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The impact of changes in Brent oil price on OBX and other major Norwegian indexes and Brent's impact on the USD/NOK pair.

Master's Thesis by

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Abstract

Norway is known for its oil and gas dominated industry and oil price dependency. Oil is also one of the most important commodities in the world and is often referred to as the lifeblood of the world economy. This has been a motivator for this thesis to investigate how the Norwegian stock market is affected by the world and the oil price movements. The method chosen to test this is a multiple regression analysis. OBX is used as the dependant variable and β_1=Brent, β_2=S&P 500 and β_3=USD/NOK as independent variables. S&P 500 is added as a variable that to some degree accounts for the global stock market and USD/NOK was added to test for changes in NOK. The regression was done over the last 18 years. There was also divided into five periods to test for changes in the dependency in the different independent variables. Periods of low and high oil prices was tested to study the effect of different price environments. To test if non-oil related industries is affected by the oil price, several other industry indexes was tested. Currency can be an indicator of the strength of a nations economics and it made therefore sense to test if the USD/NOK is dependent on $/b.

The results were tested with one- and two-week data points using a logarithmic return, it will be referred to two weeks datapoints if not pointed out. The results for the entire period showed a β_1=0,20 and β_2=0,87 and no significant results for USD/NOK. When each period was tested; period 1 (commodity boom), 3 (recovery from financial crisis) and 5 (shale revolution), they had about the same Brent sensitivity 0,17-0,2. The financial crisis was a more sensitive period, where one week data and two week data are very different with one week Brent β_1=0,46 and for two weeks β_1=0,18. The recovery period also had a higher Brent coefficient with β_1=0,29. The last period was the only period with significant USD/NOK coefficient and it was positive β_3=0,24. A positive USD/NOK coefficient means that OBX has some benefit from a weaker NOK. When testing the different industry indexes the energy sector had a Brent coefficient of β_1=0,33 and the oil service had a Brent coefficient of β_1=1,45. The fish sector showed no significant results for oil dependency but USD/NOK had a β_3=0,36 indicating that the sector has great benefit of a weaker NOK. The material sector is unitary elastic with S&P 500 and a β_1=0,12 for Brent. The finance sector is the most oil dependant among non-oil related sectors with β_1=0,14 and an S&P 500 coefficient of 0,92. The finance sector has USD/NOK coefficient of -0,16 which means it benefits from a high valued NOK which most likely is dependent on a higher oil price. Shipping has a Brent coefficient of 0,11 and 0,64 for S&P 500.

The USD/NOK ratio is dependent on the oil price however other factor are contributing. The first period seems affected by the dotcom bubble and low oil prices after this the oil price strengthens the NOK until very high oil price show some diminishing return on USD/NOK from Brent. The recovery period seems affected by expectations of higher oil prices. The las period the oil price doesn't seem to affect the USD/NOK ratio much.

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1 Introduction

Norway has benefited greatly from its petroleum industry in wealth fear and economic growth. This has most likely benefitted the Norwegian stock market where OBX has beaten well known indexes as S&P 500 over the last 20 years. However, the oil market is a fairly volatile market due to volatile oil prices. There are two market crashes in the oil market in the past 20 years that stand out, the financial crisis and the crash in late 2014. The crash in the financial crisis had a rapid rebound but the late 2014 crash has been more a game changer. Where US shale oil companies have disturbed the balance in the market resulting in layoffs in the industry.

We might say that Norway is an *oil dependent* nation due to the high level of cash flow from this industry. We know that there are certain large *oil dependent* companies that are part of the Oslo Stock exchange. However, how dependent are we in the petroleum industry and how much is the petroleum industry dependent on the fluctuating oil price?

In this thesis, we investigate the impact of the oil price volatility on OBX, a benchmark index representing the 25 largest companies on the Oslo Stock exchange. We also look for patterns and dependencies of other variables that could potentially make an impact on OBX, such as the S&P 500 and the value of the Norwegian currency. In addition, we investigate other Norwegian indexes that represents specific industries, such as fish, finance, materials, etc. Our main statistical approach is regression analysis.

Before the analysis, we will take the reader trough relevant topics such as Norwegian petroleum history, what is oil, how the oil price is affected by demand and supply and other factors that play a role on the oil price. In addition, we will take the reader trough some financial history. We believe that a mix of all this information will make an increased understanding of our problem to be addressed, and that this will lead to a good discussion after the analysis is presented.

2 The Norwegian petroleum system and Brent oil

For about 150 million years ago at the end of the Jurassic area the Norwegian coastline had an upper water layer thriving of life. The seabed on the other hand had low levels of oxygen and very little life. As microscopic phytoplankton died and fell to the sea floor there was no organism to decompose the phytoplankton and so they accumulated creating a dark organic rich clay. Now 150 million years later some of this layer is buried under several km of sand and cay. Since the temperature rises about 25°C/km the clay is heated and stars generating oil from the organic matter. Due to high pressure the oil fractures the shale rock and since oil is lighter than water it starts to migrate upwards. As the oil migrates upwards it might get trapped, for example in sand covered by a tight layer of rock (shale) or leak into the sea. In the middle Jurassic, Norway had large rivers running out into the North Sea creating large bodies of sand. This delta is called the Brent delta and most of Norway's petroleum resources are found in these sedimentary deposits. Geologists divide this delta into sections called formations Broom, Rannoch, Etive, Ness and Tarbert, hence Brent oil.

3 The oil industry

3.1 History of the Norwegian oil industry

The source for this chapter is based on (Smith-Solbakken, M. and H. Ryggvik), writers of Store Norske leksikon.

3.1.1 The initial interest

In 1959 one of the world's largest gas discovery was made in the Netherlands named Groningen. This discovery made international oil companies interested in the North Sea as it was likely that the geology was similar. It was the American oil company ExxonMobil and the Dutch British Shell who was involved in the Groningen and started further exploration in Dutch waters. The first company that started exploration in Norway was Phillips in 1962, at this time oil and gas activity had already started in the Dutch and British North Sea. Denmark had given A.P. Møller, Gulf and Shell exclusive rights to the Danish shelf, now Phillips wanted exclusive rights to the Norwegian continental shelf. This request was declined. In 1963 all the North Sea countries clarified where the exact borders lines where in the North Sea. In 1965 the first licensing round was announced, and the first well was drilled by Esso in 1966. The well was dry but the type of sedimentary rocks that is needed for a petroleum system was found. Essos second well was a discovery but not recoverable with the technology and oil price at the time. The discovery was named Balder and production was started in 1999. Several other exploration wells were drilled with shows of hydrocarbon but not economic viable.

3.1.2 The giant discovery

The oil companies became more pessimistic towards the Norwegian shelf until Phillips discovered Ekofisk in 1969 containing about 3 billion barrels of oil. This discovery strengthened Norway's position towards the international companies and was the start of more actively controlled oil politics.

The Norwegian industry Committee decided that there was going to be a governmentally owned oil company. There was also a goal to develop an oil service industry that would provide all aspects of the oil industry value chain. The oil was also to be produced in an environmentally responsible way.

3.1.3 Welfare for the Norwegian people

In the beginning, Norway had a lower oil tax than its neighbouring countries and could risk a governmental take of less than 60% in a potential giant field. In 1975 the parliament drastically changed the taxation on the Norwegian continental shelf and secured a governmental take of almost 80%. Towards the end of the 80s and the beginning of the 90s Norway kept a strict tax regime. The goal was to secure that the oil wealth was going to create welfare for the Norwegian people. There was also going to be well regulated work conditions with high standards for safety and environment.

3.1.4 International involvement

The oil price fell towards the end of the 80s and there was a general opinion that it was less likely to find big oil fields. This led to a reduced prioritization of Norwegian companies to let international companies take more of the risk related to exploration. It was also believed that the Norwegian oil service companies was now competitive enough to compete with international companies. One other reason to stop these protectionist measures was to prepare Norway for a membership in EEA (European economic area). Most Norwegian companies did well with the new more competitive market as well as many companies hired Norwegian workers for Norwegian projects.

3.1.5 Investment restrictions

In February 1988 the government implemented restrictions on oil investments. This led to a drastic fall in the Norwegian housing market. This spread to a crisis in the Norwegian financial sector and some banks had to be overtaken by the government. In the years that followed, growth in the Norwegian economy was strengthened by growth in the oil sector. Oil production was growing due to the development of new technology that made it possible to produce oil that previously was believed to be unrecoverable. The 90s also had a breakthrough in subsea technology as remotely operated underwater vehicles. But the most important for the economy was the lifting of the restrictions on investments which doubled the investments from 28 billion NOK in 1988 to 57 billion NOK in 1993.

3.1.6 High level of investments

The beginning of the new millennium started with a small oil crisis and record-breaking oil production, but oil prices was low. The next years oil prices started to rise as well as the government implemented new measures to keep a high level of activity in the industry. The Norwegian oil production reached its peak in 2000 at 181 M Sm^3 (million standard cubic metres) or 3.1 Mb/d (million barrels per day) and in 2004 when calculating gas, condensate and NGL (natural gas liquified) into oil equivalent Norway peaked at 264 MSm^3 or 4.5 MB/d. As production started to fall after its peak the investments only continued to rise. In 2012 the oil sector invested for 200 billion NOK that is more than three times as high as in the investment restriction for investments in 1988 (adjusted to 1988 value). The investment at this time was not only restricted to activity at the Norwegian continental shelf. The Norwegian oil service industry had now more revenues coming from international activity than the total revenue from Norwegian activity in 2000. This strong growth after the financial crisis had economists concerned that Norway would suffer from Dutch disease (an economic term economist uses when a sector in country has a very strong growth which causes a decline in other sectors). In the years between 2000 and 2014 Norway had the highest GDP per capita in Europa. As the oil price started falling fall 2014 Norway fell on the European GDP per capita ranking and on the international list of oil exporters. However, gas production continues to increase, and petroleum continues to be the largest industry and contributed with 14 % of Norway's GDP in 2017.

3.1.7 SDFI Petoro

Even though there was a general agreement among politician to establish a strong a governmentally owned company many feared that Statoil would be too dominant. This led to the splitting of Statoil in 1984 into two, one part would still be controlled by Statoil and one would be directly controlled by the government called SDFI (State's Direct Financial Interest). SDFI turned out to be an effective way of collecting oil interest to the nation. SDFI had ownership in the largest fields where it was expected to be large revenues. Until 2001 SDFI operated as a holding company with just a small administration. Around year 2000 SDFI owned oil reserves three times as large a Statoil. In 1999 Statoil planned to take back SDFI and to privatize a part of Statoil to gain more capital to start investing in other countries. To privatize 1/3 of Statoil was approved in the parliament but the proposal of taking back SDFI was denied. However, Statoil and Norsk Hydro was allowed to by a small part of SDFI. SDFI was taken out of the department and the name was changed to Petoro with headquarters in Stavanger. 2008 was Petoro's best year with 158,8 billion NOK of governmental income. In comparison the total income from taxation was 239,6 billion NOK and a Statoil-Hydro dividend of 16,9 billion NOK.

4 Stock market

4.1 OBX

OBX is an index that represent the 25 most liquid companies on Oslo Stock Exchange. The OBX can be mistaken for being the benchmark index OSEBX which cover the 67 most liquid stocks on Oslo Stock Exchange. Both indexes are semi-annually revised 1 December and 1 June. OBX is a total return index which means it is dividend adjusted, i.e. dividend is reinvested into the index. OBX has gone through several periods of weak or negative growth, however the long-term trend is up about 9-10% every year on average (Statistisk_Sentralbyrå). Norway seems to be heavily influenced by international events and trends as global stock market and oil prices as Figure 1 shows.

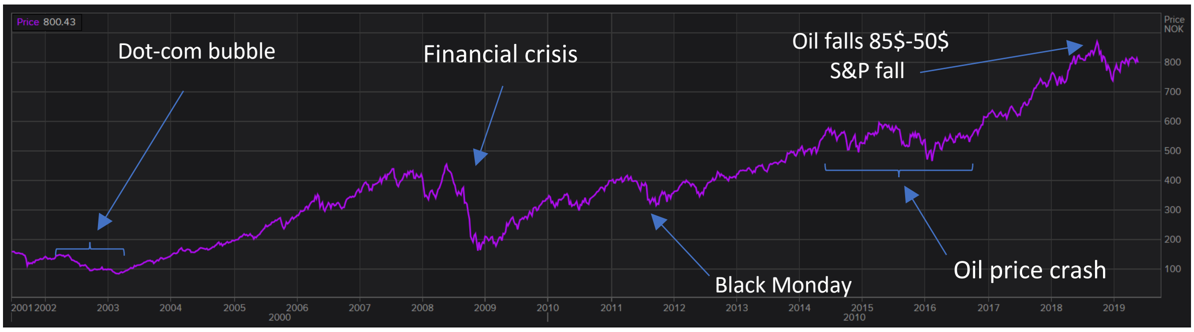


Figure 1: Incidents that influenced OBX. Source: Thomson Reuters.

4.1.1 Oil stocks in OBX

Since 2004 OBX has been dominated by oil companies, and especially by Equinor. The first years from 2004 to 2006 is where Equinor represents the smallest market shear of oil companies on OBX before it merges with Norsk Hydro in 2007 see Figure 3 (Stortinget 2006). The merge was done to strengthen Statoil's financial ability to compete for international oil and gas reserves. The merger would also unify two strong petroleum communities.

Both market value and Shear of OBX data is sampled at the last day of the year. The graph shows that the oil shear of OBX rises from the end 2007 to the end 2008 which is interesting as Brent fell from about 93 $/barrel to about 35 $/barrel. However, the market value of Equinor fell about 33%. This tells us that Equinor did better than OBX during the stock market crash in 2008. The other oil related companies in OBX did worse than OBX. The other category in Figure 3 continues to fall from 2008 to 2009. However, this is also affected by the fact that 4 companies are taken out of the index. One of the companies that was hit the hardest on OBX by the crash was a seismic company (asset heavy) PGS which lost 2/3 of its value.

Brent crude prices fell from over 100 $/barrel to about 55 $/barrel in 2014 and the oil sectors OBX shear only fell 6%, Equinor fell about 6%. Operating companies seems to handle a downturn in oil prices better than oil service companies. There are many examples as Seadrill, Dolphin Drilling, Archer and Electromagnetic Geoservices, Odfjell drilling and others (see Figure 2 for Odfjell drilling). The reason for this can be that the operating companies can cut back and push the price of oil services lower. When oil prices fall, the NOK usually becomes weaker hence reduces the price fall in NOK. Both the fall in 2008 and 2014 devaluated the NOK towards the USD about 40% (source based on downloaded data from Eikon Thomson).

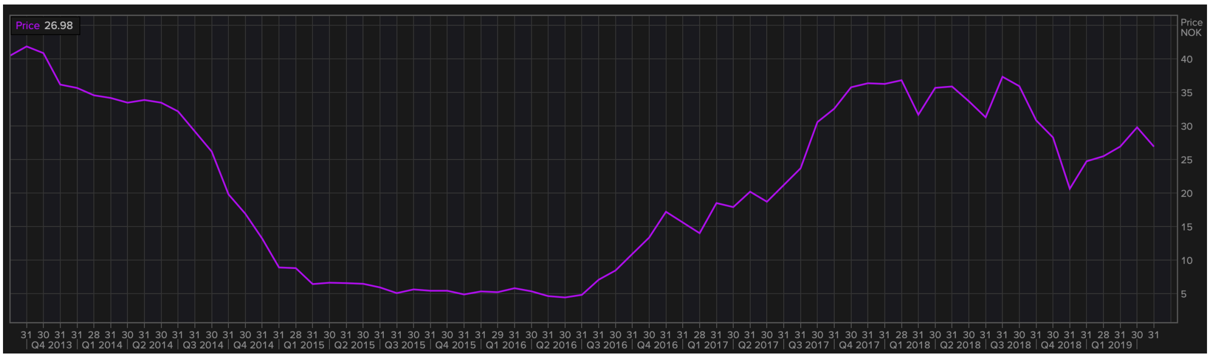


Figure 2: Stock price history of Odfjell drilling. The value is strongly affected by the volatility of the oil price.

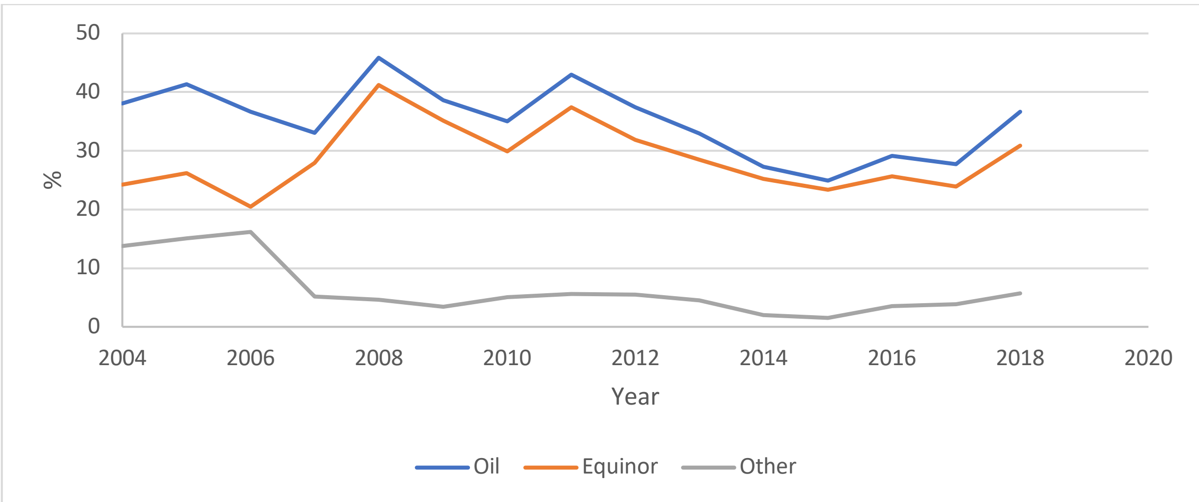


Figure 3: Shear of OBX.

The number of oil companies in OBX has fallen since 2006 (source Appendix?) but the market shear of the oil companies represent is approximately the same. Today OBX has three operator companies: Aker BP, Equinor and DNO. In addition, one service company TGS-NOPEC (asset light seismic).

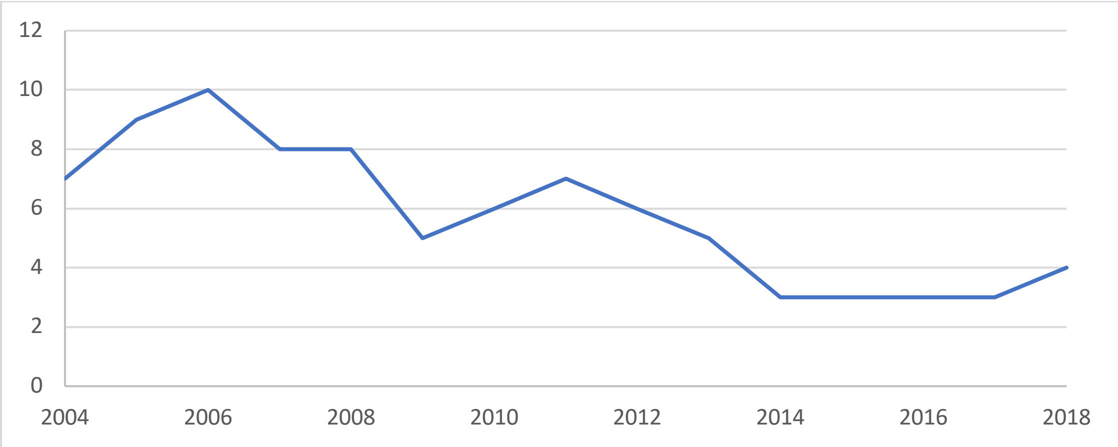


Figure 4: Number of oil companies in OBX.

4.1.2 Finance stocks of OBX

The finance sector is the second largest sector after oil. The finance sector was hit hard under the financial crisis and represented only 5% of OBX at the end of 2008. DNB which represented about 65% of finance sector in OBX lost about 67% of its market value in 2008. The sector recovered the years after the financial crisis and has recovered from 5% in the end of 2008 to more than 15% of OBX today.

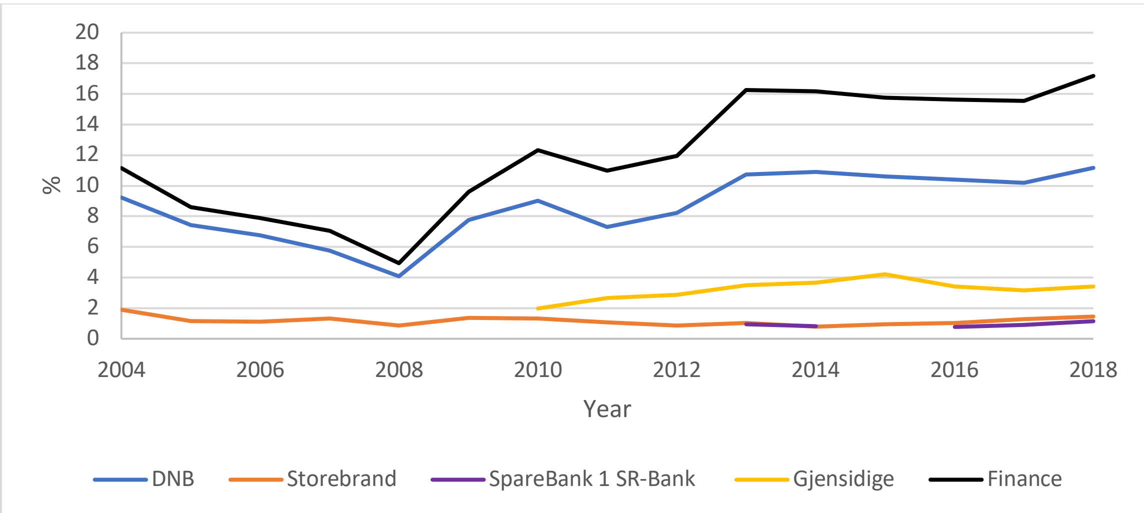


Figure 5: Percentage share of finance companies in OBX.

4.1.3 Fish stocks of OBX

Fish has had an impressive growth and has grown from zero % in 2008 to more than 10% at the end of 2018. These companies have their revenues manly from farmed fish. The sector does not seem negatively affected by the fall in oil prices in 2014 and there is no reason it should but rather gain from the devaluation of the NOK against other major currencies.

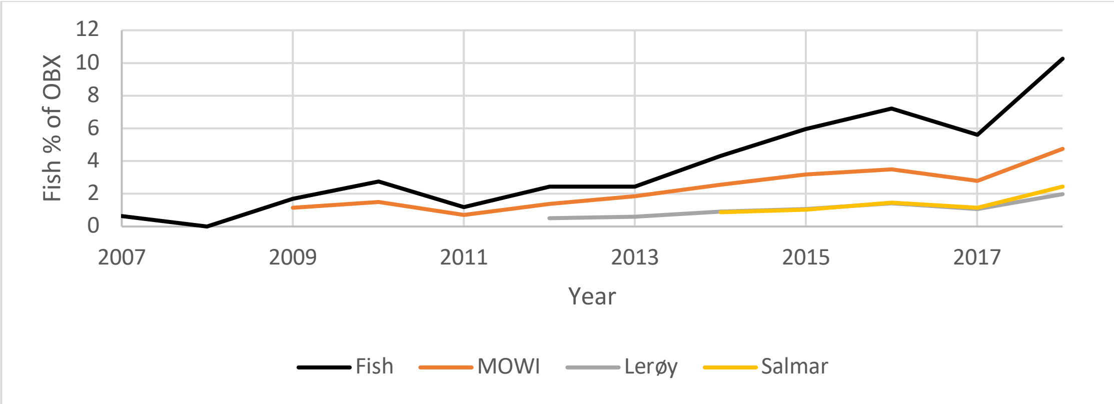


Figure 6: Percentage share of fish companies in OBX.

4.1.4 The «others»

Telenor is a telecom company which has been among the top three companies on OBX since 2004. These companies have been very stable compared to OBX and has grown at approximately the same pace. Hydro's market shear falls as Statoil and Hydro merges in 2007. See Figure 7 for details.

