

UNIVERSITY OF VAASA
FACULTY OF BUSINESS STUDIES
DEPARTMENT OF FINANCE

Anton Hietala

**RELATIONSHIP BETWEEN OIL PRICE AND STOCK MARKETS BEFORE
AND AFTER 2014-2015 OIL PRICE COLLAPSE**

Accounting and Finance

Master's Thesis

Finance

Vaasa 2020

TABLE OF CONTENTS

1. Introduction	8
1.1. Purpose of the study	11
1.2. Structure of the thesis	12
1.3. Research hypothesis	13
2. Factors determining the oil price	15
2.1. Oil supply and demand	15
2.2. Political and capital intensity of oil	17
3. Stock market pricing	20
3.1. Capital asset pricing model	21
3.2. Factor models	23
3.3. Valuation models	27
4. Previous studies	30
5. Data and Methodology	38
5.1. Data	38
5.2. Descriptive statistics methodology	38
5.3. Methodology of two models used in the research	39
6. Empirical results and findings	42
6.1. Descriptive statistics results	42
6.2. Result table of model with two independent variables	43
6.3. Result tables of model with multiple control variables	44
6.4. Regression results interpretation	46
6.5. Comparing results to previous literature	50
7. Possibilities for further research	53
8. Conclusion	54
9. References	58
Appendix 1. Correlation matrices	61

Graph 1 Relationship between oil price and SP500 index	31
Table 1. Stock markets accumulated responses to real oil price	34
Table 2. Non linearity test results	35
Table 3. Result table of simpler model before 2014-2015 price collapse	43
Table 4. Result table of simpler model after 2014-2015 price collapse	43
Table 5. Result table of complex model before 2014-2015 price collapse	44
Table 6. Result table of complex model after 2014-2015 price collapse	45
Formula 1. CAPM formula	22
Formula 2. Risk premium	23
Formula 3. Market and company risk separated	24
Formula 4. Index model	25
Formula 5. Arbitrage pricing theory	26
Formula 6. Dividend discount model	27
Formula 7. Gordon's model	28
Formula 8. Residual earnings model	29
Formula 9. Two independent variable market model	40
Formula 10. Multiple control variable model	41

UNIVERSITY OF VAASA**Faculty of Business Studies**

Author:	Anton Hietala	
Topic of the Thesis:	Relationship between oil price and stock markets before and after 2014-2015 oil price collapse	
Name of the Supervisor:	Klaus Grobys	
Degree:	Master of Science in Economics and Business Administration	
Department:	Department of Accounting and Finance	
Master`s Degree Programme:	Finance	
Year of Entering the University:	2013	
Year of Completing the Thesis:	2020	Pages: 60

Abstract:

The priming of this thesis investigates the price formation of oil and stock market shares which is followed by the introduction of previous studies. The evidence of the relationship between oil price and stock markets in previous papers are introduced globally and mainly from 21-century. Majority of the previous results indicates that oil price shock affects negatively to stock markets in most of the countries with the exception of oil producer countries or companies examined. However, contrary results with none significant effect occurred also. Reason for the asymmetric results can be that the economy consists of many factors impacting the relationship of oil price and stock markets. These factors are for example changes in wages, interest rates, commodity prices, stock market behavior or changes in technology or even in political situation. Many impacting factors or changes in different commodity prices may offset the changes in energy cost which complex the effect of oil price to the stock markets.

Particularly, this research concentrates on the effect of oil price to stock markets on 2010s separately before and after the 2014 oil price collapse. The thesis investigates whether the relationship between oil and stock market is similar in the 2010s as in the previous literature and whether the price collapse has had any impact on the relationship.

The analysis is executed by conducting simpler two independent variable market models and multiple control variable models separately from time before the oil price collapse in 2014-2015 and after it. The research concentrates on important economic and oil regions including United States, Canada, Europe, Norway, China and Russia.

The results of the research are somewhat in line with the previous literature stating that countries with relatively large oil production industry often tend to have positive relationship between oil price and stock markets. The positive impact was slightly milder after concluding the control variables to the model in effort to make model more reliable. The oil price impact to the stock markets also seemed to be weaker after the oil price collapse, stating that the oil price might be less crucial in lower price levels, exception being Norway. This research does not find any significant negative relationship on oil price and stock markets in any of the regions in 2010s. When examining large economies, the oil price impact on stock markets seemed not to be significant, excluding China's positive relationship before the oil price collapse.

1. Introduction

Crude oil runs the modern society as the world needs it more than ever. The importance of oil makes its price the center of attention. The recent collapse in crude oil price, even with the reasonable pull back, has changed oil industry and the global economy tremendously. Consequences have divided society into two groups, winners and losers. The oil and its price have once again earned its place in headlines as the speculations of the situation are made.

Oil is one of the key facilitator of our life. It enable us a variety of possibilities. Some of the obvious petroleum products are transportation fuels, fuel oils for heating and electricity generation, asphalt and road oil. Petroleum is not just used for fuel. Various plastics, synthetic materials and chemical products are made from petroleum; in fact, petroleum can be found in many common household items.

Oil and more specifically crude oil and the business related to it is more complex than it might seem to be from just consumer point of view. Many factors influence in crude oil price as it happens to be one of the most important commodities in the world. Oil has not just economical importance but it has also great political and environmental influence.

Everyone's life is affected by oil. Otherwise than you might imagine, people who are most dependant on oil prices are ones with the lowest income. Dependence is due to transportation cost of necessary commodities, like food and clothes. World's poorest places often are not self-reliant, which lead to a necessary transportation of most important commodities. Oil is a crucial factor responsible for the transportation costs.

