Statistics	
Multiple R	0.566576339
R Square	0.321008748
Adjusted R Square	0.314946326
Standard Error	0.010391584
Observations	453

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000210327	0.000490916	0.428437729
Ln_Oilprice	0.144601608	0.020137955	7.180550647
Ln_Currency	-0.106891593	0.064665399	-1.652995188
Ln_Nibor	-0.006683934	0.029238867	-0.228597568
Ln_S&P500	0.510059096	0.054139391	9.42121975

Table 10.10 Regression results for the OSEBX for Period 4, using model 4.

Results for the OSEBX with a one day lag in the Oil Price

Regression Statistics	
Multiple R	0.568965485
R Square	0.323721723
Adjusted R Square	0.316157089
Standard Error	0.010382397
Observations	453

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.000247584	0.00049127	0.503966337
ln_Oilprice	0.142571523	0.020177184	7.065977212
ln_Lagprice	0.02557936	0.01910186	1.339103094
ln_Currency	-0.097028672	0.065026695	-1.492135987
ln_Nibor	-0.003975377	0.029282957	-0.135757359
ln_S&P500	0.510694839	0.05409361	9.440945813

Table 10.11 Regression results for the OSEBX for Period 4, with a one day lag in the Oil Price.

Results for the OSE10GI Index

Regression Statistics	
Multiple R	0.557327193
R Square	0.3106136
Adjusted R Square	0.304458364
Standard Error	0.017722942
Observations	453

	Coefficients	*Standard Error*	*t Stat*
Intercept	-0.000262437	0.000837262	-0.313446656
Ln_Oilprice	0.30855853	0.034345469	8.983966228
Ln_Currency	-0.402425011	0.110287434	-3.648874545
Ln_Nibor	-0.060238227	0.049867158	-1.207973932
Ln_S&P500	0.55851993	0.09233523	6.048828038

Table 10.12 Regression results for the OSE10GI Index for Period 4, using model 4.