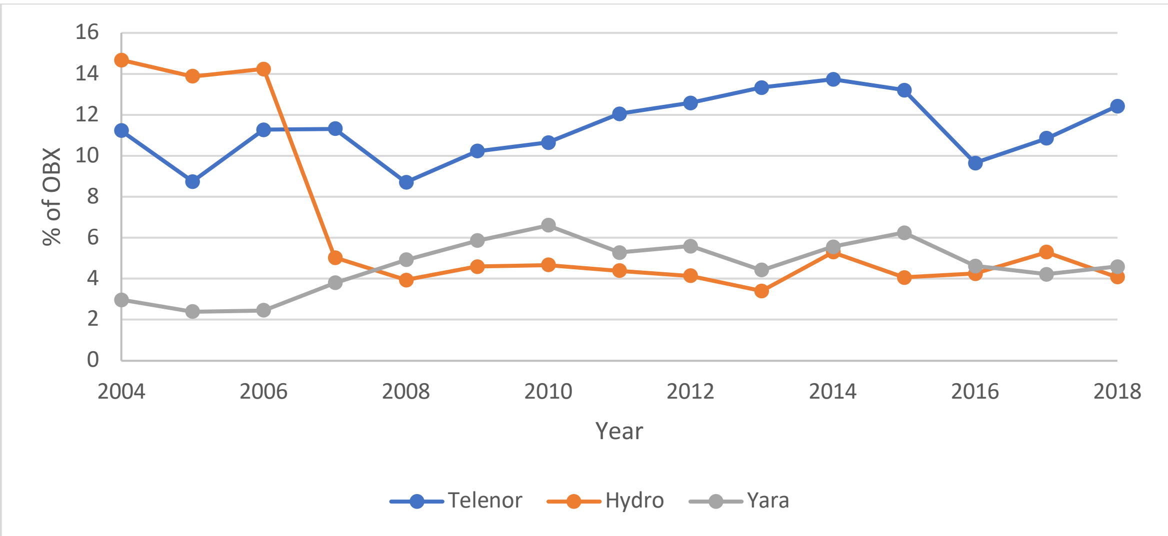


Figure 7: Percentage share of major companies in OBX.

4.2 S&P500

S&P 500 is an index that contains the 500 biggest publicly traded companies from the United States (Investopedia 2019). The index is a good indicator of the American stock market performance and economy. The index is seen as a good reference to the US economy since it covers 500 companies and contains wide range of sectors as seen in Figure 8. The figure shows that the sector for information and technology is the biggest with 21,7% shear. This sector contains well-known companies as Apple and Exxon Mobile (Dividend 2019).

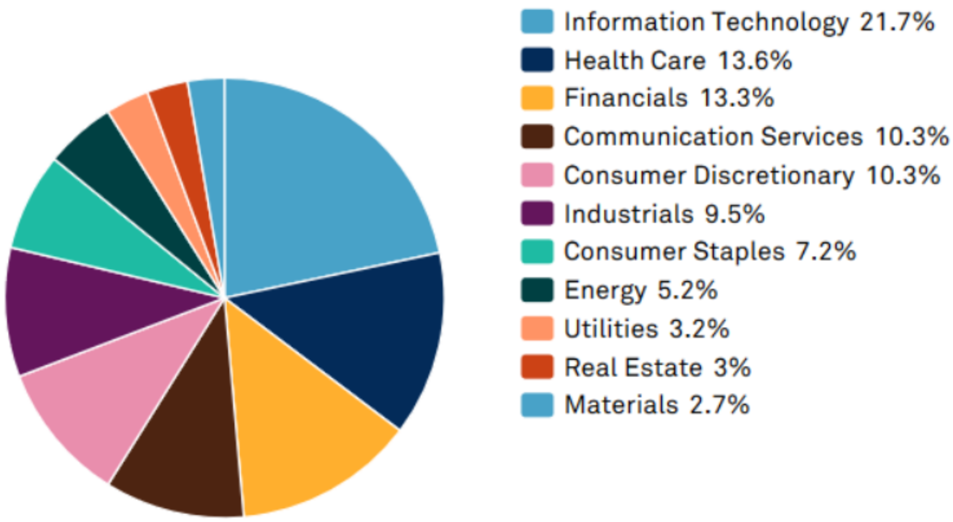


Figure 8: A sector breakdown of the S&P 500 Index. Investopedia.

4.3 Currency

Currency trading is the largest market in the world followed by the bond market (Cattlin 2018). Currency is traded on the foreign exchange market (Forex) which determines the foreign exchange rate. The top 10 traded currencies are called the G10 currencies:

1. United State dollar
2. Euro
3. Pound sterling
4. Japanese yen
5. Australian dollar
6. New Zealand dollar
7. Canadian dollar
8. Swiss franc
9. Norwegian krone
10. Swedish krona

Currency prices are affected by several factor as commodity prices. Countries can be correlated to commodity prices as their economy are dependent imports or export. A good example is Norway's economy which is dependent on the oil price as an oil exporter. The NOK is therefore positively correlated with rising oil prices. Countries that are dependent on importing oil are often negatively correlated to oil prices. This can create large movements in currency pares with opposite correlation as CAD/JPY (Canada dollar/Japan Yen). Currency pairs are also affected by the interest rate controlled by the native central bank. When a central bank raises the interest rate traders see this as a sign of strong economic growth. An interest hike can increase the native currency towards other currency's that doesn't increase the interest rate. A nations inflation rate is also related to its interest rate (Investopedia). Where a low interest rate increase consumption and GDP growth which leads to an increase in the native currency. Improved growth can than lead to higher interest rate and more foreign investment increasing the demand for the currency which increases its value. Politics can be a major mover in currency's where there have been many examples as Brexit 2016 reduced the value of the sterling against other currencies. Times of economic distress can have a positive effect on currency's which are known to have stable governments and solid financial system as the Swiss franc.

4.4 Relationship between stock market and economy

In many ways the stock market is in perfect competition as there are a large number of buyers and sellers. Today, information is also easily available to everyone and it is very easy for everyone to buy or sell stocks. However, the stock market has large fluctuations and crashes in share prices (Pettinger 2010). This suggests that the market is not perfectly competitive and that the investors do not have perfect information. When an investor investigates a company, he only has information about the past and therefore he must estimate the future. The future may be very different from the past and the future can be affected by many unforeseen events. Unforeseen events can come from many things as war, weather, politics or technology these events can be both negative and positive. There is also a fear shear of psychology involved when people buy stocks. People are affected by the behaviour of the herd, as many assume rising prices are rising for a good reason and many professional investors buy the stock so why shouldn't I. This way the market can overreact when the market rises and falls.

4.4.1 Can the stock market affect the economy?

The stock market can have serious effects on the economy. A collapse in the stock market in 1929 was an important factor in the coming great depression in the 1930s. However, daily movements in the market has very small effects on the economy. The market can move up or down for many reasons as overvaluations without affecting the economy, so the stock market is not the economy. There are examples of stock market crashes that didn't affect the economy as the crash in 1987 called black Monday. The stock market fell 25% without any serious effect on the world economy as the world continued to grow with a normal pace. However, it affected for example the UK central bank to cut interest rates which accelerated the economic growth. The financial crisis in 2008/2009 reflected real economic problems where the crash in stock prices may have been contributing to worsen the economic downturn.

Falling stock prices can affect consumer behaviour since it's a loss of wealth. The wealth loss can make consumers cut back and hence affect the economy. The same effect can come from headlines of falling stocks which can worry consumers and reduce their spending's. Pension funds will also affect consumption over time if the output is lower than expected.

Companies use the stock marked as a source of financing to expand. This is done by issuing more shears instead of borrowing from a bank. Falling shear prices makes this difficult (Pettinger 2018).

4.5 Bubbles

4.5.1 Dotcom

The dotcom bubble began in the 1990 when internet was seen as the next big thing with high hopes for future profits (Hayes 2019). Enormous amounts of capital flowed into Nasdaq and in 1993 39% of all venture capital investments (investments made in start-ups with high risk and high expected return) went to internet-based companies. The dotcom companies were pouring into the stock market and 295 of 457 IPO (initial public offering) in 1993 was internet based and the first quarter of 2000 alone had 91 internet related IPOs. The bubble formed by a period of cheap money and very optimistic predictions of future earning and that investors were willing to overlook the fundamentals. This optimism turned stock prices of companies that didn't even generate revenue to triple their value in a day. In March 2000 Nasdaq reached 5048 points, which was almost double of the year before. The downfall was initiated by several tech companies placing selling orders on their stocks. The panic spread among investors sending the market down 10% in a few weeks. As the investment capital for the dotcom companies started to dry up, so did the lifeblood of these companies. Within the end of 2001 a large portion of the dotcom companies had gone bankrupt and trillions of dollars (10^{12}) of invested capital was lost. In October 2002 Nasdaq reached the bottom of 1139 points down 76,8% from the peak. It took 15 years for Nasdaq to come back to its peak in 2000. S&P 500 was not hit as hard as Nasdaq; however, it fell from about 1516 April 2000 to 827 in September 2002, a 45% drop.

4.5.2 The financial crisis of 2008

The US economy went through a short recession in 2001 and the dotcom bobble combined with terror attacks. To speed up the economic growth the Federal Reserve lowered the Federal funds rate (the interest rate banks charge other banks) 11 times from 6,5% in May 2000 to 1,75% in December 2001 (Singh 2019). Money was now cheap which created increased liquidity in the economy. Borrowers with no job and no assets were allowed to borrow money called subprime mortgage. This pushed home prices higher and made investments in these high yield subprime mortgages look like a gold rush. In June 2003 the Federal Reserves lowered the interest to 1% the lowest in 45 years. To sell more mortgages the banks repacked these loans into CDOs (collateralized debt obligations) to sell them on the stock market. And as if that wasn't enough; the Security Exchange Commission reduced the net capital requirements in October 2004 for five investment banks. This allowed banks as Lehman Brothers and Bear Stearns to leverage their investment up to 30-40 times.

In 2004 US homeownership had reach its peak at 70% (Hristova 2019). Demand for homes started to decline and with it the home prices. This led to a 40% decline in the US home construction index in 2006. From 2004 to June 2006 the Federal Reserve increased the federal funds rate to 5,25%. At this rate many subprime borrowers started to default on their loans. This hit the subprime lenders hard and by March 2007 more than 25 subprime lenders had gone bankrupt. Financial firms and hedge funds now owned enormous values in security's backed by failing subprime mortgages. In August 2007 it became clear that the financial market was unable to handle the situation and the problem was now international. The Fed started to cut interest as bad news poured in as Lehman Brothers filed for bankruptcy and Bearn Stearns was acquired by JP Morgen Chase. In October 2008 the Fed and other central banks as the European Central Bank had lowered the rate, but it was not enough to stop the downturn. The US government started purchasing distressed assets as mortgage backed securities for about 700 billion US dollars. Other countries also had bailout packages and nationalization (the government takes control of a company) of companies.

5 Demand and supply

5.1 Crude Oil Demand

Demand for crude oil is mainly driven by economic growth as can be seen in Figure 9. The demand grows with 0.612*economic growth rate, which means that if the world consumes 100 million barrels a day with a 2% global economic growth, the annual demand growth would be about 1.24 million barrels a day (with a R square of 0,506) (Coyne 2018);

$$Oil\ Consumtion\ Growth\ Rate = -0{,}008 + 0{,}612 \cdot Economic\ Growth\ Rate$$

The demand for crude oil is dependent on global GDP growth as well as the price of oil can affect the growth of the global economy. Global oil demand can be split into two categories;

- demand from OECD (Organization of Economic Cooperation and development)
- demand from non-OECD countries

OECD is a group of 34 member countries that discuss and develop economic and social policy. The members are democratic countries that support free market economies (Kenton 2019). In 2010 the OECD countries consumed 53% of the global consumption. These two groups react differently to price changes as seen in Figure 9 where demand declines from 2000 to 2010 in the OECD countries and increased 40% in non-OECD countries. The difference in consumption pattern can be explained by more mature transportation with a higher vehicle per person. This results in a higher shear of oil consumption from the transport system in OECD countries than non-OECD countries. More mature countries are also slower growing and has implemented higher taxes to reduce fuel consumption and pollution. Consumer expectation of future prices can affect the behaviour of the consumer as a fear of higher future prices can reduce the demand today due to changes in consumer behaviour (EIA).

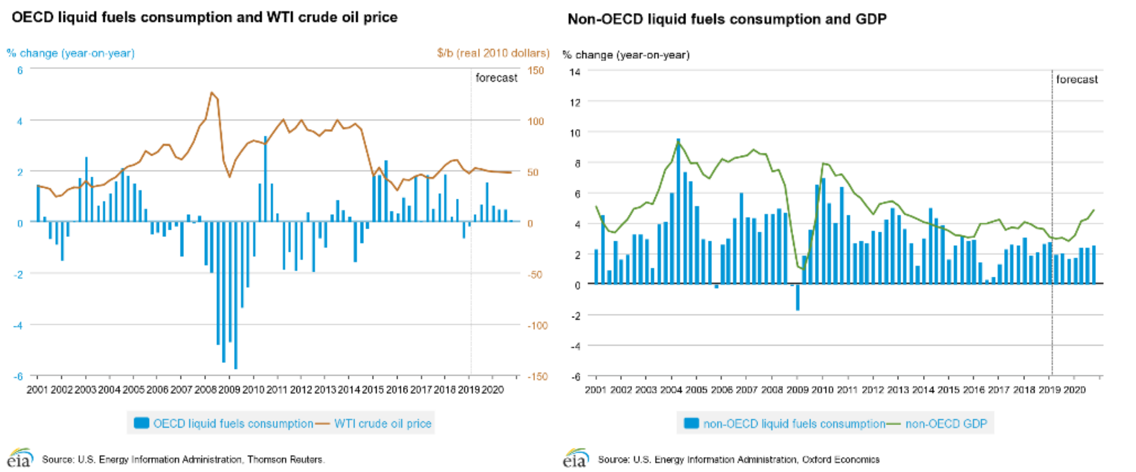


Figure 9: Quarterly changes in oil consumption for OECD and non-OECD countries. Left chart shows the liquid fuels consumption and WTI crude oil price for OECD countries. Right chart shows how the change in liquid fuels consumption and GDP growth is correlated for the non-OECD countries. Source: U.S. Energy information Administration, Thomson Reuters.

Commodities are known to be inelastic consumer products. The main reasons for this is that it takes time to increase the supply. It also takes time and costs money to change habits as changing to public transport or buy an electric vehicle. A study done by the Norwegian central Bank in 2012 shown in Figure 10 shows the elasticities for long and short-run income and price changes divided into G7, remaining OECD, developing Asia and Latin America. Short-run price elasticities are close to zero indicating that the consumer will continue to consume the same amount of oil if prices increase. The income effect is higher in the short run compared to price effect, where Latin America has the highest elasticity of 0.905 and remaining OECD countries has 0.61. In the long run the consumer changes behaviour more in the same direction (people consume more when their income rises, and consumes less when prices rises), except for the G7 countries who have a lower long-run income elasticity than a short-run income elasticity.

	Long-run elasticities		Short-run elasticities		Feedback
	Price	Income	Price	Income	
G7	-0.068^{***} (0.028)	0.267^{**} (0.075)	0.008^{***} (0.001)	0.65^{***} (0.09)	-0.22^{***} (0.011)
Remaining OECD	-0.075^{***} (0.019)	0.93^{***} (0.049)	-0.047^{***} (0.006)	0.61^{***} (0.006)	-0.15^{***} (0.005)
Developing Asia	-0.106^{***} (0.046)	0.681^{***} (0.031)	-0.017^{***} (0.001)	0.736^{***} (0.176)	-0.245^{***} (0.018)
Latin America	-0.154^{***} (0.019)	1.321^{***} (0.046)	-0.006 (0.004)	0.905^{***} (0.033)	-0.110^{***} (0.009)

- Long-run: pooled for each group
- Hausman test accepts poolability of long-run parameters in all cases
- Short-run & feedback: weighted mean-group estimates

Figure 10: Price and income elasticity in long-run and short run for G7, Remaining OECD, Developing Asia, Latin America.

It is worth mentioning that the price of oil is priced in US dollar, hence the price of oil can therefore change dependent on the changes in the native currency relative to USD. This can be damaging for oil importing countries when their economy is struggling, and their currency becomes weaker in respect to the dollar. For oil producing countries this is generally a good thing. A good example is the last oil downturn where the USD/NOK went from around 6 USD/NOK to around 8,5 USD/NOK which is a 42% change. This softens the blow to oil dependent nations and the companies operating in these nations.

5.2 Future demand

Many speculate in future oil demand peak as more and more countries implement environmental policies. However, IEA (international energy agency) predict world oil demand to grow by 1,2 million bbl/d per year until 2024 as seen in Figure 11. Chinese demand growth is expected to slow due to a shift to a more consumer-based economy and implementation of environmental policies. Indian demand growth is expected to catch up with Chines demand growth by 2024. US demand is expected to remain flat (IEA).

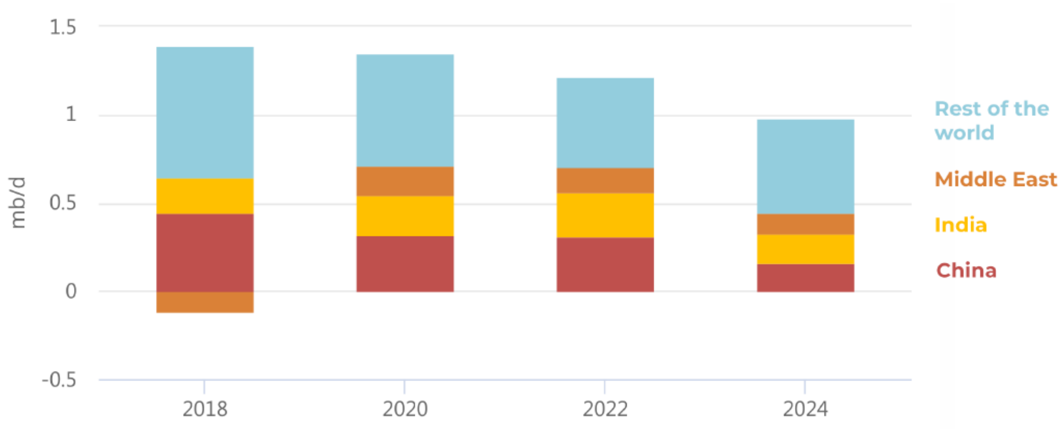


Figure 11: World oil demand growth, predicted by IEA.

5.3 Non-combusted

Demand for non-combusted oil is increasing in volume and as % of total oil demand (British_Petroleum). The demand comes from petrochemicals, lubricants, bitumen and plastics. BP estimates that non-combusted use of fuel will grow by 1.7 % per annum approximately 10% of total growth in energy demand. Oil accounts for around 60% of the growth. BP estimates include a doubling in recycling to about 30%, this would reduce demand with about 3 Mb/d. In this scenario, non-combusted demand would grow by 7 Mb/d and be responsible for 18% of global oil demand in 2040. If a global ban of single-use plastics is implemented demand is estimated to be about 6 Mb/d lower than the ET scenario (BP) (*Evolving Transition*, i.e. continued improvement in the living standard).

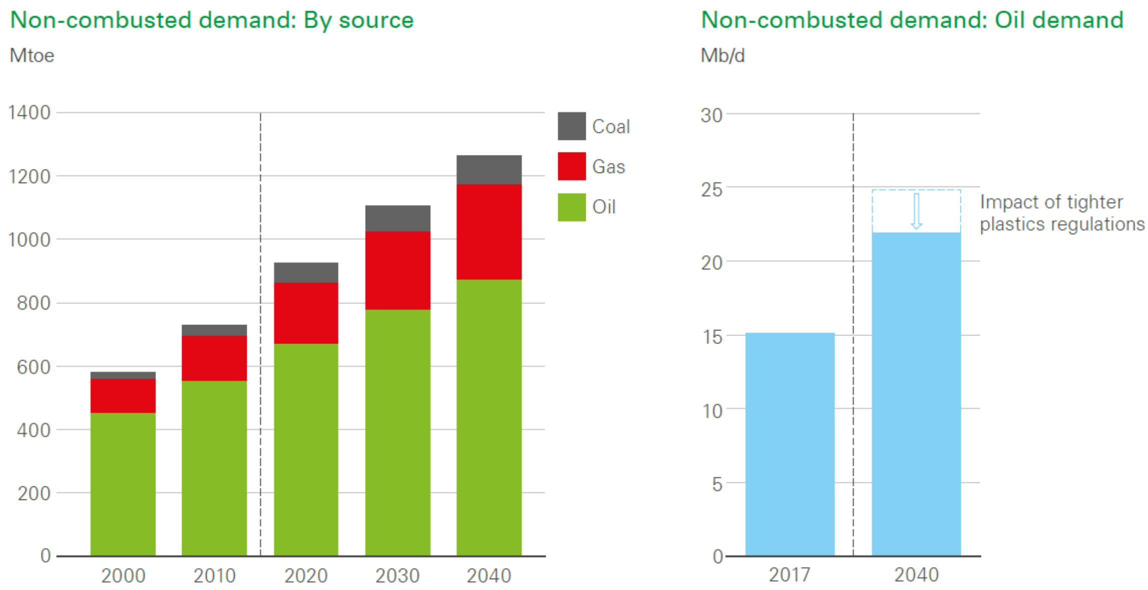


Figure 12: Non-combusted use of oil, gas and coal grows robustly, despite increasing regulation on the use of plastics.

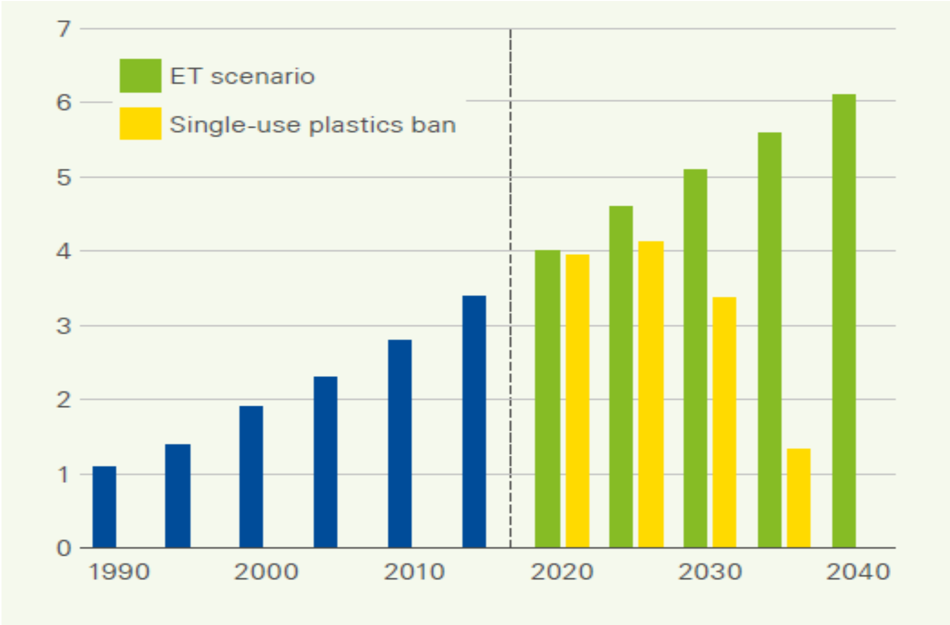


Figure 13: Liquid feedstocks for single-use plastics (Mb/d).

5.4 Transport demand

The transport sector is dominated by oil and in 2017 oil had a 94% market shear of all transport fuel. In BP's ET scenario oil's shear in the transport sector is expected to fall to 85% by 2040. The market shear is expected to be taken by natural gas, biofuels and electrification where each contribute to about 5% of the market shear in 2040. Despite the increase in alternative fuels, oil demand is expected to increase by 4 Mb/d. This demand is believed to come mostly from aviation activity but also some in marine and road transport as shown in Figure 14. As shown in Figure 15 electric vehicles shear of the global car parc is expected to grow to about 15% in 2040. The shear of km driven by electrical cars are expected to increase even more as autonomous cars enter the market in the early 2020 and will take a 25% of all passenger km driven in 2040 (British Petroleum).

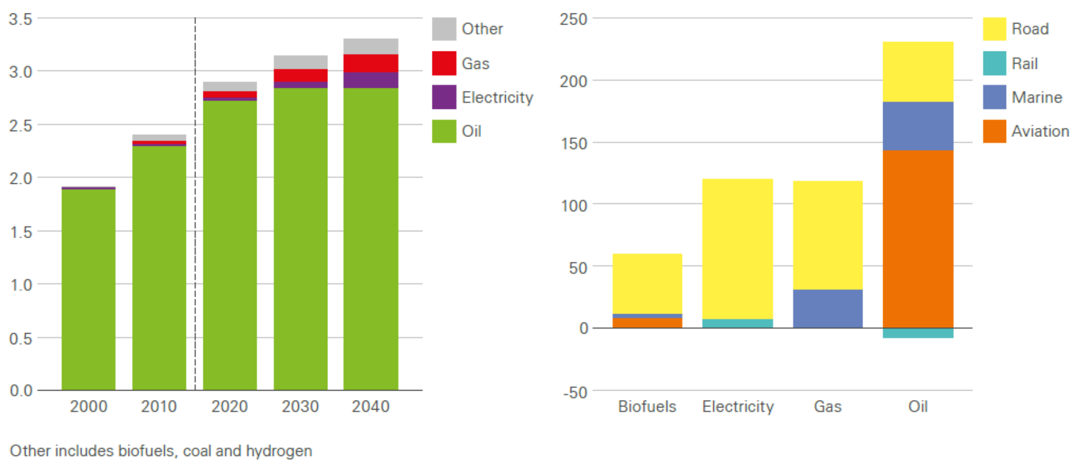


Figure 14: Final energy consumption in transport. Left chart: consumption by fuel (Billion tons oil equivalent). Other includes biofuels, coal and hydrogen. Right chart: growth by fuel and mode, 2017-2040 (Million tons oil equivalent).