Oil and its price influences directly to world balance of powers. Oil exporters gain economical and political power when the prices are high but when the prices are low they suffer severely. Even wars have occurred over commodities in the human history. As oil has become extremely important commodity, it is no wonder it causes conflicts in a modern politics. As said earlier the crude oil price is one of the most important economical variables and it affects to everything globally. Accordingly, crude oil price can also impact the stock markets extensively.

Oil price is an excellent example of commodity and macroeconomic variable which influence to economy and stock markets is not entirely clear. The causation in relationship of oil price and stock markets is complicated; it is not clearly and easily understandable. One reason for the incomplete understanding might be that oil price did not float freely until 1973 when oil price was liberated from regulation. The World has had only couple of decades to research oil prices and stock markets correlations.

The determining of the share price on the stock market depends both on the information regarding the shares future expectations, and the economic challenges and possibilities that the company may face. In theory, the price of oil may affect the company's expected cash flows and the discount rate in several different ways. Expected cash flow is affected by the oil price, because oil is a very versatile resource and an important raw material for manufacturing of products. For many companies oil is as important resource as work force. The expected values of the future price of oil cause changes in the expected production costs of the company, which again affect the company's share price. The effect on the share price depends on whether the company is a net producer or a net consumer of oil. Macroeconomically oil is a consumable, which means that the increasing of the oil price lowers the global stock markets. (Huang, Masulis & Stoll 1996: 4.)

Kilian (2008) claims that oil prices also affect stock returns via expected discount rate, which is composed of the expected inflation rate and the expected real interest rate, both of which may be influenced by oil prices. Higher oil prices often cause inflationary pressures for net oil-importing countries. Bernanke (1997) discuss that a higher expected inflation rate provides a boost to increase in the discount rate which has a negative effect on stock returns. Further, central banks may react to inflationary pressures by raising interest rates. Higher interest rates tend to make the stock market less attractive place to investment rather than the bond market, which has a negative impact on stock prices. Furthermore, the increase of the oil price may impact positively on net producer countries stock markets. (Kilian 2008, Bernanke 1997)

As already said the oil price has recently been in the headlines due to its extreme drop in 2014. The oil industry history has had its ups and downs since the beginning. For the past decades it has been making record breaking revenues until July 2014, when the oil price collapsed suddenly. Since the collapse, price has been cut roughly to half.

The low oil price has influenced economies and companies unevenly. The winners are the countries and companies with high oil demand and many oil consumers. Although the low oil price has not affected the global economy as positively as previously estimated. The influence to stock markets has also been slightly more negative than positive contrary to expectations. The biggest losers of the situation are oil producer countries and companies, low prices cause harm also to oil industry workers and investors. (Gevorkyan 2016)

More than 200,000 oil workers lost their jobs when the prices collapsed. Production investments were cut to its minimum by decreasing manufacturing of drilling and production equipment. The investments in exploration of new oil reserves also shrunk to almost nothing. The situation have been somewhat stabilizing since the worst times of the collapse. (Gevorkyan 2016)

The main reason for oil price collapse is the shale oil production. It is the new way of producing oil from the shale rock. The world's largest oil consumer and nowadays also the largest producer, the United States started to produce own oil from shale rock, decreasing demand and increasing supply in the global oil markets. China's oil demand has also decreased during their recent slowdown in economic growth. Other matters intensifying price decrease is OPEC's intensions to drive new producers off the markets by increasing production. At the same time, Iran is recovering from oil export restrictions increasing its own oil production. (Gevorkyan 2016)

1.1. Purpose of the study

Speculation and analysis about oil price formation has increased profusely due to recent decrease and pull back. The opinions of oil prices future vary greatly. Even though the oil price is formed by fundamental measures such as, supply and demand, the matter is complicated and hard to predict and that's why it continues to confuse even the experts. As the crude oil price determining is more relevant topic than ever, it is important to understand it properly.

My intension is to add to the academic literature by clarifying readers understanding about the importance of oil price to stock markets. The paper concentrates on the relationship between crude oil price and stock markets, but it also introduces the factors determining the oil price and share pricing models. On the model of this research, the relationship between oil price and stock markets are examined by conducting two types of regression models separately, from the period before the oil price collapse in 2014-2015 and after the collapse. This extends the aspect of analyzing the new timeframe of 2010s on the relationship of oil price and stock markets to also analyzing the oil price collapse impact on the relationship. The oil price being in a lower level might change its impact on stock markets as the oil price is relatively smaller variable in production cost of companies. This is why the dynamics between oil price and stock markets are important to examine also after the oil price collapse.

Many statistics considering crude oil prices are highly confidential and are not easy to resolve. Knowing how the industry works, helps in making own conclusions about its future. The oil prices and industries understanding are critical in oil producers, investors, workers and even consumers point of view.

According to Sadorsky, Park and Jimenez-Rodriquez the oil price impact to macro economy is studied widely but relatively little work has done about price impact to stock markets, which make it even more important object of analysis. In addition to that not much research about oil prices impact to stock markets has been done in a recent timeframe from 2010 to 2019. It is crucial to keep the analysis up to date and add the examination of the impact of the oil price collapse to the research as mentioned earlier. There is a gap on scientific literature on proper examination of the impact of 2014-2015 oil price collapse to the relationship between oil price and

stock markets.

Most of the researches on this topic concentrate on a certain area concluding geographically or economically similar countries or regions. This research is rare as it includes all the most important economical regions globally from the continents of Asia, Europe and North America all included. It is crucial to examine and compare the results on global scale in the same research with same method, so that the differences in the way of conducting the different researches do not make it difficult to compare the results.