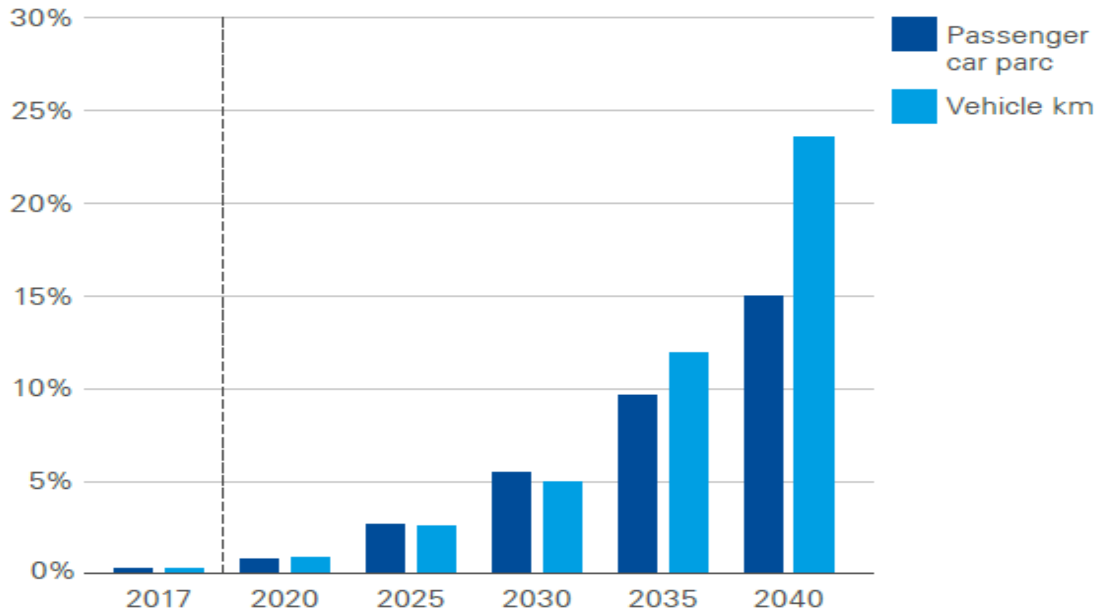


Figure 15: Passenger car parc and vehicle km electrified (share electrified).

5.5 IMO

In 2020 the IMO (International Maritime Organization) will change the regulations for marine bunker fuel to a lower sulphur content from 3,5% to 0,5% (RystadEnergy 2019). Today 80% of the global bunker demand is a high sulphur fuel oil or approximately 3,84 Mb/d of a total bunker demand of 5 Mb/d, see Figure 16. Rystad explains that the shipowners have three options: switch to low sulphur fuel, install exhaust cleaning systems called scrubbers or not to comply to the new regulations. Rystad energy estimates that 700 000 b/d of low-sulphur fuel will be consumed in 2020 and rising to 1.3 Mb/d in 2025. They estimate that 2800 scrubbers will be installed by 2020 and consume 690 000 b/d of high sulphur fuel.

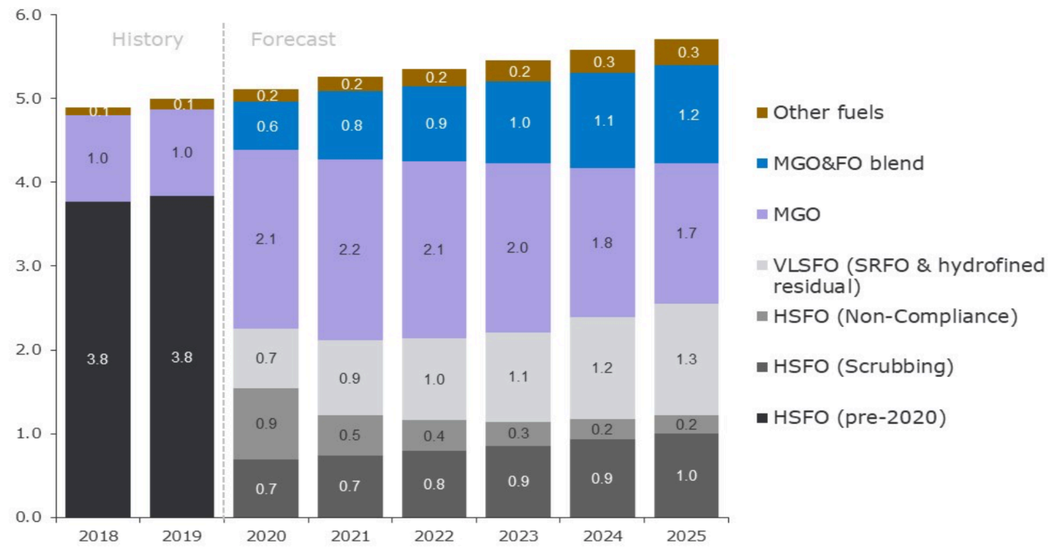
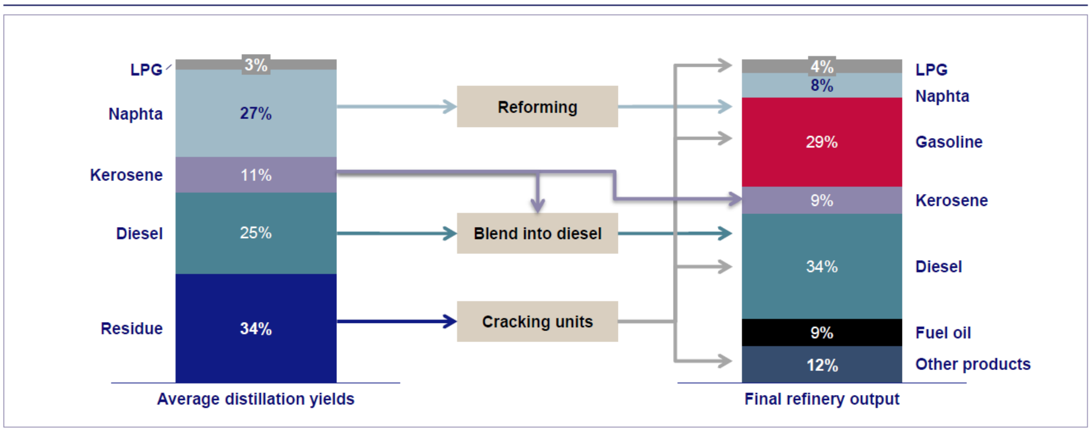


Figure 16: Marine bunker fuel demand by fuel type, base case (Mb/d). Source: Rystad Energy.

In December 2016 DNB Markets released a report where they try to explain or estimate the implications of IMO 2020 (Tveter and Kjus 2016). The report believes that the regulations will come too fast for the industry to adapt, hence affect shipping companies and fuel prices. Only 1% or less of the naval fleet has installed scrubbers, 2016 numbers and a market shear of 10% scrubbers by 2020 would require $30 billion investment. DNB believes this to be unrealistic as the industry is struggling and will therefore have a restricted access to capital. To reach 10% market shear, a large amount of scrubber must also be supplied which may seem unrealistic by the year of 2020. This implies that a large shear of the fuel must run on diesel. In a refinery, diesel is considered a high value product or more expensive than its feedstock crude oil. The bunker fuel is a by-product of the refining process and is considered a waste product from the refiner's perspective and is sold at a discount to its feedstock. The refiner can upgrade some of this residual fuel with complex refineries to reduce residual waste at an extra cost. There are many different types of crude oil with different API gravity and sulphur content. Brent is a low sulphur petroleum with a high API-gravity, thus low density. Low sulphur and high API gravity is priced higher than high sulphur and low API. They estimate that in 2020 demand for diesel will increase by 1,2Mb/d. To do this you would need to refine an additional 3,6 Mb/d see Figure 17 (1 barrel of Brent crude can be refined into 0,33 barrel of gasoil).



- **What happens to the global product yields if upgrading units around the world are fully utilized and there is still not enough to cover product demand?**
- In 1H-2008, imbalances in the refinery system (full utilization of upgrading units) led to a gearing effect on crude demand
- When there is no more spare capacity in the upgrading units one needs on avg. about 3 barrels of crude to produce one incremental barrel of diesel
- In 2008 this situation pushed Brent prices from 86 USD/b to 146 USD/b (+67%) from March to July

Figure 17: Distillation of crude oil and the final refinery output.

The increased demand for gasoil will also increase the supply for high sulphur residual fuel, estimated to be close to 1,3 Mb/d of which must be sold at a discount to other purposes as power generation in less regulated countries. DNB Market compare the situation to 2008 when demand for diesel pushed Brent prices to 147,5 $/b. The strong diesel demand was coming from China and South Africa. In March 2008 all refiners had fully utilized their refining capacity. At that time, Brent price was then about 100 $/b and the diesel crack spread was at an all-time high 25 $/b incentivising the refiners to fully utilize their upgrading units. As diesel demand continued to grow refiners had to run more crude oil through distillate towers resulting in more residual fuel than it was demand for. This resulted in a collapse in the bunker fuel crack spread.

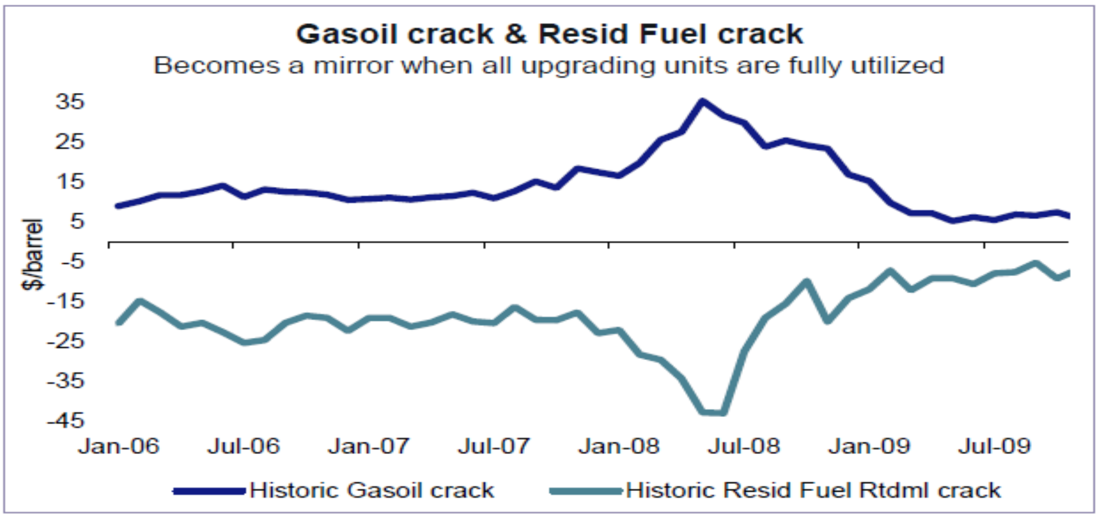


Figure 18: Gasoil crack & residual fuel crack.

The strong growth in diesel demand had the opposite effect on bunker fuel prices to the benefit of the shipping industry. There is a chance that we may experience a similar scenario in 2020 which would push low sulphur crude oil prices as Brent higher (Tveter and Kjus 2016).

5.6 Crude oil supply

As explained earlier that the demand for oil is inelastic so it does not change much with prices. However, the history of oil prices shows large and rapid changes in price. The reason for this is changes in supply, which can be affected by many factors as war in producing countries and improved technology.

The global oil reserves have increased over the last two decades as seen in Figure 19 (British_Petroleum 2018). To be defined as proven reserves it must be probable that at least 90% of the reserves can be produced with profit. The graph also shows how the middle east countries have lost global proven reserves shear to south and central America, North America and Africa. With production data from 2017, the reserves would be depleted in 50.2 years.

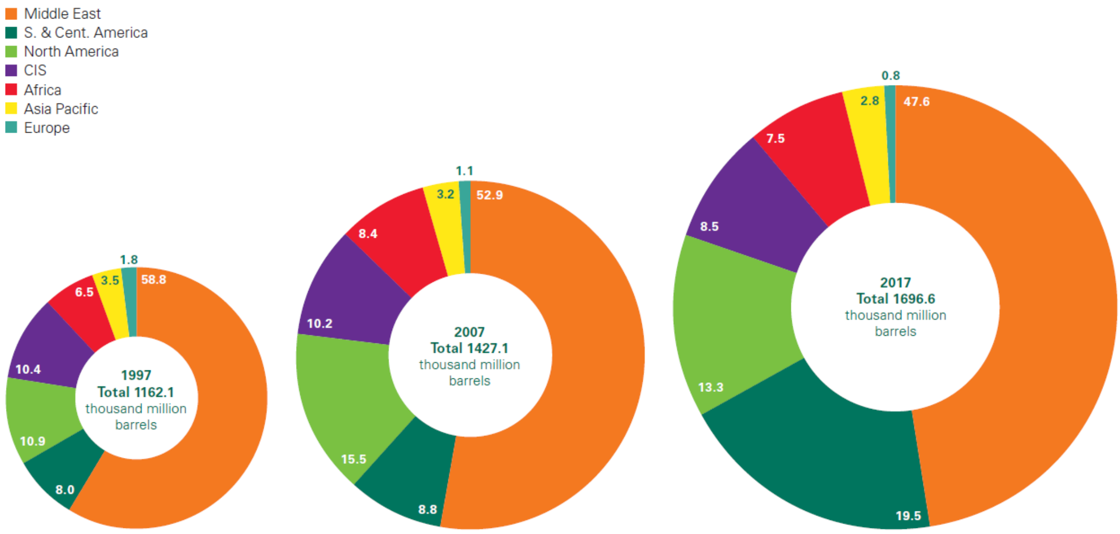


Figure 19: Distribution of proved reserves in 1997, 2007 and 2017 (percent). Source: BP Statistical Review of World Energy 2018.

As global demand grows, so does global production, see Figure 20. Global oil production has grown from 75 million bbl/d in 2000 to more than 92 million bbl/d in 2017. These numbers are taken from the BP Statistical Review of World Energy 2018 and 2008. The numbers include crude oil, shale oil, oil sands and NGLs (natural gas liquids – the liquid content of natural gas where this is recovered separately). It excludes liquid fuels from other sources such as biomass and derivatives of coal and natural gas.

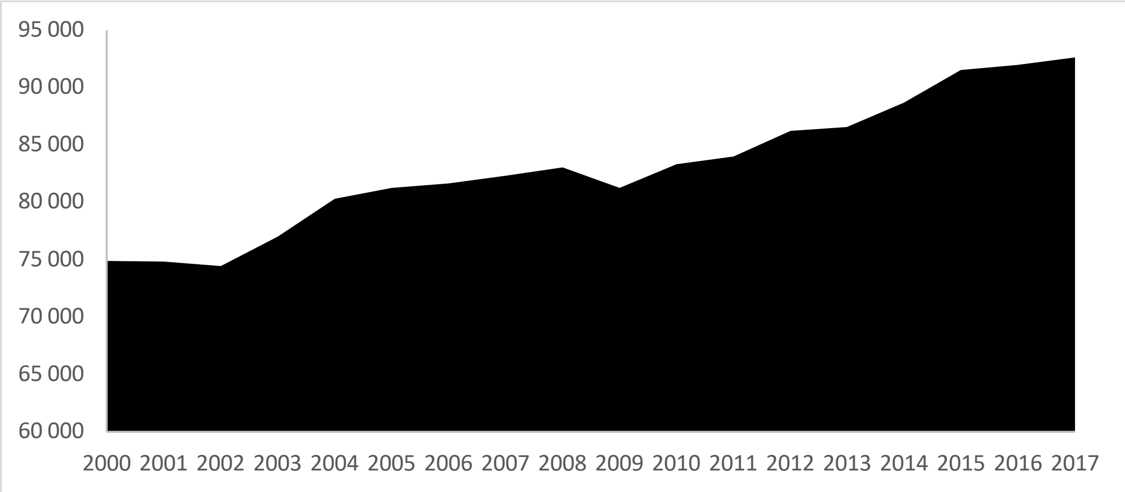


Figure 20: World oil production, measured in thousand barrels a day. Source: BP Statistical Review of World Energy 2018.

5.7 OPEC

Oil production can be divided into two groups OPEC and non-OPEC. OPEC countries produce about 40% of world production and the export represents 60% of the oil trade internationally (EIA). Production outside OPEC is manly produced by investor owned companies. These companies seek to maximize shear holder value by increasing production and cutting costs resulting in very little or no spear capacity. Nationalized oil companies often have additional objectives as providing employment and infrastructure. Investor owned companies does not have the market shear to control prices and it's illegal to cooperate with other companies to fix prices. However, nationalized oil companies are not under such restrictions and can therefore cooperate in production cuts to increase the price of oil. This can be highly profitable as oil prices are inelastic. The amount of spear capacity in OPEC countries is used by many as an indicator of tightness in the market. Spear capacity is defined by EIA as production that can be initiated within 30 days and sustained for more than 90 days. A low spear capacity in the market tend to increase prices as the risk of an undersupplied market from unexpected outages in production are higher. Figure 21 shows historical spear capacity in OPEC nations and WTI crude oil prices. The figure has marked the time period 2003-2008 where the spear capacity was below 2,5 mill bbl/d which played a part in the price increase. OPEC cuts are also affected by the willingness of the member countries to comply to the cuts agreed upon. This is closely monitored by the market and will affect the price if the cuts are not executed as planned (EIA).

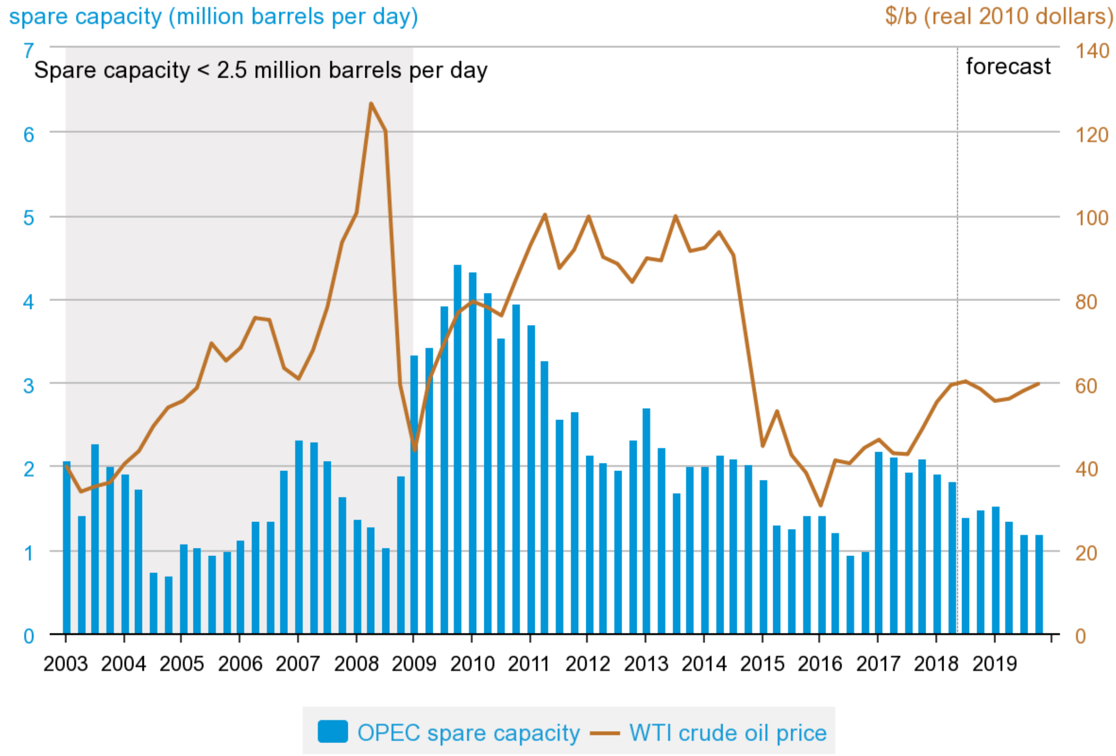


Figure 21: OPEC spare production capacity and WTI crude oil prices. Source: U.S. Energy Information Administration, Thomson Reuters.

5.8 Shale supply

Shale oil is defined as an unconventional oil resource. This means that it cannot be produced with conventional methods. The conventional method is to drill into a body of sand or chalk that oil has migrated into. The oil lies there usually under high pressure as it is trapped by a tight formation as shale. This oil has migrated from an organic rich shale formation, the sand or chalk is permeable (the oil can move) so the oil can move to the producing well. When extracting oil from the source rock (shale) one needs to use unconventional methods to bring the oil to the surface. This method is called fracking, the shale formation is fractured so the oil can move to the producer. The US has been very successful in the production of shale oil (Demirbas, Al-Sasi et al. 2017).

Figure 22 shows the rapid increase in US shale oil production from the beginning of 2010 to 2019. The figure shows production from wells that initiated production in a specific year. What the figure also shows is the rapid production decline the industry would experience if the completion of new wells where to stop. This means that to just keep production flat, more wells must be completed. If completions stopped in the beginning of 2018 production would fall more than 2 Mb/d in one year. The shale production was clearly affected by the fall in oil prices in 2014 with negative growth in 2015 and 2016. In 2017 (WTI average 50$/b) the industry seems to have adapted to the new price level and sees again steep production growth.

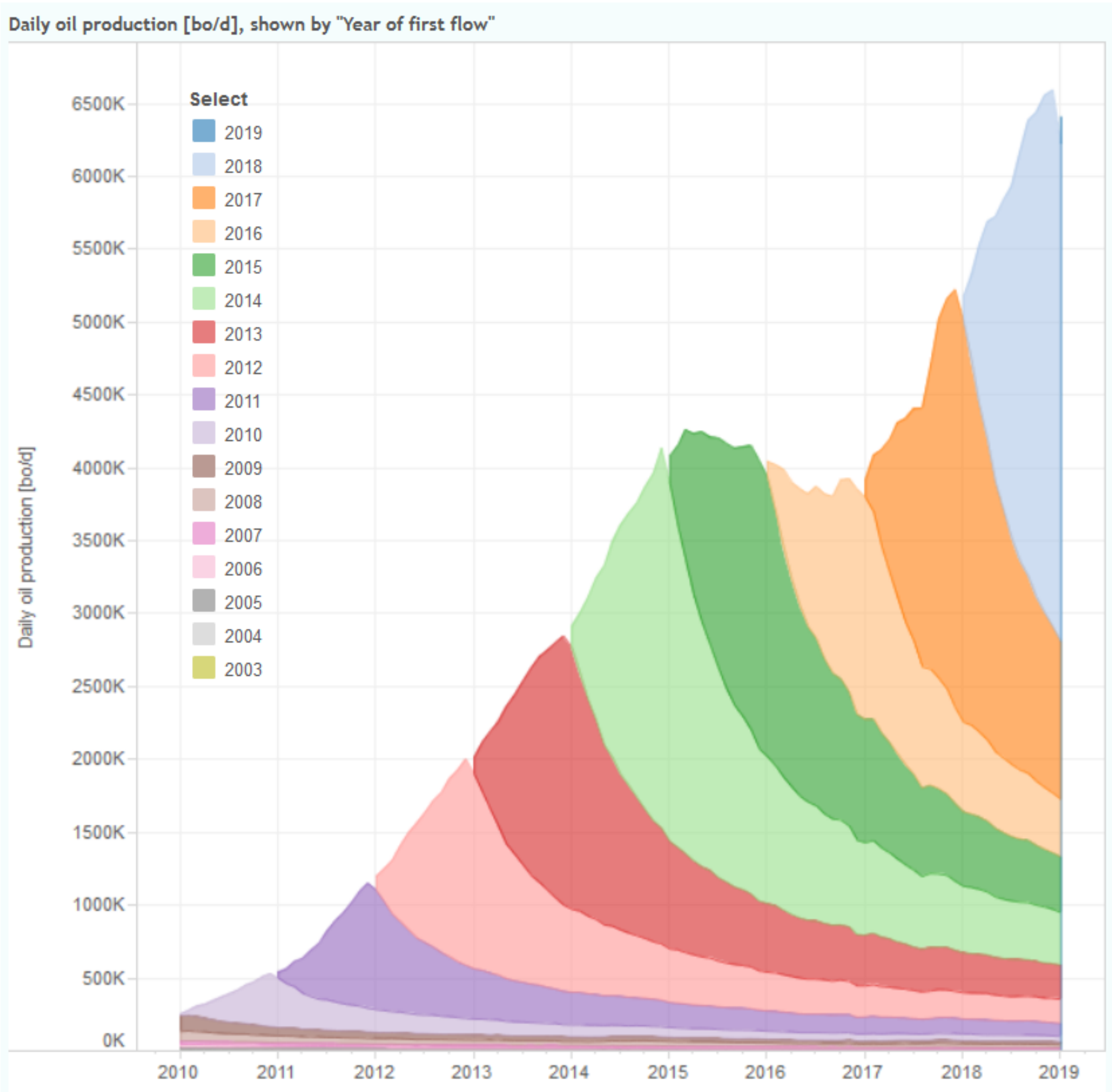


Figure 22: US shale oil production. To keep the production flat, new wells must be completed every year. Source: Shale Profile.

However, this is not for all shale plays as seen in Figure 23 where Eagel Ford has so far not been able to come back to its peak production in 2015. The story looks different in the Permian basin (the right fig) where the growth just seems to accelerate.

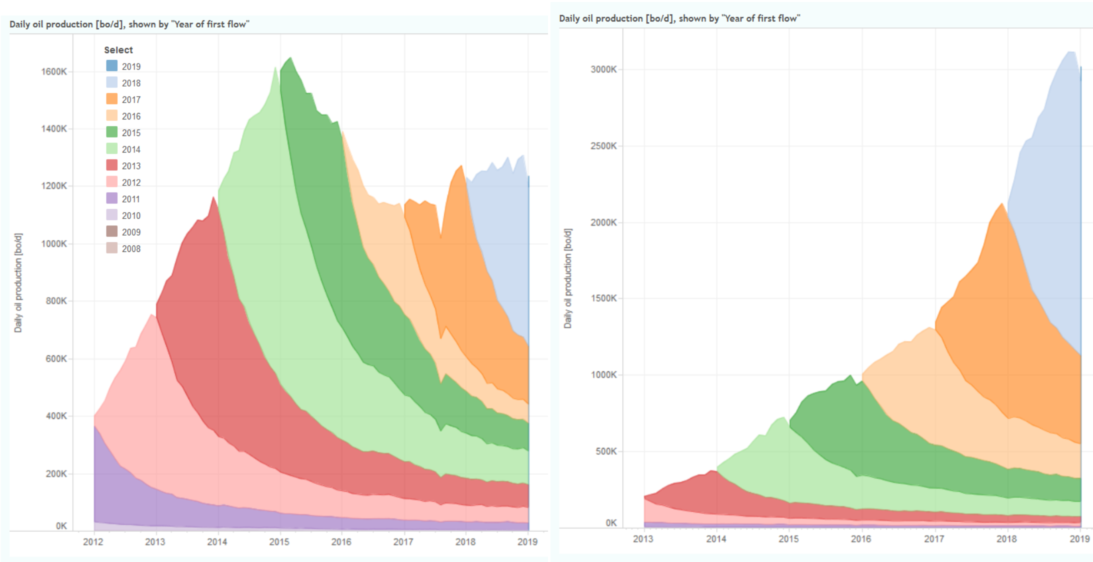


Figure 23: US shale production for Eagle Fort (left chart) and Permian (right chart) basin. Source: Shale Profile.

In the Figure 24 below the rig count and US production is shown in the same plot. The graph shows that oil companies made dramatic cutbacks in drilling activity when the oil price fell in 2014, reaching the bottom in 2016. The rig count picked up again after 2016 but not to the same levels as early 2014. This miss match in drilling activity and production can come from an increase in productivity from each well. To the right is a plot of drilled but uncompleted wells. The graph shows the relationship between drilled wells and completed wells. The DUCs are growing so it means uncompleted wells are accumulating. This backlog of 8390 wells can potentially be turned into significant volumes of crude supply (Eikon).

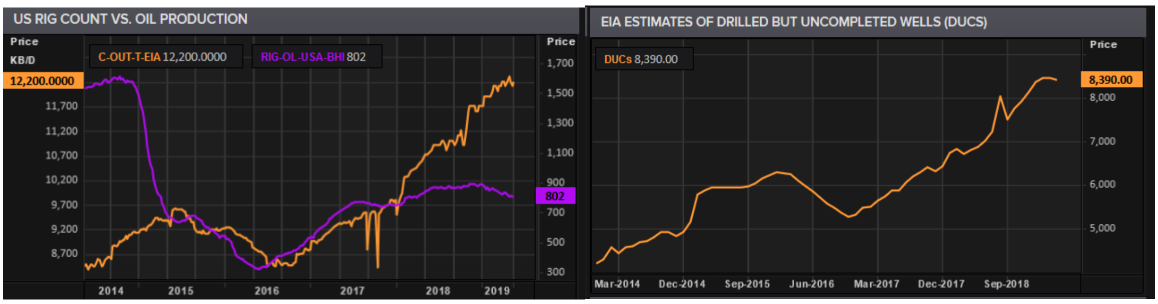


Figure 24. Left chart: US rig count vs. oil production. Right chart: EIA estimates of drilled but uncompleted wells (DUC). Source: Eikon Thomson.

5.9 Oil Market

5.9.1 Spot market

As mention earlier oil prices are determined by the demand and supply relationship (EIA). Crude oil and crude oil products are bought and sold simultaneously around the world in an auction like manner where the highest bidder wins the product. In the spot market the supply is sold for immediate delivery and therefore signals the current supply demand balance. The cost of producing a barrel can be very different like Saudi Arabia vs the Arctic. However, it is sold at the approximately same price. So, if demand increases, the producers move into more expensive areas if the consumers are willing to pay for it. This leads to enormous profits for the low-cost producers when prices are high. Figure 25 shows how the highest breakeven reserves that is sold can determine the prices.

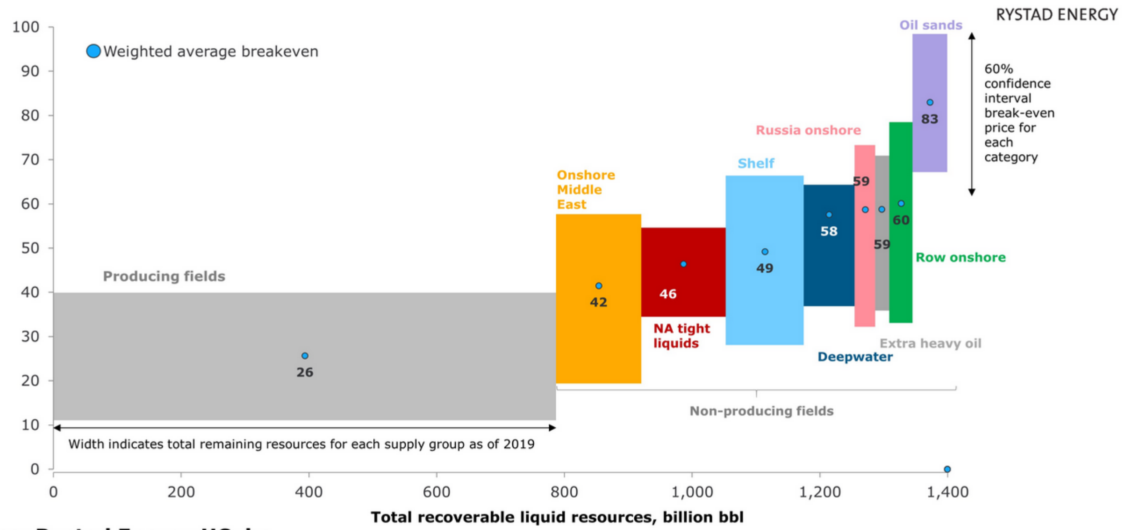


Figure 25: Global liquid supply curve, real Brent break-even price, USD/bbl. Source: Rystad Energy.

5.9.2 Future contract

Crude oil is also traded in the futures market where the oil is bought or sold at a specific date in the future. This can be useful for both buyers and sellers as they can lock in the price when it is at a preferable price. As an example, a small oil company that know they will get in trouble at lower prices can sell futures (hedge) and reduce the risk. These contracts are also bought or sold by speculator that want to take advantage of price changes to make a profit. The future contract as the NYMEX (New York Mercantile Exchange) future contract is specified in quantity, quality, delivery date and delivery location. These contracts are traded through the NYMEX and are therefore more financial which is settled in cash and not by the delivery of the oil. A forward contract is a bilateral contract where a buyer and seller agree on a price for an actual delivery in the future.

5.9.3 Spread

A future contract can be priced lower or higher than the current price (Scott 2018). When the price of a future contract is lower than the current price the market is said to be in backwardation. As the future contract moves closer to maturity the spread between the spot and the contract closes. The figure shows the close relationship between the oil price and the spot future spread. In times with high oil prices the market usually enters backwardation as the market expects lower prices in the future and contango when prices are low and future spot price is expected to be higher. Figure 26 show the historical backwardation/contango and WTI prices.

Figure 26: Crude Oil Prices and Backwardation/contango. Source: Exchange.

The market also shows its expectation in the forward curve where price of the future contracts is falling (backwardation) in time or increasing with time (contango).

6 Statistical theory

This chapter takes us though some general statistical theory which is relevant for our analysis we perform on our data. All sources of this chapter is taken from Jeffrey M. Wooldrigde (Introductory Econometrics: A modern Approach), unless other is stated (Wooldridge 2012).

6.1 Regression analysis

Regression analysis is a commonly used technique for estimating relationship among variables. With a set of data series regression analysis can be used to observe how one or more *independent variable(s)* explains a *dependent variable*;

$$y = \beta_o + \beta_1 x + u,$$

where y is the dependent variable explained by the explanatory variable x. β_o is constant and β_1 is called the regression coefficient, which measure the effect of x on the y-variable. The *error term* u represents factors other than x that explains y. One can simply think about u as "unobserved".

The equation above illustrates a simple regression model, meaning that only one independent variable explains y. This motivates for doing a multiple regression analysis because it allows us to control for multiple variables that affect the dependent variable and hence used to build better models for prediction;

$$y = \beta_o + \beta_1 x_1 + \beta_2 x_2 + (\dots) + \beta_n x_n + u.$$

6.2 Ordinary Least Square (OLS)

In order to predict how the explanatory variable affects y in linear regression, we need to find the line that fits the given data points best. *Ordinary least squares* are a commonly used method used for this. The idea of OLS is to minimize the difference between the predicted values and the observed values. However, because residuals take both positive and negative values, we take the sum of square residuals over all observation and eliminate the issue;

$$\sum_{i=1}^{n} \hat{u}_i^2 = \sum_{i=1}^{n} \left(y_i - \hat{\beta}_0 - \hat{\beta}_1 x_1\right)^2$$

This is also called residual sum of squares (SSR). The betas are called estimates which is a mathematical technique applied to a sample of data to produce real-world numerical estimates of true population. The estimated slope for $\hat{\beta}_1$ that minimizes the residual sum of squares is hence

$$\hat{\beta}_1 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}$$

6.3 Assumption for the OLS method

In order to establish an unbiased estimator of the OLS-method, the following assumptions must be held.:

MLR.1 (Linear in Parameters)
The model of the population can be written as

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_s x_k + u$$

Where the betas are the unknown parameters (constants) of interest and u is an unobservable random error term.

MLR.2 (Random Sampling)
The samples of n observations are random following the population in the first assumption.

MLR.3 (No perfect collinearity)
In our sample, there is no independent variables that are constant, and there are no exact linear relationship among the independent variables.

MLR.4 (Zero conditional mean)
The error u has an expected value zero given any values of the independent variables. This assumption is among others violated when an important variable that is correlated with any of x_1 to x_k is omitted. This is called *omitted variable bias*.

MLR.5 (Homoskedasticity)
The error u has the same variance given any values of the explanatory variables. Hence, $var(u|x_1, \dots, x_k) = \sigma^2$.

These five assumptions (known as the Gauss Markov assumptions) are conditional on the sample values of the independent variables,

$$Var(\hat{\beta}_j) = \frac{\sigma^2}{SST_j(1 - R_j^2)}, i = 1, \dots, k$$

6.4 Coefficient of determination

So far, we have talked about how we can estimate relationship among variables. However, we have not talked about how well these predictions are. It is useful to compute a number that summarizes how well the OLS regression line fits the line. To do this, we present three sum of squares formulas.

Total sum of squares: $$SST = \sum_{i=1}^{n} (y_i - \bar{y})^2$$

Explained sum of squares: $$SSE = \sum_{i=1}^{n} (\hat{y}_i - \bar{y})^2$$

Residual sum of squares: $$SSR = \sum_{i=1}^{n} \hat{u}_i^2$$

Total sum of squares (SST) is the deviation from the mean. It measures how spread out the y_i are in the sample. The explained sum of squares (SSE) is the variation in $\hat{y}_i$ from the mean. The residual sum of squares (SSR) is the sample variation in $\hat{u}$. Furthermore,

$$SST = SSE + SSR.$$

How well the OLS regression line fits the data can now be explained by the *goodness of fit*, often called R^2;

$$R^2 = \frac{SSE}{SST} = 1 - \frac{SSR}{SST}.$$

The number given is between 0 and 1 and is the ratio of the explained variation compared to the total variation. It is the fraction of the sample variation in y that is explained by x, often given in percentage. The higher R^2 the better fit.

The important fact about R^2 in multiple regression case is that R^2 never decreases, and it usually increases when another independent variable is added to the regression. Hence, during multiple regression it's often better to look at the *adjusted R^2*.

6.5 Covariance and correlation

Covariance is a measure of how two random values (X and Y) is behaving together. It measures their linear dependence. If the greater value of the X values corresponds to greater values of Y values, they move in the same direction and are positive correlated, and if the greater values of X samples corresponds to less greater values of Y samples, they move in opposite direction and are negatively correlated. Covariance is the expected value of the product $(X - \mu_x)(Y - \mu_y)$;

$$Cov(X, Y) = \sigma_{xy} = E[(X - \mu_x)(Y - \mu_Y)$$

To interpret the magnitude of the covariance can be a little tricky and misleading. The correlation between two random values are much like the same, but it is normalized by the standard deviation of X and Y in the denominator;

$$Corr(X, Y) = \rho_{xy} = \frac{E[(X - \mu_x)(Y - \mu_Y)}{\sigma_x \sigma_y} = \frac{\sigma_{xy}}{\sigma_x \sigma_y}$$

$$-1 \leq Corr(X, Y) \leq 1.$$

Values below 0 means the population correlation is negative and opposite above.

6.6 Functional form

Regression models has different functional forms, which tells how the interpretation of beta is. The level-level function is "straight forward"; the betas explain how a change in the independent variable affects the dependent variable, by a fraction ($\Delta y = \beta_1 \Delta x$). This way of interpreting betas can sometimes be misleading because of the difference in magnitude among the independent and dependent variable. To account for this, we use the log-log functional form. Hence, we look at how much the percentage change in the independent variable affect the dependent variable by percentage. See Table 1.

Table 1: Functional forms involving logarithms.

Model	Dependent variable	Independent variable	Interpretation of beta_1
Level-level	y	x	$\Delta y = \beta_1 \Delta x$
Level-log	y	$\log(x)$	$\Delta y = (\beta_1/100)\%\Delta x$
Log-level	$\log(y)$	x	$\%\Delta y = (100\beta_1)\Delta x$

Log-log	$\log(y)$	$\log(x)$	$\%\Delta y = \beta_1 \%\Delta x$

6.7 Hypothesis testing

Until now, we have talked about how we look at the relationship among different sets of variables and how well these data sets are predicted with the use of OLS-method. In financial theory, it is important to evaluate whether our hypothesis is *statistically significant* to conclude our theory. This can be done by comparing our data samples with a synthetic data set from an idealized model. We will demonstrate shorty how we formulate our hypothesis testing with the use of *the significance approach*.

Let $\hat{\beta}_j$ be the estimator of the parameter β. A t-statistics for this parameter and quantity of the form

$$t_{stat} = \frac{\hat{\beta}_j - \beta_j}{SE(\hat{\beta}_j)} \sim t_{n-k-1}$$

β_j is a known non-random constant which may match the actual unknown parameter β, or may not match. $SE(\hat{\beta}_j)$ is the standard error of the estimator $\hat{\beta}_j$.

Two hypotheses are formulated; the first one is called the "null hypothesis" ($H_0\colon \beta_j = 0$) and the "alternative hypothesis" ($H_1\colon \beta_j \neq 0$). The test statistics derived from the formula follows a *t-distribution* with n-k-1 distribution (number of samples minus degree of freedom minus 1). A significance level is chosen, normally within a 95% significance level. When the t-stat distribution test is performed, one use tables to see if the value of the test is within the critical area. If it is outside the critical area, the null hypothesis is rejected, and one can conclude that there is a statistical significance of our hypothesis. It not, keep the null hypothesis.

7 Statistical approach

In this chapter we prepare for the statistical analysis with an explanation of why and how we will interpret the results. The main idea with the thesis is to interpret the impact of the Brent oil price volatility on OBX and look for other important explanations that may explains how it behaves. We also include other independent variables that could possibly have an impact on the OBX, in addition to reduce biasness. Basically, we run a regression analysis on OBX with different independent variables, including Brent oil price. We also interpret other statistical approaches such as mean, variance and correlation.

7.1 Data handling

All the data from this analysis is downloaded from Eikon Thomson Reuters, which is licensed to the University of Stavanger. The numbers are mostly from 2001 to 2019 and includes only date and the exchange rate at the corresponding time. The time interval for the data is 1 and 2 weeks. Thus, two regressions are run separately for the time intervals. We have chosen weekly interval because we want to avoid issues regarding short period time lag. For example, Oslo stock exchange is not open at the same time as the American. Using day interval could possibly make a wrong picture of the logarithmic return. The reason we run regression on the same data with two time intervals is to see if and how that affect the statistical output of the analysis.

All the different regression analysis is done on the entire period from 2001 to 2019 (if data available). In addition, our main regression analysis (Brent's impact on OBX) is divided into four periods in order to interpret if there is any difference among these periods. The following periods we have chosen is as follows;

- **Period 1 (2001-2007):** The first period is stretching from the beginning of our available numbers (2001) toward end of 2007. This is a period with rapid growth in commodity demand and prices. The period starts off with the dotcom bobble and ends before crude oil prices takes off.
- **Period 2 (December 2007 – January 2009):** This period covers the year before the financial crisis started (with very high oil price touching 140$/barrel), and the entire crisis itself.
- **Period 3 (January 2009 – June 2011):** Our next period is during the years just after the financial crisis. This period has strong growth in OBX and Brent prices where OBX goes from about 200 to 400 NOK and Brent rises from about 40 to 110 $/b.

- **Period 4 (June 2011 – August 2014):** We call this period the "oil boom", facing a permanently high oil price between 100 and 130 USD/barrel. The period has strong growth in OBX and a slightly negative change in oil prices.
- **Period 5 (August 2014 – April 2019):** This period covers the *beginning of the end* of the oil boom and the corresponding years until today with oil price around 70-60$/b. We call this period the *shale revolution* since US shale oil production growth has been faster than demand has been growing and thereby lowering prices.

Table 2: The periods, a summary.

Period	From time	To time	Explantion
Period 1	22-Jun-2001	07-Dec-2007	Growth in stock market and oil price
Period 2	07-Dec-2007	02-Jan-2009	Pre-financial crisis and financial crisis
Period 3	02-Jan-2009	03-Jun-2011	Growth after the financial crisis
Period 4	10-Jun-2011	01-Aug-2014	The «oil boom»
Period 5	08-Aug-2014	19-Apr-2019	The shale revolution

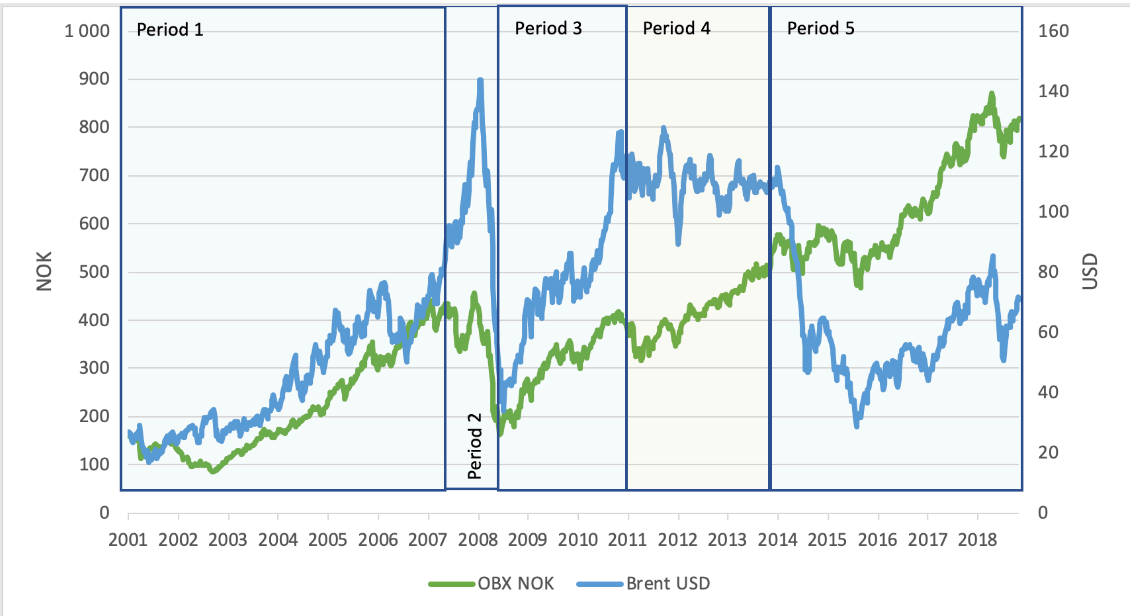


Figure 27: OBX and Brent oil price.

7.1.1 Total logarithmic return

Logarithmic return measures the continuous interest rate of return from period to period and is a commonly used method when working with empirical finance. Our data is calculated using the following formula;

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

where P_t is the price or value of the dependent or independent variable. P_{t-1} is the corresponding value at the previous period. When we run a regression analysis, the logarithmic return of all variables is our input value (unless other is stated).

7.1.2 Regression

Regression analysis is our main statistical approach of this thesis. We run different regression analysis in different periods, but mostly be set OBX as the dependent variable. From the regression output we analyse and discuss the betas of the logarithmic return of the independent variables. We will also look at the spread of the data in terms of the *goodness of fit.*

7.1.3 The hypothesis testing

All parameters from the regression output is evaluated with the hypothesis testing using a significance tolerance of 95% (p-value: 0.05). Values that are not in the rejection area is regarded *not statistically significant.*

7.1.4 Correlation moving average

We have run a correlation analysis on some of our data. The correlation between two variables are presented graphically with a moving average of one year in each calculation. That means that each data from the correlation output is based on 52 weeks. Such correlation analysis can be suitable to visually see pattern between two variables during different periods. However, one must be aware that correlation plot can be misleading – two variables does not necessarily explain each other/be dependent to each other. There could be other factors that the both are correlated or explained by.

7.2 Indexes within different sectors

In this thesis we investigate the impact of the oil price volatility on OBX which represents the 25 most liquid companies in Norway. However, a regression on Oslo benchmark index as a whole does not say anything about which of the large companies/sectors that are most influenced by the oil price volatility.

We run regressions on five different sectors of companies that are represented on the Oslo Stock exchange in order to see if there is any difference on the oil price volatility on the sectors. It must be mentioned that OBX represents the 25 most liquid companies on the Oslo Stock Exchange while the following indexes represents more companies that are not a part of the OBX. In other words; they are not only a piece of OBX.

7.2.1 OSE10GI (Norwegian Energy Index)

OSE10GI index is the name of the energy index that is representative for the energy companies on Oslo stock exchange. Most of them represents oil companies. The index comprises companies with businesses that are dominated by construction or provision of oil rigs, drilling equipment and other energy related service and equipment, including seismic data collection (OsloBørs 2019).

When we run regression one the energy index, we set oil price, S&P and USD/NOK as independent variables.

The list below represents all the companies in the OSE10GI. It worth mention that the two largest companies on the energy index, Equinor and Aker BP, which are also listed on OBX, represents more than ¾ of the energy index.

Table 3: List of companies representing OSE10GI Norwegian energy index.

Ticker	Name	Market value (MNOK)	Cumulative market share
EQNR	Equinor	608 842	67 %
AKERBP	Aker BP	98 347	77 %
SUBC	Subsea 7	33 942	81 %
TGS	TGS-NOPEC Geophysical Company	25 507	84 %
DNO	DNO	17 888	86 %
FRO	Frontline	13 569	87 %
AKSO	Aker Solutions	10 335	88 %
BDRILL	Borr Drilling	10 018	89 %
OCY	Ocean Yield	9 954	90 %
BWO	BW Offshore Limited	9 396	92 %
ODL	Odfjell Drilling	6 871	92 %
FLNG	FLEX LNG	6 860	93 %
SDRL	Seadrill	6 239	94 %
PGS	PGS	6 010	94 %
NODL	Northern Drilling	5 313	95 %
BWLPG	BW LPG	5 243	96 %
SHLF	Shelf Drilling	5 175	96 %
SPU	Spectrum	3 851	96 %
KVAER	Kværner	3 721	97 %
AKA	Akastor	3 471	97 %
HLNG	Höegh LNG Holdings	3 032	98 %
RAKP	RAK Petroleum	2 820	98 %

MSEIS	Magseis Fairfield	2 602	98 %
NOR	Norwegian Energy Company	1 979	98 %
AWDR	Awilco Drilling	1 637	99 %
SIOFF	Siem Offshore	1 507	99 %
AVANCE	Avance Gas Holding	1 407	99 %
DOF	DOF	1 220	99 %
PRS	Prosafe	1 162	99 %
PEN	Panoro Energy	989	99 %
QEC	Questerre Energy Corporation	847	99 %
SDSD	S.D. Standard Drilling	795	99 %
ARCHER	Archer	709	100 %
PLCS	Polarcus	539	100 %
MGN	Magnora	415	100 %
SOFF	Solstad Offshore	400	100 %
EMGS	Electromagnetic Geoservices	377	100 %
EIOF	Eidesvik Offshore	373	100 %
SBX	SeaBird Exploration	344	100 %
REACH	Reach Subsea	309	100 %
OTS	Oceanteam	301	100 %
ENDUR	Endúr	268	100 %
IOX	Interoil Exploration and Production	225	100 %
AQUA	Aqualis	195	100 %
PSE	Petrolia	187	100 %
EMAS	EMAS Offshore	127	100 %
HAVI	Havila Shipping	103	100 %
DDASA	Dolphin Drilling	45	100 %
ATLA NOK	Atlantic Petroleum	36	100 %

7.2.2 OSE40GI (Norwegian Finance Index)

Our next index to analyse is the Norwegian Finance Index, named OSE40GI. It contains companies involved in activities such as banking, mortgage finance, consumer finance, specialized finance, investment banking and brokerage, asset management and custody, corporate lending, insurance and financial investment (OsloBørs 2019).