This thesis investigates whether there is correlation between oil price and stock markets, and what the correlation is thought examining previous studies and conducting own research. It answers to the questions: Is there correlation? What is it? Where is it or is not? And how does it differ in various stock markets across the world?

1.2. Structure of the thesis

This papers first part introduces you the importance of commodity crude oil and goes more particularly into its price formation, defining factors determining it, including also information about the recent price collapse. It contains information and speculation beside from supply and demand also from political and capital influence in the oil markets. The theory continues by introduction of the basic stock market pricing models which helps reader to understand what influences shares price; for example capital asset pricing models, factor models and valuation models. Both of oil and share price formation is necessary for understanding of the main topic of the thesis concerning relationship between oil price and stock markets.

The thesis continues by covering the particular previous analysis of the oil prices influence to stock markets by introducing different types of research and results. The researches and data used in them are from all over the global markets. Results are mainly from oil prices impact to stock market indices. The thesis introduces also the most important connections in the relationship between oil price and stock markets in general.

The last part is the actual empirical research made on the topic. First the data used in the model is introduced comprehensively which continues by the explanation of the methodology used in the model. The particular regression models are done with two different methods. The first market model regression is simpler with only two independent variables to show if the Brent oil price actually have any impact on stock market indices. The second part is executed with more complex model having multiple control variables. This more complex model is meant to make the results more accurate by explaining more of the factors impacting the stock markets. Then the results of the regression model are introduced also comparing them to the previous research.

1.3. Research hypotesis

The primary objective of this thesis is to investigate the relationship between oil price and stock markets in recent decade. The period starting from 2010 and ending 2019 consist of recovering from the financial crisis and experiencing a steep collapse of oil price in 2014 which makes it interesting for examination. Firstly research investigates whether there is significant relationship between oil price and stock market indices in 2010s.

H1: There is significant relationship between oil price and stock market indices in 2010s

Oil's position in global market has drastically changed over the last years as new production techniques have emerged. With new expertise it is possible to produce oil from shale increasing production levels. This production surplus and slowly developing renewable energies caused oil price significant decrease in 2014-2015. Weaker scarcity might have decreased the economical importance of oil which is shown in the fact that price of oil is now in completely new lower levels. Currently the same percentage change in oil price has less financial value as the oil prices are in new lower levels. Baring this in mind, the second hypothesis claims that after the price drop the impact of oil price changes on stock market is weaker.

H2: The relationship between oil price and stock market indices is weaker after the oil price collapse in 2014-2015

Higher oil prices increase the profits of oil and gas companies leading to positive stock market returns in the industry. Higher income of the industry leads to positive cash flow and spillover effects for the whole exporting region increasing the overall stock market returns. Consequently, the third hypothesis is that oil price has significant positive impact on oil exporter regions stock indices.

H3: Oil price has significant positive impact on oil exporter regions stock indices

Oil price impact to oil consumer companies expenses directly which impact naturally also company's profitability. This is why oil importer countries stock markets are traditionally considered to have negative relationship between oil price and stock markets. Large part of the previous literature finds significant negative relationship between oil prices and stock markets supporting the theory.

H4. Oil importing regions have negative relationship between oil price and stock markets.

2. Factors determining the oil price

2.1. Oil supply and demand

The high amount of measures determine the crude oil price. I will introduce you the most crucial components on oil price determining. Components could be divided into four main groups which are supply factors, demand factors, political factors and financial measures. The significance of these factors is described in the following section.

Crude oil is an exhaustible resource even though the shale oil production has changed the industry. Although it would be most convenient to produce oil easiest accessible and with the lowest production cost, it is not necessarily discovered first and at least partial monopolist do not want to immediately produce all cheapest oil. Oil discovery and extraction involves complex time and capital consuming process.

Domination of the oil supplying is held by the oil cartel OPEC (organization of the petroleum exporting countries) whose principal members are Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. Back in 2008 OPEC members produced even half of the world's crude oil. It made the organization an obvious object for study of monopoly pricing power. (Hansen and Lindholt 2008.)

The dominance has reduced slightly by competitive producers and especially by new shale drilling and oil sand extraction, but is still significant. Also rapid economic growth of China and other developing countries have slowed down, which decreases oil demand. This led to a reducing of oil prices which slightly lowered the political and economic dominance of the OPEC. In other hand, OPEC still produces oil with the smallest cost which benefits them when the oil prices are low.

Studies suggest that OPEC has great understanding of the oil markets and its dynamics. OPEC uses its dominance and ability to reduce supplies, even after its power has weakened, so that at least partially in some periods, it can manipulate crude oil prices. Studies also suggest that the major producers in OPEC swing productions by restrictions and extraction increases to maintain constant revenues.

This manipulation leads to a negative relationship between oil prices and OPEC production. (Kaufman et al., 2004)

Variables of oil supply would describe the available quantities, cost of discovery and production; however particular data are not reliably obtainable. Information on oil production capacity and cost are highly confidential. However a number of models incorporate variables based on OPEC capacity, but they are at best a flexible estimate which varies with changes in price, demand, and regulations. Long term measure of oil is made by Energy Information Administration. It uses US listed firms annual reports to calculate oil exploration costs for the previous 3 years. Unfortunately it is a low frequency measurement with first published as late as 1982.

The oil production is a secretive industry where almost everything is confidential. It has old traditions and old strong producers as well as new arrivals with new extraction techniques. It is interesting to watch which producers will survive in the new situation where prices are lower. Only strong producers will succeed.