When we run regression on the finance index, we set oil price, S&P and USD/NOK as independent variables.

Below is the list of the companies representing the finance index. Aker is the third largest company representing the finance index and is probably the one most involved in the oil sector. Yet, it is only 9% of the market cap in the finance sector.

Table 4: List of companies representing OSE40GI Norwegian finance index.

Ticker	Navn	Market value (MNOK)	Cumulative market value
DNB	DNB	243 673	51,80 %
GJF	Gjensidige Forsikring	86 397	70,17 %
AKER	Aker	40 476	78,77 %
STB	Storebrand	31 322	85,43 %
SRBANK	SpareBank 1 SR-Bank	26 512	91,07 %
NOFI	Norwegian Finans Holding	13 399	93,92 %
SBANK	Sbanken	7 801	95,57 %
PROTCT	Protector Forsikring	4 951	96,63 %
B2H	B2Holding	4 886	97,67 %
AXA	Axactor	3 030	98,31 %
PARB	Pareto Bank	2 286	98,80 %
KOMP	Komplett Bank	2 010	99,22 %
ASC	ABG Sundal Collier Holding	1 703	99,59 %
INSR	Insr Insurance Group	1 048	99,81 %
INFRNT	Infront	603	99,94 %
VVL	Voss Veksel- og Landmandsbank	298	100,00 %

7.2.3 OBSHX (Norweigan Shipping Index)

Oslo shipping index consist of the most liquid companies in the sectors of oil & gas storage, transportation and marine.

When we run regression on the shipping index, we set oil price, S&P and USD/NOK as independent variables.

Below is the list of these companies. Frontline and Wilhelmsen constitute 37% of the market share in the shipping index.

Table 5: List of companies representing OBSHX Oslo finance index.

Ticker	Navn	Market value (MNOK)	Cumulative market share
FRO	Frontline	13 356	19,02 %
WALWIL	Wallenius Wilhelmsen	12 475	36,78 %
GOGL	Golden Ocean Group	6 806	46,47 %
SNI	Stolt-Nielsen	5 674	54,55 %
WWI	Wilh. Wilhelmsen Holding ser. A	5 543	62,44 %
BWLPG	BW LPG	5 220	69,88 %
NTS	NTS	4 111	75,73 %
FJORD	Fjord1	3 640	80,91 %
HLNG	Höegh LNG Holdings	3 062	85,27 %

MPCC	MPC Container Ships	2 438	88,75 %
AMSC	American Shipping Company	2 055	91,67 %
WWIB	Wilh. Wilhelmsen Holding ser. B	1 881	94,35 %
ODF	Odfjell ser. A	1 721	96,80 %
AVANCE	Avance Gas Holding	1 388	98,78 %
JIN	Jinhui Shipping and Transportation	859	100,00 %

7.2.4 OSLSFX (Norwegian Seafood Index)

Oslo seafood index include stocks that are operated under the seafood sector. Below is the list of the companies of OSLSFX.

When we run regression one the seafood index, we set oil price, S&P and USD/NOK as independent variables.

Table 6: Listed companies in the OSLSFX Seafood index.

Ticker	Name	Market value (MNOK)	Cumulative market share
MOWI	Mowi	108 059	39,52 %
SALM	SalMar	46 155	56,40 %
LSG	Lerøy Seafood Group	36 467	69,73 %
BAKKA	Bakkafrost	23 584	78,36 %
AUSS	Austevoll Seafood	20 182	85,74 %
GSF	Grieg Seafood	13 727	90,76 %
NRS	Norway Royal Salmon	8 561	93,89 %
SALMON	Salmones Camanchaca	4 831	95,65 %
SSC	The Scottish Salmon Company	4 517	97,31 %
NTS	NTS	4 183	98,84 %
AKVA	AKVA Group	2 427	99,72 %
HBC	Hofseth BioCare	758	100,00 %

7.2.5 OBOSX (Norwegian Oil Service Index)

Oslo Oil Service index include stocks that are operated under the oil service sectors. These companies are known for delivering service to the operator oil companies like Equinor and Aker BP. Below is the list of the companies belonging to OBOSX.

When we run regression on the oil service index, we set oil price, S&P and USD/NOK as independent variables.

Table 7: Listed companies in the OBOSX Oil Service Index.

Ticker	Name	Markedsverdi (MNOK)	Cumulative market share
SUBC	Subsea 7	30 098	38,62 %
TGS	TGS-NOPEC Geophysical Company	23 031	68,18 %
BWO	BW Offshore Limited	10 237	81,32 %
AKSO	Aker Solutions	9 474	93,47 %
PGS	PGS	5 085	100,00 %

7.2.6 OSE1510 (Norwegian Materials Index)

This index includes Norwegian companies that are producing materials. That is products like alumina, fertilizer, etc. Yara, Norsk Hydro and Elkem are the three largest companies of this index, covering 95% of it.

When we run regression on the Materials index, we set oil price, S&P and USD/NOK as independent variables.

Table 8: Listed companies in the OSE1015 Materials index.

Ticker	Name	Market value (MNOK)	Cumulative market share
YAR	Yara International	101 280	53,41 %
NHY	Norsk Hydro	63 558	86,93 %
ELK	Elkem	14 870	94,77 %
BRG	Borregaard	9 643	99,85 %
INC	Incus Investor	112	99,91 %
BOR	Borgestad	103	99,97 %
AVM	Avocet Mining PLC	33	99,98 %
ELE	Element	30	100,00 %

7.3 USD/NOK currency exchange rate

This is a slightly different regression model. Until now, we have set OBX or an index as the dependent variable. In this regression model we set the USD/NOK as dependent variable and the Brent oil price as independent variable. A regression output for this model explain how the oil price affects the USD/NOK.

In this model, we run a linear regression in two periods: 2001-2009 and 2009-2019.

8 Statistical results

8.1 Volatility

We start to present our results by presenting some descriptive statistics of the five periods. In Table 9, we have presented the average return of all variables on weekly basis and their volatility for the entire period from 2001-2019. NB! The sector indexes shipping, seafood and oil service does not cover all years.

Table 9: Average return (in percent) and standard deviation of all variables during 2001-2019, except for shipping, seafood and oil service index which is for the last years.

	OBX	Brent USD	S&P500	USD/NOK	Finance index	Energy index	Shipping index	Seafood index	Oil service index	Materials index
Average	0,18	0,10	0,09	-0,01	0,21	0,18	0,06	0,43	-0,23	0,12
Std	3,19	4,82	2,37	1,60	3,70	3,53	2,59	3,16	5,02	4,10

On average, the weekly expected return on OBX is 0,18%. This is more than twice as much as the return of S&P 500. By using compound interest, the annual return over 52 weeks is 9,8% for OBX and 4,8% for S&P 500.

Table 10 divides the descriptive statistics into the following 5 periods for comparing. For period 2, which involves the financial crisis, the average return is negative, and the volatility is highest for all the variables available. Period 4, which was the oil boom, has the lowest volatility on all variables. For period 5, the volatility is slightly increased for oil price, USD/NOK and oil service index.

Table 10: Average weekly return and standard deviation of all variables with respect to each period.

	OBX	Brent USD	S&P500	USD/NOK	Finance	Energy	Shipping	Seafood	Oil service	Materials
Periode 1							-	-	-	-
Average	0,06 %	0,12 %	-0,09 %	0,05 %	-0,07 %	0,19 %	-	-	-	-
Std	2,89 %	5,00 %	2,08 %	4,90 %	2,81 %	3,29 %				
Periode 2							-	-	-	-
Average	-1,32 %	-1,48 %	-0,87 %	-1,05 %	-2,07 %	-1,02 %	-	-	-	-
Std	6,90 %	7,11 %	4,58 %	5,69 %	7,20 %	6,79 %				
Periode 3										
Average	0,49 %	0,41 %	0,24 %	0,25 %	0,64 %	0,36 %	-	0,67 %	-	-
Std	4,66 %	5,64 %	3,20 %	4,90 %	6,20 %	4,44 %	-	2,97 %	-	-
Periode 4										
Average	0,18 %	-0,06 %	0,24 %	0,03 %	0,22 %	0,16 %	-	0,26 %	-1,22 %	-0,04 %
Std	2,45 %	2,89 %	2,07 %	2,91 %	3,06 %	2,42 %	-	3,49 %	3,09 %	3,15 %
Periode 5										
Average	0,16 %	-0,15 %	0,17 %	-0,03 %	0,27 %	0,06 %	0,06 %	0,46 %	-0,20 %	0,13 %
Std	2,18 %	4,82 %	1,83 %	4,52 %	2,33 %	3,43 %	2,59 %	3,04 %	5,07 %	3,16 %

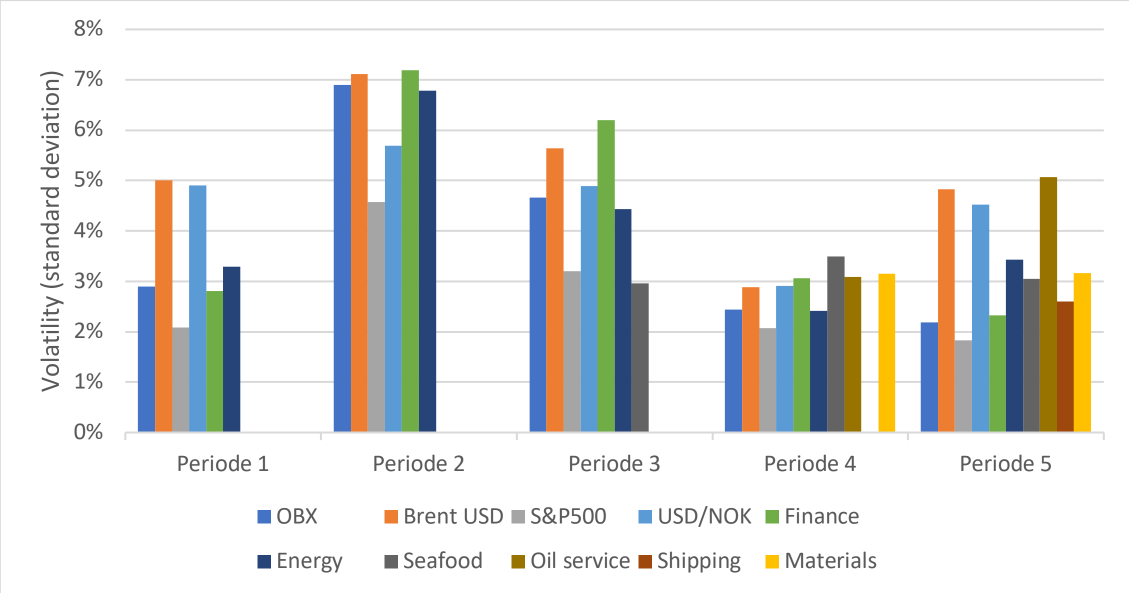


Figure 28: Volatility (standard deviation) for all the variables on each period. Period 2 and 4 set apart from the other periods with its high and low volatility. This is explained by the financial crisis and the oil boom which is two quite different financial environments.

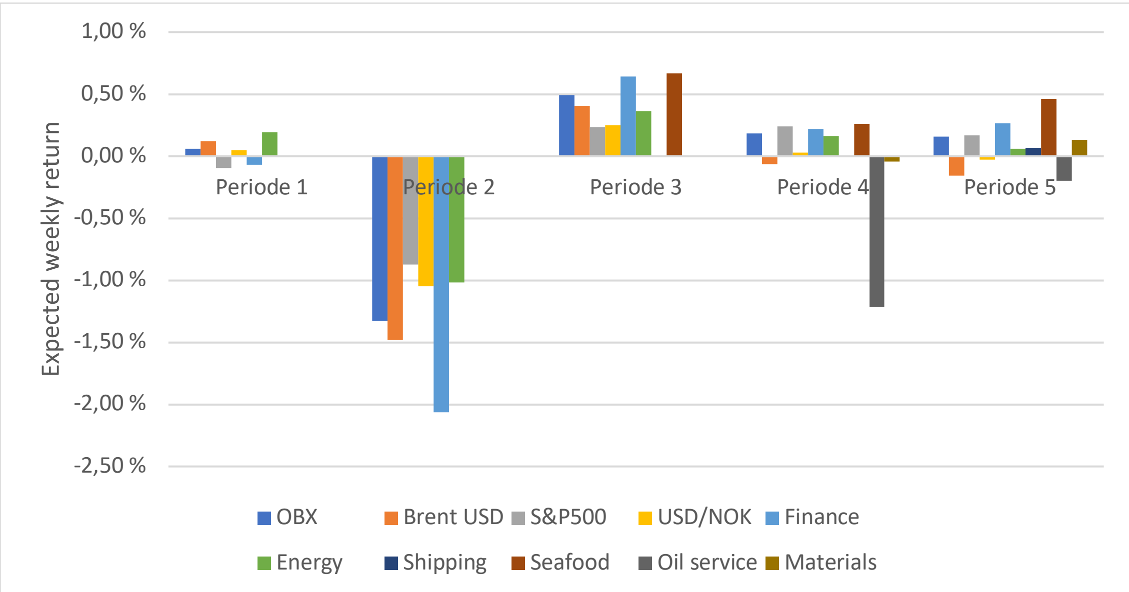


Figure 29: Expected weekly return.

8.2 OBX (Norwegian benchmark index)

First up is the regression analysis on OBX with the independent variables; Brent, S&P and USD/NOK. The regression formula is as follows;

$$Return_{OBX} = \beta_0 + \beta_1 Return_{BRENT} + \beta_2 Return_{S\&P500} + \beta_3 Return_{USD/NOK} + \mu$$

8.2.1 Entire period

Table 11 and Table 12 shows the regression output for the period 2001 – 2019.

Table 11: Regression output of Brent for the entire period 2001 – 2019 with weekly interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,75		Intercept	0,00	0,00	1,11	0,27
R Square	0,56		ln Brent	0,19	0,02	12,24	0,00
Adjusted R Square	0,56		ln S&P 500	0,84	0,03	27,40	0,00
Standard Error	0,02		ln USD/NOK	-0,01	0,05	-0,24	0,81
Observations	929						

Table 12: Regression output of Brent for the entire period 2001 - 20019 with 2 weeks interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,80		Intercept	0,00	0,00	1,18	0,24
R Square	0,63		ln Brent	0,20	0,02	10,32	0,00
Adjusted R Square	0,63		ln S&P 500	0,87	0,04	21,47	0,00
Standard Error	0,03		ln USD/NOK	0,05	0,06	0,83	0,40
Observations	464						

From the regression output we see that S&P 500 has the greatest affect on OBX with a beta of 0,84 (1-week interval) and 0,87 (2-week interval), while Brent has 0,19 (1-week interval) and 0,20 (2-week interval). This means that changes in S&P 500 has 4 times greater impact on OBX than changes in the oil price. Both parameters are statistically significant.

There is no evidence that changes in USD/NOK explains changes in OBX due to no statistically significant result.

The regression formula for 1-week interval is shown below;

$$Return_{OBX} = 0 + 0{,}19 \cdot Return_{BRENT} + 0{,}84 \cdot Return_{S\&P500} - 0{,}01 \cdot Return_{USD/NOK} + \mu$$

The correlation between the Brent oil price and OBX is shown below. Most of the time they seem highly correlated. However, there are periods with less correlation like in 2003, 2007-2008 and 2013-2016.

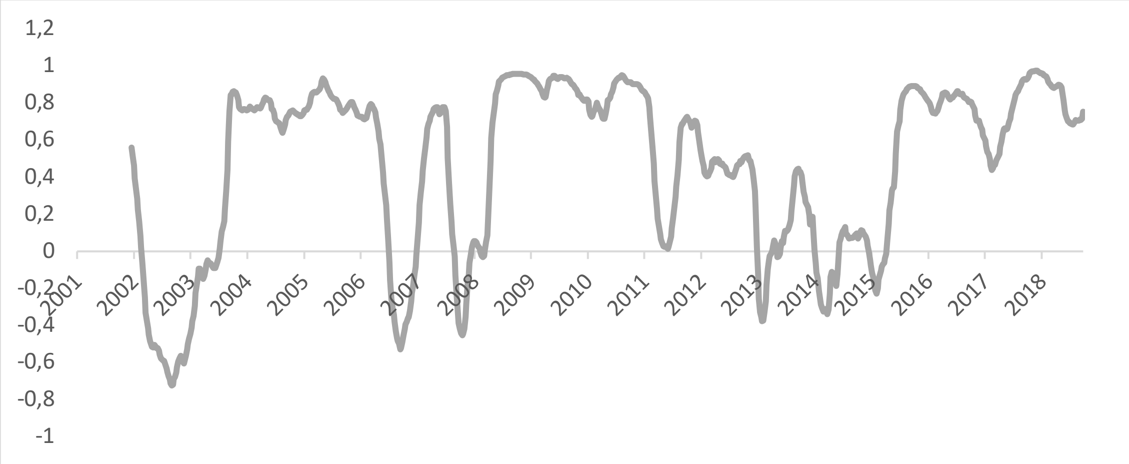


Figure 30: Correlation between OBX and Brent oil price. Moving average of 52 weeks.

Correlation between oil price and all variables is shown in Figure 31. In addition, a correlation plot of OBX and S&P 500 is shown. OBX and S&P 500 itself is the most correlated.

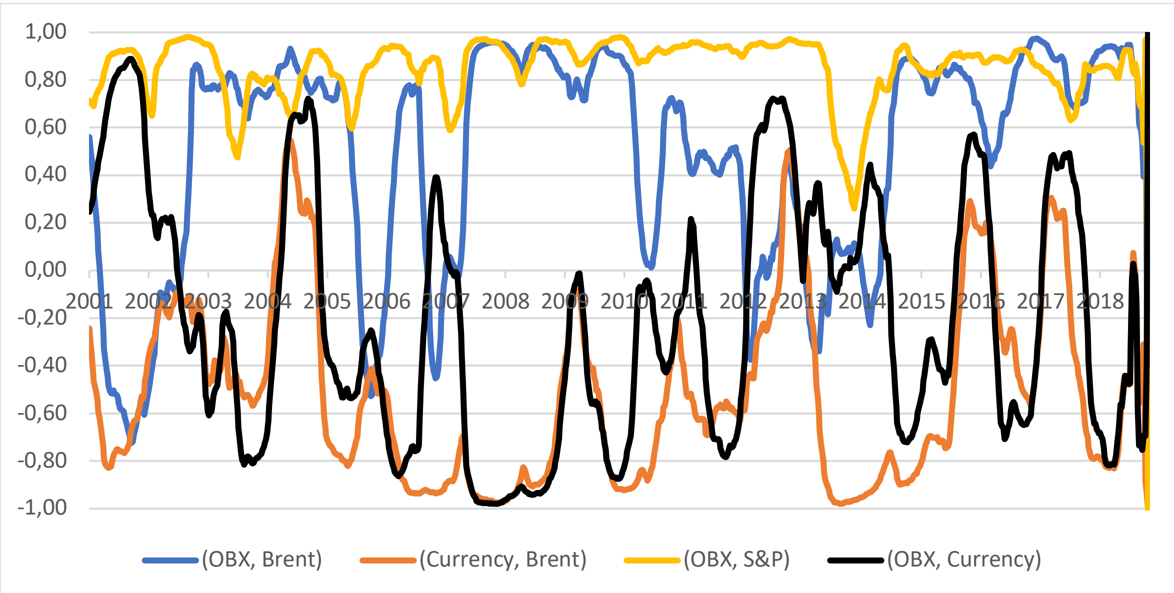


Figure 31: Correlations for all independent variables on Brent. Calculated with a moving average using 52 weeks as interval.

8.2.2 Period 1 (commodity boom)

The next regression analysis takes the first period of our timeline, from 2001 – 2007. The regression output is quite similar compared to the analysis for the entire period.

However, the coefficients for Brent and S&P 500 are a few decimals lower. These coefficients are statistically significant.

Table 13: Regression output of OBX for period 1, 2001 - 2007 with a weekly interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,64		Intercept	0,00	0,00	1,59	0,11
R Square	0,41		ln Brent	0,16	0,02	6,52	0,00
Adjusted R Square	0,41		ln S&P 500	0,83	0,06	14,12	0,00
Standard Error	0,02		ln USD/NOK	0,12	0,08	1,45	0,15
Observations	336						

Table 14: Regression output of OBX for period 1, 2001 - 2007 with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,66		Intercept	0,00	0,00	1,56	0,12
R Square	0,44		ln Brent	0,19	0,03	5,74	0,00
Adjusted R Square	0,43		ln S&P 500	0,82	0,08	9,91	0,00
Standard Error	0,03		ln USD/NOK	0,14	0,11	1,23	0,22
Observations	168						

8.2.3 Period 2 (finance crisis)

This regression analysis deals with the period just before the financial crisis and the crisis itself. Here, we see some changes with respect to the previous regressions. First, the *goodness of fit* is stronger (R^2 =0,72-0,78), proving more explained data. For the 1-week regression interval, Brent coefficient is about twice as high, indicating that this has a greater affect towards OBX in this period. However, S&P 500 has also increased and is still grater that Brent. For the 2-week interval, S&P 500 is actually greater that 1 with its 1,21.

According to this analysis, OBX is much more affected by the coefficients in the financial crisis. However, the reader must be aware of that this was a special time period. The financial crisis was worldwide, and the coefficients may be explained by other factors.

It’s also worth mention that for the 2-week interval, there is only 27 observations. The Brent coefficient is not statistically significant at this time and therefore not discussed.

USD/NOK dos does not have any statistically significant effect on OBX.

Table 15: Regression output of OBX for period 2, 2007-2009 with a weekly interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,85		Intercept	0,00	0,01	0,23	0,82
R Square	0,72		ln Brent	0,46	0,10	4,54	0,00
Adjusted R Square	0,70		ln S&P 500	0,90	0,12	7,33	0,00
Standard Error	0,04		ln USD/NOK	0,05	0,31	0,16	0,87
Observations	56						

Table 16: Regression output of OBX for period 2, 2007-2009 with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,88		Intercept	0,01	0,01	0,56	0,58
R Square	0,78		ln Brent	0,18	0,12	1,52	0,14
Adjusted R Square	0,75		ln S&P 500	1,21	0,19	6,24	0,00
Standard Error	0,04		ln USD/NOK	-0,44	0,39	-1,11	0,28
Observations	27						

8.2.4 Period 3 (recovery)

This recovery period after the financial crisis is quite similarly compared to period 1. The Brent coefficient 0,23 and 0,29 which is slightly higher. The S&P 500 coefficient 0,78 and 0,74 is slightly lower (compared to period 1). They are both statistically significant, indicating that the oil price yields a greater impact on OBX.

Table 17: Regression output of OBX for period 3 with a weekly interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,81		Intercept	0,00	0,00	0,55	0,58
R Square	0,65		ln Brent	0,23	0,06	4,03	0,00
Adjusted R Square	0,64		ln S&P 500	0,78	0,08	9,22	0,00
Standard Error	0,02		ln USD/NOK	-0,04	0,12	-0,36	0,72
Observations	126						

Table 18: Regression output of OBX for period 3 with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,91		Intercept	0,00	0,00	0,49	0,62
R Square	0,83		ln Brent	0,29	0,05	5,95	0,00
Adjusted R Square	0,82		ln S&P 500	0,74	0,08	9,47	0,00
Standard Error	0,02		ln USD/NOK	0,07	0,13	0,56	0,57
Observations	64						

8.2.5 Period 4 (oil boom)

In the oil boom, with permanently high oil prices, the Brent coefficient affects OBX with the same magnitude as in period 1. S&P 500 still seems to have the strongest impact on OBX with coefficients of 0,88 and 0,86.

Table 19: Regression output of OBX for period 4 with a weekly interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,84		Intercept	0,00	0,00	-0,12	0,91
R Square	0,71		ln Brent	0,15	0,04	3,72	0,00
Adjusted R Square	0,70		ln S&P 500	0,88	0,06	13,83	0,00
Standard Error	0,01		ln USD/NOK	0,01	0,08	0,09	0,93
Observations	165						

Table 20: Regression output of OBX for period 4 with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,88		Intercept	0,00	0,00	0,06	0,95
R Square	0,77		ln Brent	0,20	0,05	4,35	0,00
Adjusted R Square	0,77		ln S&P 500	0,86	0,08	10,63	0,00
Standard Error	0,02		ln USD/NOK	0,03	0,10	0,29	0,77
Observations	83						

8.2.6 Period 5 (shale revolution)

For the last periods with downturn and another recovery we have the smallest magnitude of both the Brent and S&P 500 compared to the other periods. They are both statistically significant for the 1- and 2-week interval.

For the 2-week interval we can see that the USD/NOK coefficient is higher than the Brent coefficient ($\beta_{USD/NOK} = 0{,}24$) and it is statistically significant. It was not significant for either of the previous periods.

Table 21: Regression output of OBX for period 5 with a weekly interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,70		Intercept	0,00	0,00	0,75	0,45
R Square	0,49		ln Brent	0,14	0,02	6,14	0,00
Adjusted R Square	0,48		ln S&P 500	0,64	0,06	11,12	0,00

Standard Error	0,02		ln USD/NOK	0,08	0,08	1,07	0,29
Observations	245						

Table 22: Regression output of OBX for period 5 with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,77		Intercept	0,00	0,00	0,52	0,60
R Square	0,59		ln Brent	0,17	0,03	5,93	0,00
Adjusted R Square	0,58		ln S&P 500	0,66	0,08	8,14	0,00
Standard Error	0,02		ln USD/NOK	0,24	0,10	2,53	0,01
Observations	122						

8.3 OSE10GI (Energy index)

The regression output for the same variables on the Norwegian energy index shows an increased magnitude on the Brent coefficient. The value is 0,32 (1-week) and 0,33 (2-week), which is about 50% greater than from the average of the OBX-regressions. Thus, the oil price has a greater effect on the energy index, which is not surprising given that Equnior and Aker BP represents a large shear of OSE10GI. The S&P 500-coefficient has no big changes compared to previously regressions.

USD/NOK is not statistically significant.

Table 23: Regression output of Norwegian energy index for the entire period 2001 – 2019 with a 1-week interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,71		Intercept	0,00	0,00	0,97	0,33
R Square	0,50		ln Brent	0,32	0,02	17,14	0,00
Adjusted R Square	0,50		ln S&P 500	0,69	0,04	19,22	0,00
Standard Error	0,02		ln USD/NOK	-0,02	0,06	-0,31	0,75
Observations	929						

Table 24: Regression output of Norwegian energy index for the entire period 2001 – 2019 with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,75		Intercept	0,00	0,00	1,04	0,30
R Square	0,57		ln Brent	0,33	0,02	14,06	0,00
Adjusted R Square	0,57		ln S&P 500	0,72	0,05	14,50	0,00
Standard Error	0,03		ln USD/NOK	0,06	0,07	0,80	0,43
Observations	464						

The regression formula for the 1-week interval can be shown as

$$Return_{OSE10GI} = 0{,}32\ Return_{BRENT} + 0{,}69\ Return_{S\&P500} + 0{,}06\ Return_{USD/NOK}$$

8.4 OSE40GI (Finance index)

For the Norwegian finance index, it's still S&P 500 that is the greatest affecter, and the coefficient has increased from 0,60-0,70 from the previous regressions toward 0,94 (1-week) and 0,92 (2-week). Brent oil price coefficients has is decreased to 0,12 and 0,14. The USD/NOK coefficient is now significant and negative meaning that a stronger NOK has a slight positive impact on the Norwegian finance index.

Based on the number we got from the analysis, S&P 500 is the most important to OSE40GI. Oil price does have an effect, it's significant, but 30-40% less that for the other regressions.

Table 25: Regression output of Norwegian finance index for the entire period with a 1-week interval.

Regression Statistics			***1 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,68		Intercept	0,00	0,00	1,24	0,22
R Square	0,46		ln Brent	0,12	0,02	5,86	0,00
Adjusted R Square	0,46		ln S&P 500	0,94	0,04	23,74	0,00
Standard Error	0,03		ln USD/NOK	-0,14	0,06	-2,25	0,02
Observations	929						

Table 26: Regression output of Norwegian finance index for the entire period with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,70		Intercept	0,00	0,00	1,31	0,19
R Square	0,50		ln Brent	0,14	0,03	5,30	0,00
Adjusted R Square	0,49		ln S&P 500	0,92	0,05	16,69	0,00
Standard Error	0,04		ln USD/NOK	-0,16	0,08	-2,04	0,04
Observations	464						

Regression formula:

$$Return_{OSE40GI} = 0{,}12\ Return_{BRENT} + 0{,}94\ Return_{S\&P500} - 0{,}14\ Return_{USD/NOK}$$

8.5 OBSHX (Shipping index)

$$Return_{OBSHX} = \beta_0 + \beta_1 Return_{BRENT} + \beta_2 Return_{S\&P500} + \beta_3 Return_{USD/NOK} + \mu$$

Regression on the Norwegian shipping index does not give any big surprises. The Brent coefficients are 0,18 (1-week) and 0,11 (2-week) which is slightly lower than the average compared to the regression on OBX. The coefficient of S&P 500 is 0,56 and 0,64. The USD/NOK is not significant. The reader should be aware of that the regression statistics have a low R^2 of 0,3. Also, the period is from October 2016 – April 2019 due to lack of data.

Table 27: Regression output of Norwegian shipping index for the available period (october 2016 - april 2019) with a 1-week interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,55		Intercept	0,00	0,00	-0,57	0,57
R Square	0,30		ln Brent	0,18	0,05	3,66	0,00
Adjusted R Square	0,29		ln S&P 500	0,56	0,11	5,15	0,00
Standard Error	0,02		ln USD/NOK	0,01	0,17	0,04	0,97
Observations	131						

Table 28: Regression output of Norwegian shipping index for the available period (october 2016 - april 2019) with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,57		Intercept	0,00	0,00	-0,56	0,58
R Square	0,33		ln Brent	0,11	0,06	1,79	0,08
Adjusted R Square	0,30		ln S&P 500	0,64	0,16	4,10	0,00
Standard Error	0,03		ln USD/NOK	-0,10	0,22	-0,46	0,64
Observations	66						

8.6 OSLSFX (Seafood index)

The regression on the Norwegian seafood index shows that oil price has no significance. The S&P-index coefficients are 0,56 (1-week) and 0,69 (2-week). The USD/NOK affects the index with coefficients of 0,18 (1-week) and 0,36 (2-week). However, only 2-week interval regression shows statistical significance on the USD/NOK. This means that a stronger NOK affects the seafood index negatively. The time period of the regression includes 2010-2019.

$$Return_{OSLSFX} = \beta_0 + \beta_1 Return_{BRENT} + \beta_2 Return_{S\&P500} + \beta_3 Return_{USD/NOK} + \mu$$

Table 29: Regression output of Norwegian seafood index for the available period (2010-2019) with a 1-week interval.

Regression Statistics		***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***

Multiple R	0,33		Intercept	0,00	0,00	1,91	0,06
R Square	0,11		ln Brent	0,01	0,04	0,25	0,80
Adjusted R Square	0,10		ln S&P 500	0,56	0,08	6,66	0,00
Standard Error	0,03		ln USD/NOK	0,18	0,11	1,62	0,11
Observations	410						

Table 30: Regression output of Norwegian seafood index for the available period (2010-2019) with a 2-week interval.

Regression Statistics			***2 weeks***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,38		Intercept	0,00	0,00	1,79	0,08
R Square	0,15		ln Brent	-0,02	0,05	-0,50	0,62
Adjusted R Square	0,13		ln S&P 500	0,69	0,12	5,97	0,00
Standard Error	0,04		ln USD/NOK	0,36	0,14	2,59	0,01
Observations	229						

8.7 OBOSX (Oil Service Index)

The regression output from this analysis differs quite much for the 1-week and 2-week periods. What is common is that the Brent coefficient is higher than for all the previous regressions. The Brent coefficient is 0,51 (1-week) and 1,45 (2-week) and both statistically significant. The S&P 500 coefficients are 0,84 (1-week) and 0,29 (2-week).

It's hard to draw any conclusions on the coefficients due to wide-spread numbers, but what is common for them both is that the Brent coefficient is higher on both regressions. This is not surprising as the oil service companies is highly dependent on petroleum activity.

Table 31: Regression output of Norwegian oil service index for the available period (2014-2019) with a 1-week interval.

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,65		Intercept	0,00	0,00	-1,17	0,24
R Square	0,42		ln Brent	0,51	0,06	9,08	0,00
Adjusted R Square	0,41		ln S&P 500	0,84	0,14	5,92	0,00
Standard Error	0,04		ln USD/NOK	0,05	0,18	0,28	0,78
Observations	253						

Table 32: Regression output of Norwegian oil service index for the available period (2014-2019) with a 2-week interval.

Regression Statistics				*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,83		Intercept	-0,01	0,00	-2,02	0,05
R Square	0,69		ln Brent	1,45	0,19	7,82	0,00

Adjusted R Square	0,68		ln S&P 500	0,29	0,06	4,70	0,00
Standard Error	0,04		ln USD/NOK	0,07	0,21	0,33	0,74
Observations	125						

8.8 OSE1510 (Materials Index)

The regression output for this index is quite similar for 1-week and 2-week interval except for the USD/NOK coefficient. The model explains that the S&P 500-index does influence the most with its 0,90 and 1,02 coefficients. The USD/NOK coefficient is only statistically significant for the 1-week interval with a value of -0,17 meaning that stronger Norwegian currency has a positive effect on the index.

The time period of the regression includes 2010-2019.

Table 33: Regression output of Norwegian materials index with a 1-week interval.

Regression Statistics			***1 week***	***Coefficients***	***Std error***	***t Stat***	***P-value***
Multiple R	0,60		Intercept	0,00	0,00	0,16	0,87
R Square	0,36		ln Brent	0,13	0,02	5,21	0,00
Adjusted R Square	0,36		ln S&P 500	0,90	0,05	18,86	0,00
Standard Error	0,03		ln USD/NOK	-0,17	0,07	-2,25	0,02
Observations	928						

Table 34: Regression output of Norwegian materials index with a 1-week interval.

Regression Statistics			***2 week***	***Coefficients***	***Std error***	***t Stat***	***P-value***
Multiple R	0,65		Intercept	0,00	0,00	0,03	0,97
R Square	0,42		ln Brent	0,12	0,03	3,87	0,00
Adjusted R Square	0,42		ln S&P 500	1,02	0,07	15,29	0,00
Standard Error	0,04		ln USD/NOK	-0,04	0,10	-0,37	0,71
Observations	464						

8.9 USD/NOK currency exchange rate

8.9.1 Linear regression

First, we present the linear regression. With the two figures below, we have plotted USD/NOK (the price of an American dollar in Norwegian krone) vs the Brent oil price in American dollar. The regressions and plots are divided in two periods;

- First part involves the period 1 and period 2 (2001-2009)
- Second part involves period 3, 4 and 5 (2009-2019)

The reason for this is to make the plots less messy and see if the regression coefficients are different within these periods.

The regression output is similar. The Brent coefficient is $-0{,}039$ for 2001-2009 and $-0{,}037$ for 2009-2019, meaning that a 1 US dollar-increase in oil price should adjusts the USD/NOK by ca 0,038. The analysis is statistically significant.

All 5 periods are sorted by colour, and each period has its own history. As for first period (Figure 32), we see that the Brent oil price is increasing with a clear relation to a stronger NOK. Before the financial crisis, the NOK is at its strongest at 5 USD/NOK. When the financial crisis hits and oil price falls drastically, the NOK falls with it.

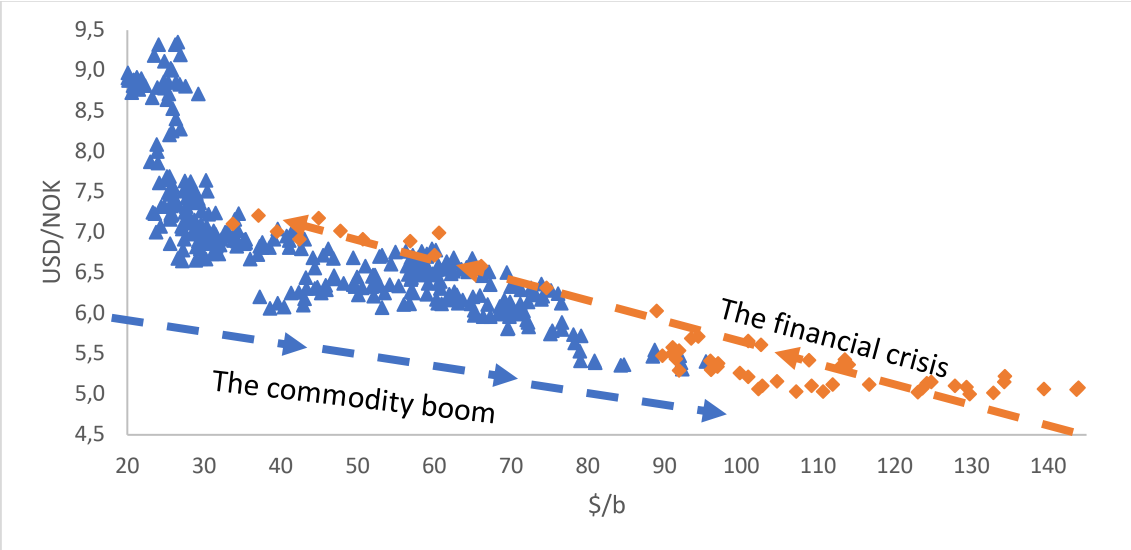


Figure 32: USD/NOK vs Brent oil price, from 2001-2009.

In the recovery period (Figure 33), the we see a similar pattern as in period 1. The price vs dollar moves into a small cluster which covers the oil boom (period 4). Furthermore, we move into the oil crisis, and the value of NOK falls. For the last years, 2018-2019 when the oil price again is rising, (end of period 5) we observe that the NOK is still weak and has not strengthened on higher oil prices. This violates the regression line, meaning the NOK might be undervalued. This is discussed in the discussion chapter.

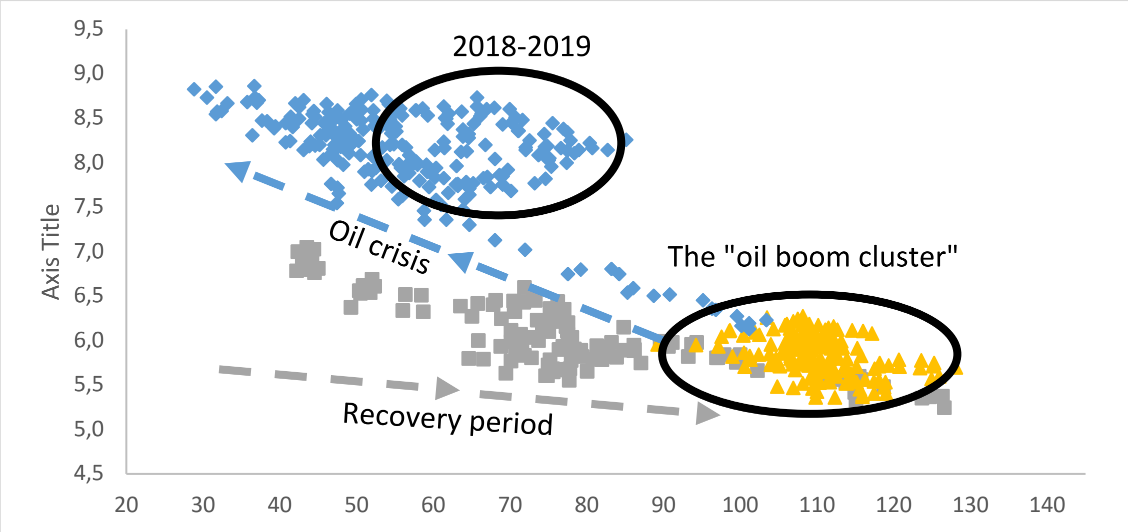


Figure 33: USD/NOK bs Brent oil price, from 2009-2019.

Table 35: Linear regression of USD/NOK vs Brent oil price for the period 2001-2009.

Regression Statistics				*Coefficients*	*Std error*	*t Stat*	*P-value*
Multiple R	0,81		Intercept	8,69	0,08	113,67	0,00
R Square	0,65		Brent	-0,039	0,00	-25,01	0,00
Adjusted R Square	0,65						
Standard Error	0,055						
Observations	337						

Table 36: Linear regression of USD/NOK vs Brent oil price for the period 2009-2019.

Regression Statistics				*Coefficients*	*Std error*	*t Stat*	*P-value*
Multiple R	0,83		Intercept	9,83	0,09	108,62	0,00
R Square	0,68		Brent	-0,037	0,00	-33,79	0,00
Adjusted R Square	0,68						
Standard Error	0,66						
Observations	537						

8.9.2 Logarithmic return regression

Regression output of the logarithmic return gives a coefficient of -0,12, meaning a 10% change oil price gives a -1,2% change in the USD/NOK. The regression is statistically significant, however the R^2 is low (0,13) indicating that the data points are spread out.

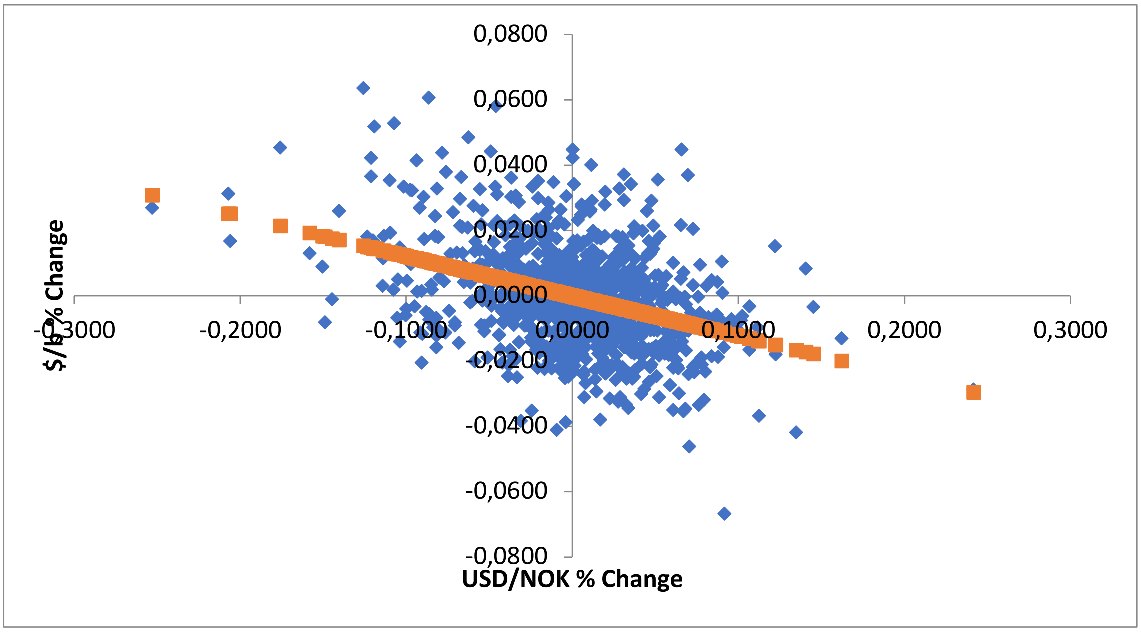


Figure 34: Logarithmic return of USD/NOK vs Brent oil price. High spread in data.

Table 37: Regression output of logarithmic return for USD/NOK vs. Brent oil price in the period 2001-2019.

Regression Statistics			***1-week***	***Coefficients***	***Std error***	***t Stat***	***P-value***
Multiple R	0,37		Intercept	0,00	0,00	0,07	0,95
R Square	0,13		ln Brent	-0,12	0,01	-12,02	0,00
Adjusted R Square	0,13						
Standard Error	0,01						
Observations	929						

9 Discussion

9.1 Introduction

In this thesis we wished to investigate if the oil price influences Norwegian stocks. To investigate this and to what degree five periods of the last 18 years was chosen for a regression analysis. The start and ending of each period were determined by the end or beginning of a different price or economic environment. The periods had the OBX index to represent the Norwegian stock marked as dependent variable and Brent, S&P 500 and USD/NOK as independent variables. S&P 500 is used as an indicator of how dependent Norwegian stocks are on the global stock market. USD/NOK was added to see if a weaker/stronger NOK had a positive/negative effect on OBX. Periods of low and high oil price was also regressed to investigate if there is a difference in OBX sensitivity to changes in oil price in a high or low oil price environment.

Regressions of the oil index and oil service index was performed to see how strongly they were affected but also as a reference to OBX. Further we wanted to see if other sectors in Norway where affected by a changing oil price. To test this, five indexes was regressed; Materials, Fish, Finance, Shipping and oil service.

The economic state of a country or others faith in it is often shown in the strength of its currency. To test if the value of the Norwegian currency is dependent on the price of oil, a regression with USD/NOK as dependent variable and Brent oil as independent variable was performed. Currency traders try to anticipate changes in factors that affects the currency. To investigate if there is a pattern where the currency changes before Brent, several time lags was regressed.

The results from the regression gives us the impact of each variable but tells us very little about the correlation within each period. Therefore a 12 months trailing correlation plot was made, this is also a useful tool to see when correlation changes.

9.2 The periods

It will be referred to the two-week data results unless stated otherwise. The results from the entire period shows a very rough estimate of how OBX is affected by the independent variables. As the hole period contains smaller periods with very different properties. The results show that for the entire period OBX is dependent on the oil price (β_1=0,20) but the factor with the most impact is S&P 500 (β_2=0,87). There was not found any statistically significant results that show that OBX is dependent on USD/NOK. This does not mean that there isn’t a dependency where the effect can be lost in time lag in both directions as well as other factors as interest rate, international economic trouble and political unrest.

The price of Brent oil (E(0,20%)) has grown more than S&P 500 (E(0,18%)) over the entire period which is important to consider when comparing β_1=Brent and β_2=S&P 500. It is also worth mentioning that the cost of the dollar changes and Norwegian oil companies are paid less per USD when the NOK is strong. This is a buffering effect when the price of oil falls and NOK weakens.

9.2.1 Correlation

The correlation plot shows that OBX is highly correlated with S&P 500. There is one period with low correlation and that is the crash in oil prices in late 2014. Brent starts off with a low correlation as OBX falls with the dotcom bubble and Brent rises from the end of 2001 to 2003. This is followed by years of rising oil prices and OBX growth and high correlation. In the years before the financial crisis the correlation is unstable and at times non existing. The reason for this can be that the stock market fears for the global economy at these high oil prices. The oil market is also in backwardation indicating a bearish sentiment for future oil prices. As the oil price drops in the financial crises the correlation comes back and is sustained until the end of 2010 when the oil price reaches 120 $/b. The correlation is weaker through the oil boom years and returns as the oil price crashes in late 2014. There is also a dip in correlation when the oil price reaches the bottom. This may be the same situation as before the financial crises where the market does not believe this is sustainable, this is seen again in Brent spot-future spread with a contango of more than 10$/b. The correlation between OBX and USD/NOK is about the same as for USD/NOK and Brent. The OBX USD/NOK correlation is mainly negative meaning that OBX grows when the currency is strengthening, and that the currency is strengthening when the oil price is rising.

The correlation between USD/NOK and Brent seems to be most stable in period with dramatic changes as the financial crises and dramatic changes in the oil price. The correlation is in general negative meaning that a positive change in Brent strengthens the value of NOK compared to USD.

The results show correlation when there are big changes in Brent and less in when oil prices are stable. This might show that the correlation is there but is most likely lost in the noise of other factors when oil prices are stable.

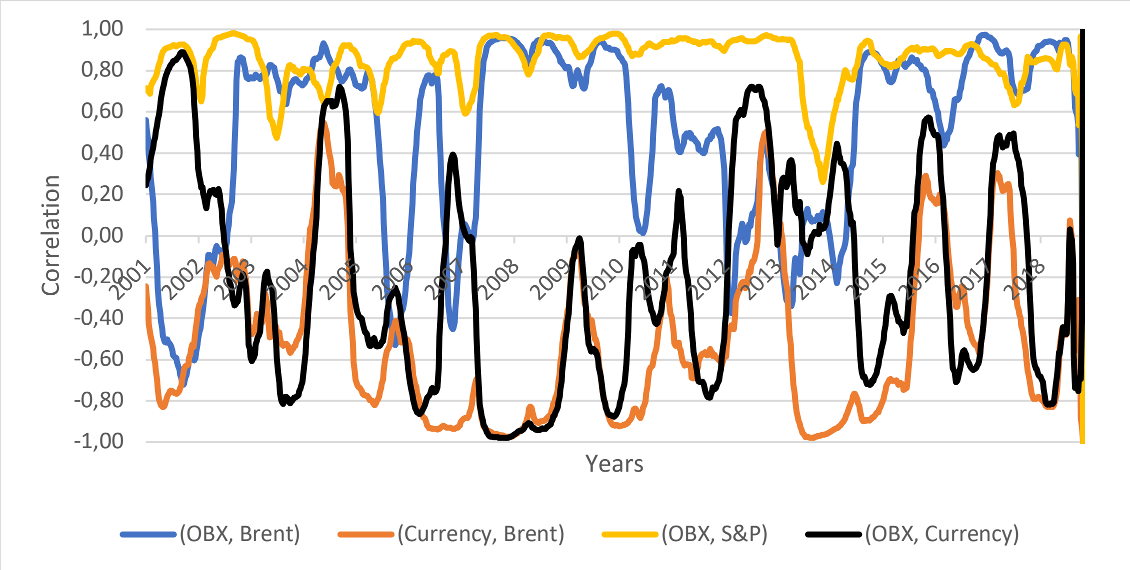


Figure 35: Recap of Figure 31: Correlations for all independent variables on Brent. Calculated with a moving average using 52 weeks as interval.