The oil supply requires demand which is naturally also as important factor affecting crude oil price as the supply. Greatest oil consumer countries do not produce oil as much as they need it, if any. This leads to a market imbalance which makes it very crucial for the consuming countries to secure their oil supply. The demand is also highly concentrated to industrialized developed (for example OECD) countries.

Transportation covers over half of the world oil consumption and makes oil an economical necessity. (Checillon and Riffart 2009) Price elasticity of demand and supply are low, which makes prices vulnerable for frequent shocks. If choose to measure the affection of economic activity on oil prices it is crucial to have global indicators of economic activity also from China and other developed countries, rather than incomplete data such as OECD GDP. Because transportation is such an important factor in oil demand it is inevitable to look at the economical activity by fundamental measures like global transportation and freight rates. (Coleman 2011.)

Past studies have proven different conclusions of OPECs ability to act as a powerful market influencer and manipulator. It suggests that OPECs power to influence prices may be time-variant. According to Coleman OPECs pricing power is greatest at times when its higher market control co-indicates with OECD countries elevated dependence on oil imports, which is captured in an interaction term OPEC market share x OECD import dependence. (Coleman 2011)

2.2. Political and capital intensity of oil

Crude oil's political impact is tremendous as it is one of the world's most crucial commodities. High price of the oil has supported its political weight as it is has been necessity and expensive. Recent decrease in oil price has been welcomed by the countries with high consumption of the oil but has weakened producer countries. The weakening can be severe because many oil producers economy relies on oil as they haven't been forced to develop alternative industry.

Geographical control over oil sources has lead to many conflicts in global politics. Geopolitical forces and conflicts seem to be greatest in the Middle East, which produces around third of world's oil and where locates almost 60 percent of proved reserves excluding oil shale rock. As countries tries to drive their own benefits it is inevitable that even wars may occur. The crude oil has its special features which makes it necessity for the modern society. The recent situation is alarming as oil has formed in the layers of earth from the fossils over hundreds of millions years and is now used million times faster than it is formed. Only time will show when this exhaustible resource is not available anymore and the time when alternatives have been invented. (Hansen and Lindholt 2008.)

Changes and events in politics affect to oil prices and vice versa. Higher prices benefits producers and they gain more power. On the other hand it may increase the global interest over the area, which is not always a positive, as you can observe for example from the events in the Middle East. Diplomatic and true force is used when countries are securing their oil supply.

The political history of the oil prices can be sectioned roughly into three separate periods. The three periods were calm beginning when oil supply were not capable of producing oil for all demand, second period when political events and market power shaped the price path, and the third and present volatile period where the politics effect to the price and the price is driven by more fundamental factors like supply and demand. Although the political pressure over oil has slightly settled, it is still crucial factor in crude oils price formation. (Simmons 2005)

As the situation in the Middle East is sensitive, the political events may affect to supply factors tremendously. For example recent events political between Iran and United States caused strong volatility in oil prices. The disturbance of the supply routes may lead to a serious blockage of oil supply which would raise the oil price suddenly. Another two examples of incident causing sudden short term price shocks are drone attack against Saudi Aramco oil processing facilities and lump mine attack against international oil tanker which both happened recently in 2019. Wars including oil producing countries are especially dangerous for the supply. The wars increase oil prices even if oil producers are not involved. Not because of the supply factors but ongoing war consumes plenty oil which lead to a higher demand and rises oil prices.

The political impacts to oil prices are not just concentrated in Middle East or just about conflicts and wars. In addition, increasing of the oil supply to be in equilibrium with the demand is difficult, but decreasing should be easier. The production is often not turned down on the technical difficulties, but because of national budgets and politics. As well as the economic situation, also the national budget has been made according to revenues during the time of high oil price. When the prices were high nations have expanded their public sector, military budget and investments. As the situation has changed and prices dropped during the recent years countries has been difficult to stay in their budgets forcing them to produce as much oil as possible. As long as the prices stay above the production cost it is not profitable to decrease extraction rates. (Hamilton 2008)

By keeping the production rate high, countries with lower margin cost are able to decrease overall global production rate by outplaying the oil companies and areas with a higher margin cost. OPEC has managed to decrease USA oil production marginally, but the impact has not yet affected to the oil price significantly. Future will show us how the OPEC will cope with the price decrease and how the price will settle in long run, if they will continue the recent strategy to not cut the production rates. Despite OPEC's actions to paralyze USA shale oil production, the production rates have been going up till today 2020. In 2018 59% of USA's 6.5 million barrel oil production was from tight oil resources (shale, sandstone, and carbonate rock). Nowadays USA is the largest oil producer due to tight oil production with 16.2% market share. Second is Saudi Arabia with market share of 13% and third Russia with market share of 12.1%. (Garside M. 2019)

Besides politics oil industry is also highly capital intensive. The capital intensity makes oil production subject to cost of debt and equity finance. It makes the industry more risky, but it's great revenues make it viable. Uncertain global financial period may decrease the demand of oil but may also decrease the investments and loan giving for the producers, which eventually increase the oil price. This happens in longer term than the decreasing of the demand. Oil companies and oil dependant companies are often required to use financial derivatives as protection. The derivatives are used for example against price changes. Risk management is expensive but often necessary. (Hamilton 2008)

According to Coleman, one intuition is that oil prices respond to speculative activity by major investors in the future markets who is sometimes claimed to be hedge funds. Those investors have dominant sources of information about possible future prices and price shocks. This allows them to squeeze prizes which are aggravated by other investors' speculation. Second opinion assumes that liquid future markets complement the physical oil markets, providing opportunity of price protection that is facilitated by speculators. (Coleman 2011)

3. Stock market pricing

To examine the oil price impact to the stock markets we need to investigate stock market pricing. Share valuation is one of the most important aspects of investing. This importance makes share pricing popular object of examination and analysis. The main idea of share pricing is to signify whether the shares real value is higher than its market price. If the real value of the share is higher than the market price, the investment is profitable. Determining of the real price is performed by financial indicators and pricing models. Financial indicators are used to ease the investigation of any enterprise's real economical situation. Financial indicators are used to compare firms. They are conducted by collecting the data from reports and comparing them together into as understandable form as possible. They are used in formation of shares real price.