9.2.2 Period 1 (commodity boom)

This period is the weakest growth period for OBX (E(0,12)) except for the financial crisis. This period also has the lowest R^2 which indicates that the data points are very spread out. The reason for this can be the market crash called the dotcom bubble in the beginning of the period. There were also a few large movements by companies as Norske Skog who lost 80% of their stock value in 2007 and is no longer a part of OBX at the end of 2008. Another stock that may have influenced R^2 is REC silicone who entered OBX in 2006 and took a 3% OBX shear and 7% OBX shear in 2007. One can observe weak correlation in the beginning of this period, see Figure 35, that may be consistent with the hypothesis that the dot com bobble has affected the results. However, when we remove this period R^2 only increases by 0,03 but OBX is more affected by Brent and S&P 500. Brent has a coefficient of 0,19 and S&P 500 as 0,82 and is therefore the most important influencer of OBX. However as mention earlier that the last part of 2007 period with rapid rising oil prices and weak growth on OBX should contribute to lower R^2 and Brent coefficient. See Figure 36 for the regression results of each period.

9.2.3 Period 2 (the financial crisis 2008)

This period has very low expected values due to a stock market crash driven by the American housing bubble which lead to large volumes of demand destruction for crude oil. OBX did a lot worse with an expected decrease of -2,64% every two weeks compared to -1,74% for S&P 500 and the worst was Brent with -2,96%. The results of one week and two-week data points are quite different for this period. The one-week data has a high Brent coefficient (β_1=0,46) and a slightly higher S&P 500 (β_2=0,90) than for the entire period. The 2-week data has similar coefficient for Brent ((β_1=0,18) as in the entire period but the S&P 500 (β_2=1,21) coefficient is about 50% higher than the entire period. The numbers don't tell us why there is such a difference in one- and two-week sampling but this is a small time period and the two-week period only has 27 observations. This is also a period with very large changes which can increase the effect of opening hours for OBX and S&P 500 which should favour the two-week data. This might be a period where S&P 500 actually is a good measure of the economic situation. This makes the Brent and S&P 500 more intertwined as a deteriorating economy is a synonymous with deteriorating crud demand. Even though there are some uncertainties about the coefficients, the period shows that OBX is very dependent on the global economy and therefore falls harder than S&P 500.

9.2.4 Period 3 (Recovery after financial crisis)

Even though the stock market crash ended in late 2008 the economy continued to worsen, and Norway was in a recession through 2009 with a negative GDP growth of -1,7%. The next two years the BNP growth is positive but slow with 0,7% and 1%. However, OBX recovers back to early 2008 level in only three years from the worst economic disaster since the great depression. The recovery is more driven by changes in Brent (β_1=0,29) than in period 1 and slightly less by S&P 500 (β_2=0,74). This period might be an example where the stock market isn't a good indicator of the present economic situation in Norway and represents more a faith in a recovery.

9.2.5 Period 4 (The oil boom)

The boom period is characterised by high and more stable oil price with a standard deviation of 2,89% compared to 4,82% for the whole period. The coefficients are very similar to period 1 with Brent β_1=0,20 and S&P 500 β_2=0,86. This means that the OBX is affected by % changes in Brent prices and not the actual price increase in US dollar. The NOK is also at its strongest in this period indicating an even less oil dependent OBX. This period is the best growth period for OBX in our data sets except for the recovery after the financial crisis. However, the expected two weeks change for Brent is -0,06% indicating that Brent had nearly no impact in the period and the impact was negative. This is a weakness in this study that only a change in the oil price can be measured to impact OBX. There are good reasons for believing that a high oil price should benefit the Norwegian economy which should affect company's profitability and their stock prices.

9.2.6 Period 5 (The shale revolution)

The shale revolution takes the oil market by surprise and the oil market is also surprised by OPECs decision to protect markets shear instead of protecting the oil price. The oil market is flooded by oil and crude inventories are basically full until OPEC give up the mission of breaking the marginal producers as shale and makes a production cut at the end of 2016. The results show that OBX and S&P 500 had about the same growth rate at 0,32% and 0,34% on 2-week basis. This period has the lowest Brent coefficient of 0,17 but quite similar to period 1,2 and 4. The S&P 500 coefficient is also the lowest in this period with 0,66. What is interesting about this period is the statistically significant USD/NOK coefficient of 0,24. The USD/NOK coefficient was expected to be negative since it is to some degree corelated with the price of oil. This can be related to two factors as the fishing industry has boomed in this period, this industry is dependent on exports and has therefore great benefit of a weaker NOK hence driving OBX higher when NOK is devalued. A reason for this can also be that the USD/NOK is not so dependent on the oil price in this period and more affected by politics as the trade war between USA and China. This would have a positive effect on all Norwegian export industry as they are paid more when their costs are in NOK. Although the trade war might affect the global economy and later weaken the demand for these export products.

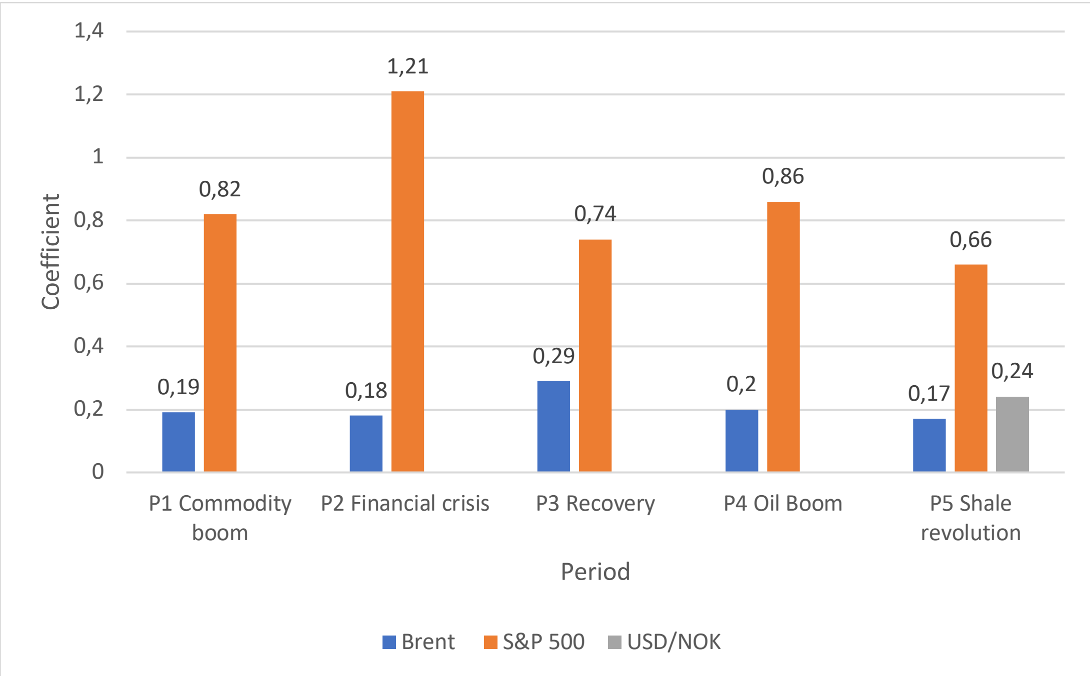
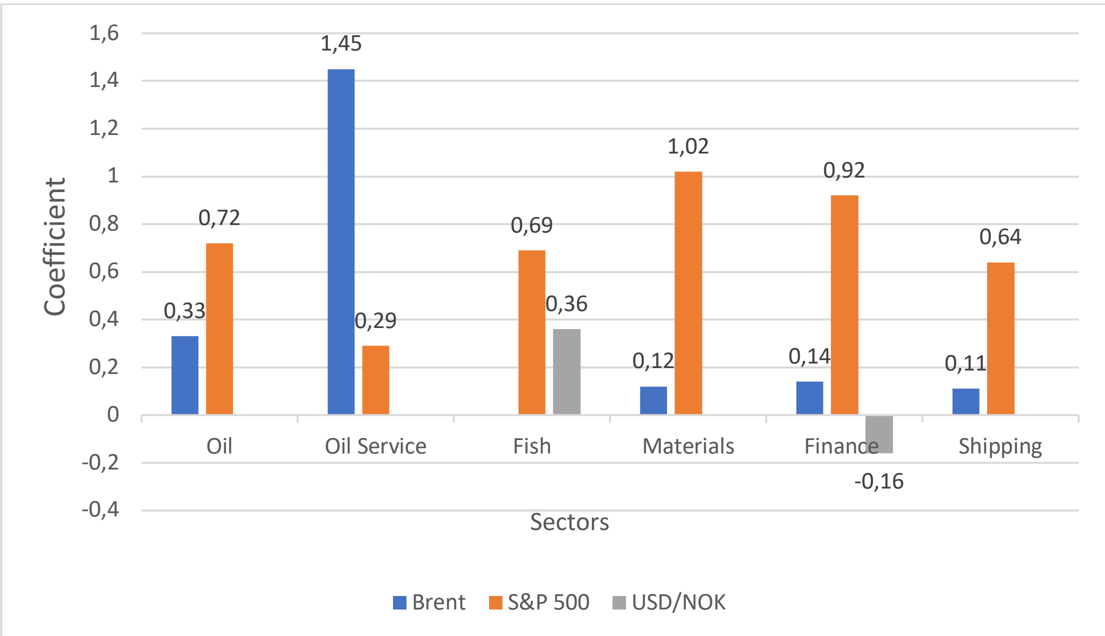


Figure 36: Coefficients for all periods within all parameters. 2-week interval.

9.3 Sector indexes

The regression results from the sector indexes show a big difference in dependency in the different coefficients. As expected, the energy sector is more dependent on oil than OBX. This index is heavily dominated by Equinor thus reflecting the operating companies. The oil service is a lot more sensitive (elastic) with a coefficient of 1.45. The oil service index is dominated by the largest and most stable service companies as TGS-NOPEC and subsea 7. There is reason to believe that the rest of the service sector would be even more sensitive to the oil price. The finance sector shows high dependency on S&P 500, almost unitary elasticity (β_2=0,92). There is also significant and positive effect of a strengthening NOK as was expected to show up in OBX or at least the energy indexes. This can come from an oil dependency in the finance sector as a stronger NOK is related to higher oil prices. The shipping sector seems to be less affected by weekly Brent changes. The sector is probably most affected by its own cyclic behaviour and S&P 500 as a driver of trade and demand for shipping. The fish farming industry is affected by S&P 500 (β_1=0,69) and USD/NOK (β_1=0,36). However, the R^2 is very low only 0,13 which means they are more uncertain even though the results make sense. The Materials sector is very S&P 500 dependant which was expected as commodity prices are very elastic and are therefore dependant on global growth. However, the one-week data has a -0,17 USD/NOK coefficient, explaining a benefit from a stronger NOK. Bothe the one-week data and two-week data shows oil dependence at 0,13 and 0,12.



9.4 USD/NOK affected by the Brent price?

The result with OBX as dependant variable shows only a significant dependency in the last period. This dependency was believed to come from an increase in the farmed fish industry. Although when one study the change in Brent price and the change in USD/NOK the pattern is obvious. However, when a Δln regression is performed with USD/NOK as dependant and Brent as independent variable the results show very low R^2 (0,13). It is unclear why, but it might be that traders are often taking positions before or after the changes in Brent prices happen. When a simple linear regression is performed R^2 is high (0,74) and P-value of 0.00 with a Brent coefficient of -0,04. With this data the currency (30/05/2019) predicted USD/NOK is 6,80 USD/NOK=9,552-0,4*68,8$. However, the USD/NOK is 8,76 which makes NOK undervalued compared to USD with about 22%.

The simple linear regression was divided into two periods and divided into the 5 periods, each market by a different colour. The first two periods are shown in Figure 37 where the first period in blue show a very weak US NOK in the early 2000. The weak NOK may be a product of low oil prices and the financial trouble with the dotcom bubble. After this the price of the NOK and the price of a barrel of Brent seems very interlinked where the USD/NOK falls with an increasing oil price.

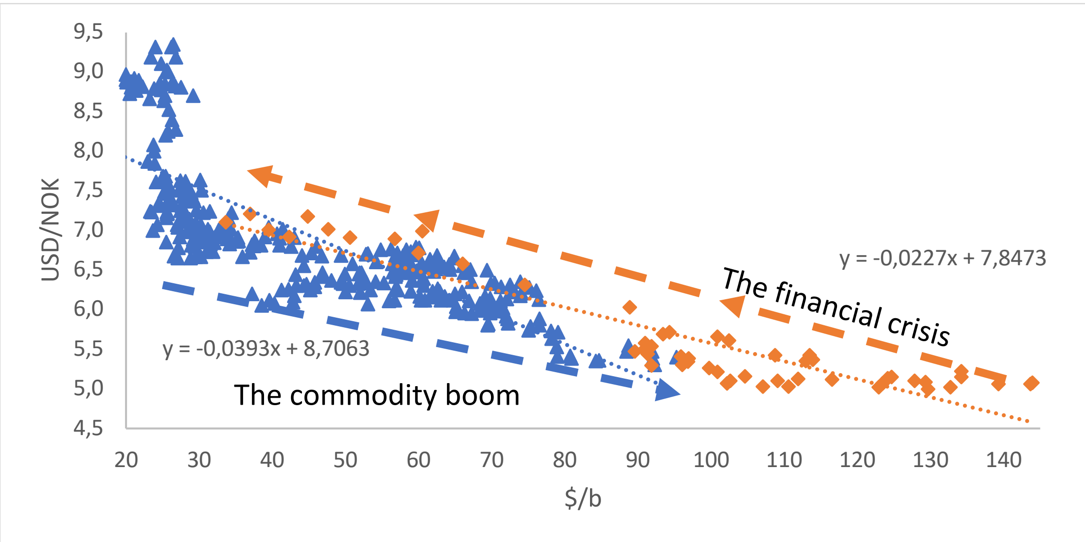


Figure 37: A linear plot showing USD/NOK vs Brent oil price for period 1 and 2.

When we look at the period after the financial crisis the picture gets messier. As oil bottoms at the end 2008 oil prices trade at the lower 40$/b and slightly weaker NOK compared to the two first periods. The strong NOK can be explained by a contango of -20$/b indicating that the oil market strongly believes in higher oil prices. The oil boom is relatively stable and has the lowest coefficient indicating a diminishing return on the strengthening of the NOK from rising oil prices. As the oil boom is over and oil prices declines and the value of the NOK follows. The NOK is now clearly less valued compared to Brent than in the recovery period. These are two different situations where Norway survived the financial crisis well and the oil crash was more a Norwegian problem and a gift to many other importing nations. As the market first expected a V shape in oil price recovery the expectation got more and more gloomy as investor started to talk about an L shape (no recovery) or lower for longer. This is also illustrated in the backwardation as the contango slowly fades as oil prices stabilize in the mid-2016 to mid-2017. However, as oil prices starts to improve and exceeds 60$/b the USD/NOK does not change much. Is this the new normal where the currency is less dependent on the price of oil or is it just a period affected by international uncertainty as the US China trade war and a weaker global growth outlook. These numbers are not inflation adjusted although USD and NOK have had about the same inflation the last 18 years, about 40-45%. This makes it difficult to compare early 2000 to 2018 when 80 USD/b is cheaper in 2018 than in 2001.

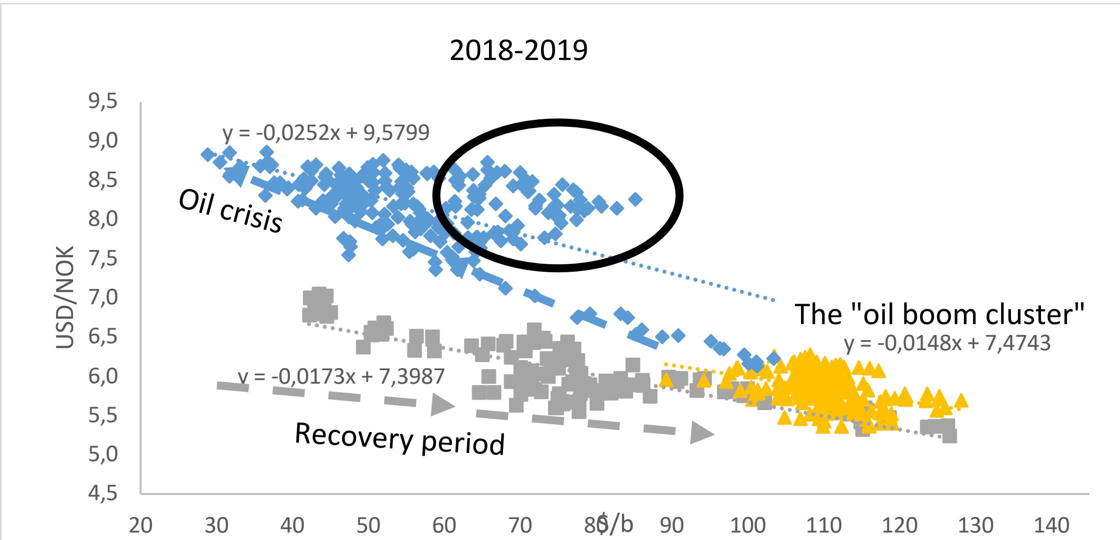


Figure 38: A linear plot showing USD/NOK vs Brent oil price for period 3, 4 and 5.

9.5 The big picture

In the broader picture OBX is affected by changes in the oil price to a slightly varying degree. The Brent price also affects the oil, finance, materials and shipping sector. The fish sector is not affected by a change in Brent price but if the USD/NOK is affected by a change in Brent price and then indirectly affected by a Brent price change. This is probably true for many Norwegian companies that import or export products.

The regression results in this thesis tell us how a change in the Brent price can affect the different indexes. However, the result dose not tell us how a high or low oil price can

affect the growth rate. The results have shown that S&P 500 is more important than oil prices, but these things are very interlinked as a growing US stock market can be a sign of strong future growth in the economy and the demand for commodity's (crude oil).
There was also tested for different oil price sensitivity in a low and high price environment. However, the results showed approximately the same sensitivity to a % change in the oil price. The results are based only on a few periods which gives an extra uncertainty to the analysis, but if the data are reflecting the real world then there is a diminishing return on an $/barrel increase in the oil price.

10 Conclusion

The data has shown that OBX is affected by changes in the oil price. The effect that the oil price has on OBX has been relatively stable since 2001 with a coefficient around 0,2. The biggest anomaly is the financial crisis where our data is undecisive. The difference between one-week data and two-week data is large, however this was a period where OBX was more sensitive to Brent and S&P 500. The recovery period showed the importance of the oil price with ha Brent coefficient of 0,29 and only 0,74 for S&P 500. The last period showed less dependency on Brent and S&P 500 and the first period with significant USD/NOK of 0,24. The data may be affected by Norway's rapid growing farmed fish industry which is affected by the currency.

The data shows a diminishing return on an increasing $/barrel change. Other indexes were also tested to compare them to OBX but also to see if they were indirectly affected by the oil price. The oil sector index was more affected by OBX with a coefficient of 0,33. Since this sectors existence is solely dependent on oil makes it a good reference. When comparing this with Brent for the whole period with 0,20, we can say that OBX is influenced by the oil price. The service sector had the highest Brent coefficient of 1,45 indicating a sector with sharp stock price changes. The finance sector has a Brent coefficient of 0,14 and a USD/NOK of -0,16. The negative USD/NOK coefficient may be related to an oil price dependency as a stronger NOK may be related to a higher oil price. Shipping has a 0,11 Brent coefficient and 0,64 for S&P 500. The sector is most likely more dependent on ship rates than on the weekly change of Brent and S&P 500. The fishing industry showed a S&P 500 coefficient of 0,69 and USD/NOK of 0,36. This was the most currency dependant sector and benefits from a weaker NOK. However, it might be affected by the oil price, as it might affect the USD/NOK relationship.

The currency is an important factor for many exporting companies; however, the USD/NOK coefficient was only significant in the last period for OBX. Both a simple linear regression and a logarithmic regression was performed. The logarithmic regression gave very weak R^2=0,13 and simple linear regression was run with R^2=0,76. The simple linear regression is also a better way of investigating if the currency today is over or under valued. The simple linear regression model (USD/NOK=9,552-0,04*($/b Brent) says that the dollar should cost 6,8 NOK at the current Brent price at 68,8 $/b and current USD/NOK=68,8. The data shows that NOK is undervalued compared to USD/NOK Brent relationship the last 10 years.

11 Future work

- The currencies can be inflation adjusted to get a clear overview of how OBX is affected by Brent prices. This is also useful when testing for how USD/NOK is dependent on Brent.
- Adjust for the cost level in the industry.
- Compare and study the GDP growth and oil price level

Appendix A – Data

Appendix A.1 Brent oil price

$$Return_{BRENT} = \beta_0 + \beta_1 Return_{S\&P500} + \mu$$

Regression Statistics			***1 week***	***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,24		Intercept	0,00	0,00	0,40	0,69
R Square	0,06		ln_S&P	0,48	0,06	7,41	0,00
Adjusted R Square	0,05						
Standard Error	0,05						
Observations	929						

Appendix A.2 USD/NOK

$$Return_{USD/NOK} = \beta_0 + \beta_1 Return_{BRENT} + \mu$$

Regression Statistics				***Coefficients***	***Std Error***	***t Stat***	***P-value***
Multiple R	0,37		Intercept	0,00	0,00	0,07	0,95
R Square	0,13		ln_BRENT	-0,12	0,01	-12,02	0,00
Adjusted R Square	0,13						
Standard Error	0,01						
Observations	929						

Appendix A.3 Logarithmic return on OBX in periods with low oil price

The three following tables shows a regression output on OBX for three periods with a low oil price. The idea was to see if there was a different pattern on the regression compared to the periods we have discussed. There were no discoveries on these regressions.

Table 38: Regression output on OBX (logarithmic return) in the period 2003-2005, a period with a low oil price.

Regression Statistics				*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,62		Intercept	0,00	0,00	2,83	0,01
R Square	0,39		ln_Brent	0,19	0,03	5,47	0,00
Adjusted R Square	0,37		ln_S&P	0,83	0,12	7,17	0,00
Standard Error	0,02		ln_USD/NOK	0,34	0,11	3,15	0,00
Observations	118						

Table 39: Regression output on OBX (logarithmic return) in the period 2008-2009, a period with a low oil price.

Regression Statistics			*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,85	Intercept	0,00	0,01	0,78	0,44
R Square	0,72	ln_BRENT	0,33	0,08	3,97	0,00
Adjusted R Square	0,70	ln_S&P	0,84	0,15	5,53	0,00
Standard Error	0,04	ln_USD/NOK	-0,17	0,31	-0,54	0,59
Observations	50					

Table 40: Regression output on OBX (logarithmic return) in the period 2008-2009, a period with a low oil price.

Regression Statistics			*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,69	Intercept	0,00	0,00	1,00	0,32
R Square	0,47	ln_BRENT	0,13	0,03	4,97	0,00
Adjusted R Square	0,46	ln_S&P	0,68	0,07	9,44	0,00
Standard Error	0,02	ln_USD/NOK	0,15	0,09	1,79	0,08
Observations	173					

Appendix A.4 List of the 25 largest companies in Norway 2004-2018

Table 41: 25 largest companies in Norway, 2018-2014.

EGENKAPITALINSTRUMENTER / *EQUITY CAPITAL INSTRUMENTS* — OSLO BØRS

Største norske selskaper etter markedsverdi 31/12-18 (VPS registert)
The largest domestic companies by market value 31/12-18

	Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of total* %
1	Equinor	613 478 999	31
2	Telenor	246 469 220	12
3	DNB	221 643 286	11
4	Mowi	94 280 457	5
5	Yara International	91 118 146	5
6	Norsk Hydro	81 125 422	4
7	Aker BP	78 504 745	4
8	Orkla	69 328 063	3
9	Gjensidige Forsikring	67 600 000	3
10	Schibsted (Ser. A & B)	65 625 696	3
11	SalMar	48 492 400	2
12	Lerøy Seafood Group	39 285 316	2
13	Aker	34 336 700	2
14	Storebrand	28 836 054	1
15	Tomra Systems	28 834 311	1
16	SpareBank 1 SR-Bank	22 812 997	1
17	Austevoll Seafood	21 650 216	1
18	TGS-NOPEC Geophysical Company	21 432 859	1
19	Kongsberg Gruppen	21 166 832	1
20	Entra	21 165 980	1
21	Olav Thon Eiendomsselskap	14 902 345	1
22	DNO	13 601 868	1
23	AF Gruppen	13 069 212	1
24	Veidekke	12 956 009	1
25	Elkem	12 902 183	1
	sum 1- 5	1 266 990 108	64
	sum 1-10	1 629 174 034	82
	sum 1-25	1 984 619 316	100
	Sum all	**1 984 619 316**	**100,00**

EGENKAPITALINSTRUMENTER / *EQUITY CAPITAL INSTRUMENTS* — OSLO BØRS

Største norske selskaper etter markedsverdi 31/12-17 (VPS registert)
The largest domestic companies by market value 31/12-17

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of total* %
Statoil	582 219 008	23,9
Telenor	264 106 467	10,9
DNB	247 740 307	10,2
Norsk Hydro	129 002 043	5,3
Yara International	102 921 157	4,2
Orkla	88 697 941	3,6
Gjensidige Forsikring	77 450 000	3,2
Aker BP	72 706 917	3,0
Marine Harvest	68 133 321	2,8
Schibsted	53 826 841,00	2,2
Storebrand	31 296 755	1,3
Aker	29 951 710,00	1,2
SalMar	27 962 440	1,1
Lerøy Seafood Group	26 202 126	1,1
Wallenius Wilhelmsen Logis	25 068 968,00	1,0
Entra	22 415 360,00	0,9
SpareBank 1 SR-Bank	22 250 344,00	0,9
TGS-NOPEC Geophysical Co	19 875 572	0,8
Tomra Systems	19 464 640,00	0,8
Kongsberg Gruppen	18 120 000,00	0,7
Olav Thon Eiendomsselska	17 350 587,00	0,7
Norwegian Finans Holding	17 175 379	0,7
Austevoll Seafood	13 835 461,00	0,6
AF Gruppen	13 077 794,00	0,5
Aker Solutions	12 565 730	0,5
sum 1- 5	1 325 988 982	54
sum 1-10	1 686 804 002	69
sum 1-25	2 003 416 868	82
sum 26-50	213 321 814	9
sum 51-	217 301 958	9
Sum all	**2 434 040 640**	**100,00**

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Største norske selskaper etter markedsverdi 31/12-16 (VPS registert)
The largest domestic companies by market value 31/12-16

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of total* %
Statoil	514 015 827	25,61
DNB	209 137 774	10,42
Telenor	193 688 086	9,65
Yara International	92 894 062	4,63
Norsk Hydro	85 449 629	4,26
Orkla	79 680 402	3,97
Marine Harvest	70 078 336	3,49
Gjensidige Forsikring	68 500 000	3,41
Aker BP	52 180 377	2,60
Schibsted	43 136 644	2,15
SalMar	29 242 730	1,46
Lerøy Seafood Group	28 662 672	1,43
Aker	24 005 961	1,20
Storebrand	20 659 862	1,03
TGS-NOPEC Geophysical	19 579 469	0,98
AF Gruppen	18 513 189	0,92
Hafslund	18 456 124	0,92
Olav Thon Eiendomsselskap	17 031 251	0,85
Austevoll Seafood	16 977 580	0,85
Veidekke	16 512 560	0,82
Entra	15 755 059	0,79
SpareBank 1 SR-Bank	15 536 878	0,77
Kongsberg Gruppen	14 940 000	0,74
AF Gruppen	14 462 745	0,72
XXL	13 574 188	0,68
sum 1- 5	1 095 185 378	54,57
sum 1-10	1 408 761 137	70,19
sum 1-25	1 692 671 405	84,34
sum 26-50	200 030 346	9,97
sum 51-	114 294 355	5,69
Sum all	**2 006 996 106**	**100,00**

EGENKAPITALINSTRUMENTER / *EQUITY CAPITAL INSTRUMENTS* — OSLO BØRS

Største norske selskaper etter markedsverdi 31/12-15(VPS registert)
The largest domestic companies by market value 31/12-15

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of total* %
Statoil	394 435 647	23,39
Telenor	222 666 226	13,21
DNB	178 842 115	10,61
Yara	105 329 422	6,25
Orkla	71 427 061	4,24
Gjensidige	71 050 000	4,21
Norsk Hydro	68 545 913	4,07
Marine Harvest	53 830 244	3,19
Schibsted ser.	33 514 602	1,99
Schibsted ser.	31 558 656	1,87
Lerøy Seafood	18 010 531	1,07
SalMar	17 561 500	1,04
Kongsberg	17 400 000	1,03
Storebrand	15 724 351	0,93
Olav Thon	15 115 235	0,90
Veidekke	14 506 986	0,86
TGS-NOPEC	14 442 029	0,86
Tomra	14 135 917	0,84
XXL	14 128 237	0,84
Entra	13 090 938	0,78
AF Gruppen	12 928 860	0,77
Aker	12 188 785	0,72
Norwegian Air	11 575 395	0,69
Det norske	11 194 678	0,66
Austevoll	10 946 738	0,65
sum 1- 5	972 700 471	57,69
sum 1-10	1 231 199 886	73,02
sum 1-25	1 444 150 066	85,65
sum 26-50	153 399 636	9,10
sum 51-	88 461 164	5,25
Sum all	**1 686 010 866**	**100,00**

EGENKAPITALINSTRUMENTER / *EQUITY CAPITAL INSTRUMENTS* — OSLO BØRS — MERKUR MARKET

Største norske selskaper etter markedsverdi 31/12-14(VPS registert)
The largest domestic companies by market value 31/12-14

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of total* %
Statoil	418 350 500	25,26
Telenor	227 470 892	13,74
DNB	180 308 034	10,89
Yara International	92 204 831	5,57
Norsk Hydro	87 808 287	5,30
Gjensidige Forsikring	61 000 000	3,68
Orkla	52 118 319	3,15
Schibsted	51 161 312	3,09
Marine Harvest	42 227 871	2,55
TGS-NOPEC Geophysical	16 684 899	1,01
DNO	16 352 002	0,99
Lerøy Seafood Group	14 899 621	0,90
Kongsberg Gruppen	14 760 000	0,89
SalMar	14 445 750	0,87
Entra	14 055 533	0,85
Opera Software	13 604 153	0,82
SpareBank 1 SR-Bank	13 426 932	0,81
Olav Thon Eiendomsselskap	13 358 888	0,81
Storebrand	13 137 369	0,79
Aker	11 905 643	0,72
Aker Solutions	11 303 444	0,68
XXL	10 146 013	0,61
Wilh, Wilhelmsen	10 120 000	0,61
Veidekke	9 860 739	0,60
Norwegian Air Shuttle	9 711 783	0,59
sum 1- 5	1 006 142 544	60,76
sum 1-10	1 229 334 945	74,23
sum 1-25	1 420 422 815	85,77
sum 26-50	148 366 808	8,96
sum 51-	87 250 850	5,27
Sum all	**1 656 040 473**	**100,00**

Table 42: 25 largest companies i Norway, 2013-2008.

EGENKAPITALINSTRUMENTER / *EQUITY CAPITAL INSTRUMENTS* — OSLO BØRS

Største norske selskaper etter markedsverdi 31/12-13(VPS registert)
The largest domestic companies by market value 31/12-13

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of the total* %
Statoil	468 731 124	28,51
Telenor	219 303 870	13,34
DNB	176 724 676	10,75
Yara	72 688 738	4,42
Gjensidige	57 850 000	3,52
Norsk Hydro	56 007 783	3,41
Orkla	48 215 814	2,93
Schibsted	43 331 050	2,64
Marine Harvest	30 306 397	1,84
Aker Solutions	29 701 600	1,81
DNO	24 763 358	1,51
Storebrand	17 051 585	1,04
TGS-NOPEC	16 646 293	1,01
Fred. Olsen	16 466 805	1,00
Aker	16 067 190	0,98
Algeta	15 760 285	0,96
Petroleum Geo-	15 561 810	0,95
SpareBank 1	15 409 003	0,94
Kongsberg	15 300 000	0,93
Wilh.	12 485 000	0,76
Olav Thon	11 389 649	0,69
Opera Software	10 973 309	0,67
Cermaq	9 990 000	0,61
Lerøy Seafood	9 660 194	0,59
Wilh.	9 393 773	0,57
sum 1- 5	995 298 408	60,54
sum 1-10	1 202 861 052	73,17
sum 1-25	1 419 779 306	86,36
sum 26-50	140 560 440	8,55
sum 51-	83 696 714	5,09
Sum all	**1 644 036 460**	**100,00**

Største norske selskaper etter markedsverdi 31/12-12(VPS registert)
The largest domestic companies by market value 31/12-12

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of the total* %
Statoil	443 221 947	31,85
Telenor	175 026 144	12,58
DNB	114 667 440	8,24
Yara	77 815 949	5,59
Norsk Hydro	57 683 672	4,14
Orkla	49 418 152	3,55
Gjensidige	39 700 000	2,85
Aker Solutions	30 934 600	2,22
Schibsted	25 434 851	1,83
Petroleum Geo-	20 767 230	1,49
Marine Harvest	19 191 509	1,38
TGS-NOPEC	18 772 813	1,35
Fred. Olsen	16 126 665	1,16
Aker	15 343 442	1,10
Kongsberg	14 940 000	1,07
Storebrand	12 066 583	0,87
Det norske	11 608 357	0,83
Wilh.	10 934 000	0,79
DNO	9 531 846	0,68
SpareBank 1	9 513 940	0,68
Olav Thon	9 473 633	0,68
Cermaq	7 746 875	0,56
Tomra	7 438 009	0,53
Lerøy Seafood	7 067 769	0,51
Algeta	6 583 218	0,47
sum 1- 5	868 415 152	62,40
sum 1-10	1 034 669 985	74,34
sum 1-25	1 211 008 644	87,02
sum 26-50	109 630 890	7,88
sum 51-	71 080 504	5,11
Sum all	**1 391 720 038**	**100,00**

Største norske selskaper etter markedsverdi 31/12-11(VPS registert)
The largest domestic companies by market value 31/12-11

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of the total* %
Statoil	489 457 330	37,40
Telenor	157 763 793	12,05
DNB	95 366 173	7,29
Yara	69 037 478	5,27
Norsk Hydro	57 394 012	4,39
Orkla	45 941 768	3,51
Gjensidige	34 650 000	2,65
Aker Solutions	17 248 300	1,32
Schibsted	16 081 738	1,23
Petroleum Geo-	14 255 010	1,09
Storebrand	13 992 198	1,07
Kongsberg	13 920 000	1,06
TGS-NOPEC	13 703 730	1,05
Fred Olsen	13 405 540	1,02
Statoil Fuel &	13 377 000	1,02
Det norske	11 256 589	0,86
Aker	11 218 083	0,86
Marine Harvest	9 260 829	0,71
Olav Thon	8 387 891	0,64
DNO	7 104 930	0,54
Hafslund ser A	6 694 810	0,51
Cermaq	6 493 500	0,50
Wilh.	6 292 000	0,48
Algeta	6 190 980	0,47
Atea	5 991 081	0,46
sum 1- 5	869 018 786	66,40
sum 1-10	997 195 602	76,19
sum 1-25	1 144 484 763	87,44
sum 26-50	95 794 977	7,32
sum 51-	68 573 390	5,24
Sum all	**1 308 853 130**	**100,00**

Største norske selskaper etter markedsverdi 31/12-10(VPS registert)
The largest domestic companies by market value 31/12-10

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of the total* %
Statoil	441 946 488	29,92
Telenor	157 167 863	10,64
DnB NOR	133 398 627	9,03
Yara	97 480 772	6,60
Norsk Hydro	69 077 790	4,68
Orkla	58 340 386	3,95
Gjensidige	29 250 000	1,98
Aker Solutions	27 194 500	1,84
Marine Harvest	22 057 123	1,49
Petroleum Geo-	19 787 130	1,34
Storebrand	19 638 567	1,33
Schibsted	18 576 622	1,26
Renewable	17 739 336	1,20
Fred Olsen	17 193 772	1,16
Statoil Fuel &	15 990 000	1,08
Kongsberg	15 960 000	1,08
TGS-NOPEC	13 608 386	0,92
Lerøy Seafood	10 833 608	0,73
Aker	10 132 462	0,69
Austevoll	10 054 782	0,68
Olav Thon	9 686 524	0,66
Wilh.	9 350 000	0,63
DNO	8 615 202	0,58
Cermaq	8 325 000	0,56
Hafslund ser A	8 079 943	0,55
sum 1- 5	899 071 540	60,88
sum 1-10	1 055 700 679	71,48
sum 1-25	1 249 484 883	84,60
sum 26-50	128 492 578	8,70
sum 51-	98 875 814	6,70
Sum all	**1 476 853 275**	**100,00**

Største norske selskaper etter markedsverdi 31/12-09(VPS registert)
The largest domestic companies by market value 31/12-09

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of the total* %
Statoil	461 716 101	35,16
Telenor	134 371 891	10,23
DnB NOR	102 207 129	7,78
Yara	76 888 422	5,86
Norsk Hydro	60 405 768	4,60
Orkla	58 494 726	4,45
Renewable	29 748 372	2,27
Aker Solutions	20 673 300	1,57
Tandberg	18 476 938	1,41
Storebrand	17 798 435	1,36
Marine Harvest	15 125 395	1,15
Fred Olsen	14 806 119	1,13
Schibsted	14 051 270	1,07
Hafslund	13 534 483	1,03
Petroleum Geo-	13 167 000	1,00
Aker	11 688 519	0,89
TGS-NOPEC	10 905 726	0,83
Kongsberg	10 590 000	0,81
Olav Thon	8 196 290	0,62
Austevoll	7 318 097	0,56
Bonheur	6 689 447	0,51
Veidekke	6 658 506	0,51
Norwegian	6 119 156	0,47
Wilh	6 094 118	0,46
SpareBank 1	6 010 406	0,46
sum 1- 5	835 589 311	63,63
sum 1-10	980 781 082	74,69
sum 1-25	1 131 735 614	86,18
sum 26-50	103 148 518	7,85
sum 51-	78 313 848	5,96
Sum all	**1 313 197 980**	**100,00**

Største norske selskaper etter markedsverdi 31/12-08 (VPS registert)
The largest domestic companies by market value 31/12-08

Selskap / *Company*	Markedsverdi / *Market value* NOK 1000	Av total / *Of the total* %
StatoilHydro	363 186 905	41,21
Telenor	76 760 254	8,71
Orkla	46 764 913	5,31
Yara	43 371 834	4,92
DnB NOR	35 981 648	4,08
Norsk Hydro	34 693 203	3,94
Renewable	31 883 300	3,62
Aker Solutions	12 330 000	1,40
Fred Olsen	12 271 738	1,39
Aker	9 915 338	1,13
Kongsberg	9 840 000	1,12
Tandberg	8 571 127	0,97
Hafslund ser A	7 906 801	0,90
Storebrand	7 535 991	0,86
Pronova	6 949 231	0,79
Bonheur	5 914 450	0,67
Schibsted	5 747 750	0,65
Hafslund ser B	5 383 699	0,61
Olav Thon	5 070 147	0,58
Ganger Rolf	5 042 920	0,57
Revus Energy	5 017 330	0,57
Petroleum Geo-	4 977 000	0,56
Arendals	4 031 658	0,46
DNO	4 026 613	0,46
TGS-NOPEC	3 690 911	0,42
sum 1- 5	566 065 554	64,23
sum 1-10	667 159 133	75,71
sum 1-25	756 864 761	85,88
sum 26-50	63 600 050	7,22
sum 51-	60 796 812	6,90
Sum all	**881 261 623**	**100,00**

Table 43: 25 largest companies i Norway, 2007-2004.

EGENKAPITALINSTRUMENTER / *EQUITY CAPITAL INSTRUMENTS*

Største norske selskaper etter markedsverdi 31/12-07 (VPS registert) — ***The largest domestic companies by market value 31/12-07***
Største norske selskaper etter markedsverdi 31/12-06 (VPS registert) — ***The largest domestic companies by market value 31/12-06***

Selskap *Company*	Markedsverdi *Market value* NOK 1000	Av total *Of the total* %	Selskap *Company*	Markedsverdi *Market value* NOK 1000	Av total *Of the total* %
StatoilHydro	538 881 360	28,0	Statoil	357 955 249	20,5
Telenor	218 015 625	11,3	Norsk Hydro	248 929 131	14,2
Renewable	136 430 864	7,1	Telenor	197 012 193	11,3
DnB NOR	110 610 250	5,7	DnB NOR	118 313 428	6,8
Orkla	109 610 610	5,7	Orkla	73 525 026	4,2
Norsk Hydro	96 841 459	5,0	Renewable	56 335 595	3,2
Yara	73 331 202	3,8	Yara	42 947 336	2,5
Aker Kværner	39 593 000	2,1	Aker Kværner	42 812 744	2,4
Hafslund ser. A	30 449 057	1,58	Aker	29 022 266	1,66
Petroleum Geo-	28 395 000	1,47	Petroleum Geo-	26 370 000	1,51
Storebrand	25 509 891	1,32	Hafslund ser. A	23 494 054	1,34
Aker	24 535 033	1,27	Norske	20 419 155	1,17
Fred. Olsen	19 841 424	1,03	Prosafe	20 349 406	1,16
Schibsted	16 308 375	0,85	Storebrand	19 810 655	1,13
Sevan Marine	14 548 824	0,75	Pan Fish	19 794 095	1,13
Tandberg	12 902 160	0,67	Fred. Olsen	19 225 936	1,10
Hafslund ser. B	12 442 327	0,65	Schibsted	15 442 750	0,88
Marine Harvest	12 141 355	0,63	TGS-NOPEC	13 726 313	0,78
Kongsberg	10 170 000	0,53	Wilh.	11 539 676	0,66
Bonheur	9 993 380	0,52	Tandberg	11 364 257	0,65
DNO	9 120 958	0,47	Aker Yards	10 974 444	0,63
Awilco Offshore	9 084 462	0,47	Bonheur	10 931 535	0,63
Norske	8 585 542	0,45	Bergesen	10 588 701	0,61
Olav Thon	8 555 874	0,44	DNO	10 405 854	0,60
Ganger Rolf	7 981 600	0,41	Awilco Offshore	9 668 891	0,55
sum 1- 5	1 113 548 709	57,78	sum 1- 5	995 735 027	56,94
sum 1-10	1 382 158 427	71,72	sum 1-10	1 193 222 968	68,24
sum 1-25	1 583 879 632	82,19	sum 1-25	1 420 958 690	81,26
sum 26-50	153 868 587	7,98	sum 26-50	166 508 422	9,52
sum 51-	189 460 309	9,83	sum 51-	161 203 272	9,22
Sum all	**1 927 208 528**	**100,00**	**sum all**	**1 748 670 384**	**100,00**

Største norske selskaper etter markedsverdi 31/12-05 (VPS registert) — ***The largest domestic companies by market value 31/12-05***
Største norske selskaper etter markedsverdi 31/12-04 (VPS registert) — ***The largest domestic companies by market value 31/12-04***

Selskap *Company*	Markedsverdi *Market value* Mill NOK	Av total *Of the total* %	+/- 2004 Mill NOK	Selskap *Company*	Markedsverdi *Market value* Mill NOK	Av total *Of the total* %	+/- 2004 Mill NOK
Statoil	339 386	26,2	131 375	Statoil	208 011	24,25	44 339
Norsk Hydro	179 455	13,9	53 549	Norsk Hydro	125 906	14,68	16 468
Telenor	113 060	8,7	16 827	Telenor	96 233	11,22	17 758
DnB NOR	96 255	7,4	16 958	DnB NOR	79 297	9,24	21 175
Orkla	58 216	4,5	15 968	Orkla	42 248	4,93	10 376
Yara	30 923	2,4	5 447	Yara	25 476	2,97	25 476
Aker Kværner	22 810	1,8	13 950	Norske	17 441	2,03	533
Aker	22 726	1,8	17 361	Storebrand	16 274	1,90	4 233
Norske	20 372	1,58	2 931	Schibsted	11 911	1,39	3 982
Storebrand	15 059	1,16	-1 214	Elkem	11 285	1,32	1 676
Smedvig	14 955	1,16	7 128	Tandberg	10 108	1,18	3 655
Fred. Olsen	14 864	1,15	9 588	Odfjell	9 134	1,06	5 948
Hafslund	14 291	1,11	6 664	Aker Kværner	8 860	1,03	8 860
Schibsted	13 919	1,08	2 008	Smedvig	7 827	0,91	3 860
DNO	13 460	1,04	11 916	Hafslund	7 627	0,89	776
Petroleum Geo-	12 480	0,97	4 910	Wilh.	7 627	0,89	2 212
Wilh.	11 951	0,92	6 165	Petroleum Geo-	7 570	0,88	2 370
Odfjell	11 466	0,89	2 331	Aktiv Kapital	6 369	0,74	4 057
Bergesen	11 391	0,88	-	Tomra	5 944	0,69	-1 214
Prosafe	9 763	0,76	4 180	Prosafe	5 583	0,65	1 033
Tomra	8 621	0,67	2 677	Aker	5 365	0,63	5 365
TGS-NOPEC	8 284	0,64	4 358	Fred. Olsen	5 276	0,62	3 558
Ocean Rig	8 262	0,64	5 882	Ekornes	4 861	0,57	620
Fast Search &	7 014	0,54	3 698	EDB Business	4 484	0,52	716
Aker Yards	6 675	0,52	3 595	Rieber & Søn	4 456	0,52	477
sum 1- 5	786 372	60,82		sum 1- 5	551 695	64,32	
sum 1-10	898 261	69,47		sum 1-10	634 081	73,92	
sum 1-25	1 065 658	82,42		sum 1-25	735 173	85,71	
sum 26-50	114 195	8,83		sum 26-50	67 808	7,91	
sum 51-	113 141	8,75		sum 51-	54 794	6,39	
sum all	**1 292 994**	**100,00**	**435 219**	**sum all**	**857 775**	**100,00**	**219 639**

Appendix A.5 Time lag USD/NOK = brent

We wanted to see if the currency could be affected from the Brent oil price with a time lag. We tried one week and two-week lag. From the regression output, there was no significant results.

Table 44: Logarithmic return of brent oil price on USD/NOK in the period 2001-2019. One week lag.

Regression Statistics				*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,06		Intercept	0,00	0,00	-0,15	0,88
R Square	0,00		ln_Brent	-0,02	0,01	-1,88	0,06
Adjusted R Square	0,00						
Standard Error	0,02						
Observations	928						

Table 45: Logarithmic return of brent oil price on USD/NOK in the period 2001-2019. Two week lag.

Regression Statistics				*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,05		Intercept	0,00	0,00	-0,12	0,90
R Square	0,00		ln_Brent	-0,02	0,01	-1,61	0,11
Adjusted R Square	0,00						
Standard Error	0,02						
Observations	926						

Appendix A.6 Another period – 2016-2019

We wanted to do a regression from 2016-2019 (basically filtering away the price fall in 2014-2015) to see if that would affect the coefficients differently compared to period 5. There was no big change.

Table 46: Logarithmic return on OBX for period 2016-2019. No big change compared from 2014-2019.

Regression Statistics				*Coefficients*	*Std Error*	*t Stat*	*P-value*
Multiple R	0,69		Intercept	0,00	0,00	1,05	0,30
R Square	0,48		ln_Brent	0,16	0,02	6,59	0,00
Adjusted R Square	0,47		ln_S&P500	0,50	0,06	8,39	0,00
Standard Error	0,01		ln_USD/NOK	0,03	0,08	0,34	0,73
Observations	165						

Appendix B References

British_Petroleum. "Non-Combusted use of oil, gas and coal."

British_Petroleum (2018). "BP Statistical Review of World Energy."

Cattlin, B. (2018). "What moves G10 currencies?".

Coyne, D. (2018). "World Oil 2018-2050: World Energy Annual Report." **Part 2**.

Demirbas, A., et al. (2017). "Recent volatility in the price of crude oil."

Dividend, S. (2019). "List of All S&P 500 Stocks and Companies."

EIA, U. S. E. I. A. "OIl: Crude and Petroleum Products."

EIA, U. S. E. I. A. "What drives crude oil prices?" Energy and Financial Markets.

Hayes, A. (2019). "Dotcom Bubble." Investing **Financial Analysis**.

Hristova, K. (2019). "The Top 10 Biggest Market Crashes."

Investopedia (2019). "What Does the S&P 500 Undex Measure and How Is It Calculated."

Kenton, W. (2019). "Organisation for Economic Co-operation and Development (OECD)." Investing **International/global**.

OsloBørs (2019).

Pettinger, T. (2010). "The Economics of the Stock Market."

Pettinger, T. (2018). "How does the stock market affect the economy?".

RystadEnergy (2019). "What is the IMO 2020 Effect on the Fuel Bunker Mix Short- and Long Term?".

Scott, R. (2018). "Understanding the Oil Futures' Forward Curve."

Singh, M. (2019). "The 2008-08 Financial Crisis in Review." Insights **Markets and Economy**.

Statistisk_Sentralbyrå. 2019, from https://www.ssb.no/nasjonalregnskap-og-konjunkturer/faktaside/norsk-okonomi.

Stortinget (2006). Merger of Statoil and Hydro's petroleum operations. M. o. Petroleum. **Storting proposition no 60**.

Tveter, K. and T. Kjus (2016). "How The IMO is Not Making Shipping Great Again - Biggest cost increase since double hull." DNB Markets **Oil Market Outlook**.

Wooldridge, J. M. (2012). "Introductory Econometrics: A Modern Approach." Michigan State University **5th edition**.

Smith-Solbakken, M. and H. Ryggvik, https://snl.no/Norsk_oljehistorie