The most popular valuation ratios are for example price per book value ratio, price per earnings ratio, price per sales ratio, price per earnings to growth value, enterprise value multiple, dividend yield and cash flow cover ratio. Every one of these investment valuation ratios compares the stock price with various data of company performance. P/E ratio is the most famous financial indicator. P/B, P/S, PEG are also commonly used valuation ratios which purpose and equation is seen on a letter combination. P/E represents the profit making capability, P/S the amount of sales, P/B the real material value and the profit performance is included with growth in PEG ratio. Enterprise value multiple (EBITDA) is company's "enterprise value" divided by its earnings before taxes, interest expense, amortization and depreciation. Price per cash flow ratio is P/E ratio but without influence of depreciation and other non-cash variables. Dividend yield is company's annual cash dividend per share divided by the current price of the stock, and is expressed as an annual percentage.

In the previous paragraph just some of the many investment valuation ratios were introduced. The valuation ratios may also consider for example debt, liquidity, operating performance as well as other profitability and cash flow measures. Financial indicators must be used carefully as they cannot measure accurately for example intellectual capital or future risks and possibilities. Investment valuation ratios must also be used with great variety to accomplish the best and most

accurate results.

3.1. Capital asset pricing model

One of the most well known theories in finance is the Capital asset pricing model which is generally shortened to CAPM. It is the key element of modern financial theory; even if it is not really used much in last decades, as it is not fit real market conditions. William Sharpe developed CAPM in 1964. Sharpe used Harry Markowitz's portfolio theory to develop the model. CAPM bounds risk directly to investments expected return. If the risk is high it leads to greater revenues and if low the revenues are lower. The model is expected to examine the amount of profit for the certain risk level investment. According to CAPM expected return of an investment or a portfolio of many investments equals risk-free revenue plus a risk premium. If expected return is not same or higher than the required return, the investment should not be performed. The results of the CAPM are plotted in the security market line for all different risks (betas). CAPM is examined by means of harshly simplified rules, which are the following:

1. Aim to maximize economic utilities (Asset quantities are given and fixed).
2. Are rational and risk-averse.
3. Are broadly diversified across a range of investments.
4. Are price takers so they cannot influence prices.
5. Can lend and borrow unlimited amounts under the risk free rate of interest.
6. Trade without transaction or taxation costs.
7. Deal with securities that are all highly divisible into small parcels (All assets are perfectly divisible and liquid).
8. Have homogeneous expectations.
9. Assume all information is available at the same time to all investors.

(Glen 2005)

These rules and restrictions reveal CAPM's weakness. The model is so simplified that it does not represent in any means the real world and security markets. It is still a key fundamental for finance and tool to develop better theories in stock pricing. Previous regulations lead to next assumptions:

1. All investors want to invest in market portfolio, which includes all possible investments.
2. Market Portfolio is the best efficient portfolio, which is located in a risk-free return efficient portfolio curve's tangent.
3. All investors invest in market portfolio and the risk-free investment.
4. Each shares risk premium is shares beta and market portfolios risk premium product. (Nikkinen ym. 2002: 68-69)

Formula 1. CAPM formula:

$$E(r_i) = r_f + \beta_i[E(r_M) - r_f]$$

$E(r_i)$ = expected return for investment

$E(r_M)$ = the broad market's expected rate of return

β_i = beta of the asset

r_f = risk free interest

Model calculates investments expected return. In CAPM model the risk premium is the investment return that exceeds the risk free revenue. The model multiplies the market risk premium with the beta coefficient in other words the market risk.

Factor models allows us to define the various factors affecting share revenue at a given time (Bodie et al 2008 : 332). The most crucial factor models are introduced in the next chapter.

3.2. Factor models

Only one factor affects the shares profit in Single Index Model. Shares risk in this model is divided into a two components, company risk and market risk. The market risk represents the whole economical risk, up and downward trends in the global markets. Company risk includes only the risk and uncertainty about the future of the company or a specific industry. When using factor model, representing both of these components is possible. Represented below is the shares i risk premium, which is the return exceeding the risk free rate of return. (Nikkinen, Rothovius & Sahlström 2002: 65-67)

Formula 2. Risk premium:

$$R_i = r_i - r_f$$

Risk premium is calculated by subtracting the overall revenue by risk-free rate of return. Risk premium is divided into a three variables so that the market risk and company risk impact can be separated:

Formula 3. Market and company risk separated:

$$R_i = E(R_i) + \beta_i M + e_i$$

R_i = return of the stock

$E(R_i)$ = expected value of the risk premium

β_i = sensitivity to macroeconomic development

M = unexpected macroeconomic development or events

e_i = company's unexpected factors influence

Expected value of unexpected macroeconomic events and company's factors is zero. To use the model the factor of "M" macroeconomic development must be defined. Model requires the calculation of the factor M's variation to be possible. Stock index representing the whole market portfolio is most commonly used as M factor. The risk premium of the market portfolio is used to evaluate the macroeconomic factors impact to share profit. This Factor model is index model which equation is following. (Nikkinen, Rothovius & Sahlström 2002: 65-67)

Formula 4. Index model:

$$R_i = \alpha_i + \beta_i R_M + e_i$$

R_i = return of the stock

α_i = risk premium of the share when the markets risk premium is zero.

β_i = sensitivity to market variance

R_M = variance of the market portfolio

e_i = unexpected residual (random) returns

Model gives two separate risks for share, market risk and company risk. Two variables correlation is zero. Consequently, the variation of stock returns consist of two factors which are overall market related fluctuations and company-specific factors in returns, which along the individual share either decreases or increases in accordance with the beta factor. (Nikkinen, Rothovius & Sahlström 2002: 65-67)

Arbitrage valuation theory is based on relationship between risk and revenue as is the CAPM which was introduced earlier. All the models introduced also in the APT - theory assumes that every share is affected by the macro-economic factors and the company-specific factors. Macroeconomic risks cannot be removed by diversifying, unlike the company-specific risk. This means that the investor may forget the company-specific risk when making well diversified investment decisions. From this premise it is found that the APT is very similar to the CAPM. However they are completely different pricing models. APT is based on the next three accusations. (Bodie ym. 2002: 336, Nikkinen ym. 2002: 76.)

1. Examination of share returns is possible by the factor model.
2. Global markets consists enough shares that company specific risk can be terminated by devolution.
3. Markets are efficient and arbitrage possibilities do not occur.

Arbitrage revenue means the situation when revenue is made without risk. For example if share price is not the same in different countries stock market, it is possible to buy and sell it to get arbitrage revenue without risk. The idea is that arbitrage chances are vanished by the market participants trying to exploit them. (Bodie ym 2002: 336, Nikkinen ym. 2002: 76.)

Index models have only one factor as mentioned earlier but multiple factor models have many. Multiple factor model have many factors which affect to shares revenue at the same time. Factors can be any macroeconomic variable like for example GDP, interest rate or oil price. Factor model can conclude also the same stock market profit index than index model, but it is only one variable among the others. APT- model equation is introduced below:

Formula 5. Arbitrage pricing theory:

$$r_j = a_j + b_{j1}F_1 + b_{j2}F_2 + \cdots + b_{jn}F_n + \epsilon_j$$

- a_j = a constant for asset
- F_k = a systematic factor
- b_{jk} = the sensitivity of the the asset to systematic factor k , also called factor loading
- ϵ_j = the risky asset's idiosyncratic random shock with mean zero.

According to ATP- model two well diversified portfolio, which have the same sensitivity to different factors performance the same way. If this does not happen, the investor can use the arbitrage and delete it by using it to their advantage. (Nikkinen ym. 2002: 78-79.)

The factors used in this model should be variables which cause risk for the company's share. From those variables it is possible to calculate the share price which investors are willing to pay to accept the risk caused by the variables. The weakness of APT is that it does not provide information about how many factors or which factors should be used. (Bodie ym. 2008: 344)

3.3. Valuation models

Valuation models rely on the share value calculation based on company cash flow. The time value of money is important in valuation models. Valuation models purpose is to calculate investor's cash flow and determine the expected return used as cash flow discount. Required return represents the risk of the company. When the required return is higher, the risk is higher. Due to deviations in expected cash flow, the risk becomes reality. Next valuation models introduced uses the same theory, except in terms of what cash flow or revenue determination is used in them. (Nikkinen ym. 2002: 148-149.)

In theoretical point of view the dividend discount model is considered to be most accurate valuation model. The valuation is based only by the company's dividends in this models calculation. Dividends are actually the only real cash flow what is received from the investment. According to the model:

Formula 6. Dividend discount model:

$$P_0 = \frac{D_1}{1+r} + \frac{D_2}{(1+r)^2} + \frac{D_3}{(1+r)^3} + \dots$$

“P0” is the price of the share and “Dt” is the company's future dividends which discounted to present value. Variable “r” is the required revenue. Even if the model is theoretically accurate it has its own problems. In the real world the future dividends are hard to predict. (Nikkinen ym. 2002: 149-152.)

The further time goes into unknown future; it becomes more difficult if not impossible to predict the company's dividend changes. Model usually assumes that the dividend increases in the future with a certain rate. Gordon model, also referred as dividend growth model, calculates the expected growth rate of dividends. (Nikkinen ym. 2002: 149-152.)

Formula 7. Gordon's model:

$$P_0 = \frac{D_1}{r-g}$$

In the equation “g” is a steady growth rate of dividends. Although the dividend growth rate is rarely constant, the equation provides information about how different factors affect the share price. The increase of expected returns decreases the shares price when increase in growth rate will raise the price. (Nikkinen et al 2002. 149-152)

In Free cash flow model the free cash flow is discounted instead of dividend. Free cash flow for enterprise is considered to be cash flow as well to share investor as it increases the value of ownership. The main difficulty in the free cash flow model is the unreliable valuation of growing companies by cash flow as it is usually negative. The accurate long term valuation is impossible. Another problem for this model is that the company investments impact significantly to cash flows. Benefits of the model are that the dividend rate decisions or various accounting methods do

not affect to this model. Free cash flow model is considered to be more suitable to real markets than dividend discount model but the model has its own weaknesses. (Nikkinen ym. 2002: 152-154.)

Residual earnings model valuate company by determining the added value to equity every year based on company book value.

Formula 8. Residual earnings model

$$P_0 = BV_0 + \frac{ab_1}{1+r} + \frac{ab_2}{(1+r)^2} + \frac{ab_3}{(1+r)^3} + \dots$$

“P0” is share value, “BV0” shares substance value, “ab” added value to year t and “r” required revenue. Residual earnings model needs substance value and earnings forecasts which are usually found from different kind of easy accessible analysis.

Pricing models are used widely in finance and their importance cannot be overruled. However in real stock markets, particularly the short term price is affected often more by speculation and behavioral finance which cannot be calculated by the pricing models introduced. Pricing models are just one tool of finance which is not effective to use solely.

4. Previous studies

“In sharp contrast to the volume of work investigating link between the oil price shocks and macroeconomic variables, there has been relatively little work done on the relationship between oil price shocks and financial markets.” (Sadorsky 1999) From the days of Sadorsky’s utterance the number of research from the subject has somewhat increased and nowadays there is slightly more research available on the subject. The following section introduces evidence of the relationship between oil price and financial markets or more accurate between oil price and stock markets globally.

According to Sadorsky himself, and his results from vector auto regression, the oil price volatility has effect on economic activity but the economic activity does not have effect on the oil price. His impulse response functions suggest that movements of the oil price are important in explaining stock returns volatility. The estimated results claim that shocks of oil price depress real stock returns while shocks in real stock returns have positive impacts on interest rates and industrial production. Sadorsky discuss that the oil price dynamics have changed after 1986 so that the oil price movements explain more of the forecast error variance in real stock returns than do interest rates. Although the oil price shocks effect to markets is asymmetric. (Sadorsky 1999)

Park and Ratti (2008) claim that the impact of oil price shocks on oil-importing countries stock markets is negative while the impact on oil-exporting countries stock markets is positive. According to Huang (1996) the standard economic theory claims that stock returns are influenced by changes in expected cash flows and discount rates. These factors can be affected by oil prices which result into a conclusion that oil prices impact also to stock markets. Bernanke (1983) states that crude oil is a basic input to production and an increase in oil prices leads to a rise in production costs which induces firms to lower output, investment and revenues. This will lower stock prices. On contrary oil exporters gain more revenues when the prices are high which might impact positively on their stock prices. These are the general guideline of the oil prices relationship with the stock market. However

the correlation and relationship between oil price and stock markets are complex and vast amount of results have occurred from different kind of researches.

An example of the research which has contrary results is Pescatori's (2008) measurement of changes in the S&P 500 for stock prices and crude oil prices. Pescatori's examined that stock market prices and oil prices only occasionally had influence to stock prices and the relationship was weak. His sample discovered that no correlation exist with confidence level of 95%. (Pescatori 2008)

Graph 1 Relationship between oil price and SP500 index

Oil Prices and the S&P 500 Index



Notes: The oil price is the weekly average domestic spot price of light sweet crude oil (WTI). The S&P 500 index values are taken from the average weekly close.

Sources: *The Wall Street Journal*; S&P.

Park and Ratti (2008) examine the impact of oil price shocks to US and 13 European countries stock markets in 1.1986-12.2005 by multivariate VAR analysis. They had the same results than Sadorsky, as they examined that oil price shocks have a statistically significant impact on real stock returns. Park and Ratti specify in their research if the impact is in the same month or within one month and that result is

robust to reasonable changes in the VAR model of variable order and using of additional variables. The measurements have been made with world real oil price (Brent dollar index/US PPI) rather than national oil price to get rid of the changes in the exchange rate. (Park and Ratti 2008)

According to Park and Ratti (2008) when allowance is made and the effect of real U.S. stock returns on real stock returns in European markets is accepted, the oil price shocks have a statistically significant impact on real stock returns in all European countries in the same month or within one month. For example when spillover effects are allowed, all oil price shock measures result in statistically significant negative impact on stock prices in the U.K at the 10% level of confidence. For Norway, which is an oil exporting country, oil price shock has a positive and statistically significant impact on real stock returns at the 5% level of confidence in the same month and a positive but statistically insignificant effect with a due of one month. For Finland, a negative and statistically significant impact on real stock returns with a delay of one month is obtained at the 10% level. The median result from variance decomposition analysis is that oil price shocks account for a statistically significant 6% of the volatility in real stock returns. For numerous European countries, but not for the U.S., volatility rise in oil prices significantly lowers real stock returns simultaneously or within one month. While there is some evidence of asymmetric effects on real stock returns of oil price shocks for the U.S. and for Norway, there is little evidence of asymmetric effects for European countries importing the oil. Marginal level exception is Greece in model with spillover effect from USA. (Park and Ratti 2008)

Park and Ratti (2008) also receive similar result than Sadorsky (1999), which estimate that the U.S. and approximately half the European countries the contribution of the oil price shocks to variability in real stock returns in the U.S. and most other countries is greater than that of interest rate. A one standard deviation increase in the world real oil price significantly raises the short-term interest rate in the U.S. and eight out of 13 European countries at a delay of one or two months. The interest rate changes affect stock market via the relationship between bond markets and stock markets. When the interest rates raise, it increase the revenues from bond market depressing the stock prices as the investors relocate their money to bond markets. (Park and Ratti 2008)

Rebeca Jiménez-Rodríguez applies the Hamilton (2001) non-linearity test and compares it to linear test. She examines the relationship between real oil prices shocks and real stock returns for countries Canada, Germany, the UK, and the US. She also evaluate if there are significant differences in the impact of oil price shocks on the stock markets studied as does also Park and Ratti and Sadorsky in their researches introduced earlier. According to Jiménez-Rodríguez an oil shock in a stable price environment has more probability to cause larger consequences on stock returns than one in a volatile price environment. In all these researches including Jiménez-Rodríguez's study the results indicate oil prices shocks having a negative effect to oil importing countries stock market. Jiménez-Rodríguez finds also that there is statistical difference between North American and European countries examined. The real oil prices impact to the real stock markets in European countries seems to be stronger than for the North American countries studied. She verifies with non-linear test that oil price shock has significant negative impact to Germany, UK, US and Canada stock markets. With linear and asymmetric specifications the results are same except in case of Canada the effect is also negative but not significant. (Jiménez-Rodríguez 2013)

With linear specifications an external 10% increase in oil prices impacts negatively about 0.5% in the two North American countries and about 1% in the two European countries at the end of the first year. This means that the impact is one hundred percent stronger in the European countries. Comparing the results between countries, Jiménez-Rodríguez clarifies that they are statistically similar for Canada and the US. Results from Germany and UK are also statistically similar. Yet the Canadian impacts are statistically different from impacts of Germany and the UK. German findings are statistically different from those in the US, but similarities which are statistically significant are also found for the UK and the US. (Jiménez-Rodríguez 2013)

Table 1. Stock markets accumulated responses to real oil price.**Table 7** Accumulated responses to a real oil price shock

Country	Specification	After 1 quarter	After 2 quarters	After 3 quarters	After 4 quarters
Canada	Linear	-0.0134	-0.0370	-0.0556	-0.0522
	Asymmetric	-0.0021	-0.0552	-0.0625	-0.0622
	Net	0.0038	-0.0550	-0.0892*	-0.0944*
	Net3	0.0038	-0.0550	-0.0892*	-0.0944*
	Scaled	0.0034	-0.0669*	-0.0922*	-0.0943*
Germany	Linear	-0.0994*	-0.1291*	-0.1154*	-0.1076*
	Asymmetric	-0.1136*	-0.1819*	-0.1983*	-0.1977*
	Net	-0.0391	-0.0789*	-0.1116*	-0.1170*
	Net3	-0.0391	-0.0789*	-0.1116*	-0.1170*
	Scaled	-0.0990*	-0.1720*	-0.1936*	-0.1936*
The UK	Linear	-0.0801*	-0.0848*	-0.1031*	-0.1029*
	Asymmetric	-0.0887*	-0.1499*	-0.1782*	-0.1788*
	Net	-0.0794*	-0.1642*	-0.2382*	-0.2420*
	Net3	-0.0794*	-0.1642*	-0.2382*	-0.2420*
	Scaled	-0.0871*	-0.1628*	-0.2097*	-0.2098*
The US	Linear	-0.0361	-0.0391	-0.0580	-0.0600*
	Asymmetric	-0.0307	-0.0603	-0.0721	-0.0730
	Net	-0.0184	-0.0809*	-0.1403*	-0.1487*
	Net3	-0.0184	-0.0809*	-0.1403*	-0.1487*
	Scaled	-0.0222	-0.0788*	-0.1117*	-0.1142*

This table reports the accumulated responses to a real oil price shock (a unit shock). One asterisk means that the response is statistically significant at the 5% significance level

(Jiménez-Rodríguez 2013)

Considering the non-linear specifications we observe that real stock returns are statistically significantly lower after an oil price shock in all countries, including Canada. Two other specifications show statistically similar effects in Canada, Germany and the US, when the scaled specification indicates that the German impacts are statistically different from those found for Canada and the US, which are similar between each other. The impacts in the US and Canada are also statistically different from those in the UK. Germany and UK has statistically similar impacts, but only in the scaled specification. These three non-linear specifications yield higher responses after 1 year than the linear specification. (Jiménez-Rodríguez 2013)

Table 2. Non linearity test results.**Table 6** Non-linearity Test applied to non-linear specifications

Country	Specification	v^2	Asymptotic p -value
Canada	Asymmetric	0.933466	0.333963
	Net	0.531856	0.465827
	Net3	0.531856	0.465827
	Scaled	1.51879	0.217801
Germany	Asymmetric	0.153145	0.695547
	Net	0.867702	0.351592
	Net3	0.867702	0.351592
	Scaled	0.071941	0.788531
The UK	Asymmetric	0.122891	0.725919
	Net	0.234950	0.627877
	Net3	0.234950	0.627877
	Scaled	0.081997	0.774608
The US	Asymmetric	1.085199	0.297537
	Net	1.046052	0.306418
	Net3	1.046052	0.306418
	Scaled	2.064891	0.150725

This table reports the statistic value and the asymptotic p -value of the non-linearity Hamilton's (2001) test performed in the full sample (1971:2–2012:8) for the non-linear specifications of oil prices. One/two asterisks mean a p -value less than 5%/1%

(Jiménez-Rodríguez 2013)

The outcome indicates that the pattern of negative responses to real oil price shocks by real stock returns is exceedingly similar in Germany and the UK, and also in Canada and the US but cross-country differences occur between the European countries and the North American. With nonlinear specifications Jiménez-Rodríguez observe that the negative accumulated response of real stock returns after 1 year is about 1% in the North American countries and about 2% in the two European countries following a 10% increase in oil prices for the best-performing specification. (Jiménez-Rodríguez 2013)

Rong-Gang Cong, Yi-Ming Wei, Jian-Lin Jiao and Ying Fan (2008) examined oil price shocks impact to stock market in China using multivariate vector auto-regression. China's stock markets are considered being less correlative with macro economy than western countries stock markets. One perspective is that the stock market has a weak positive correlation with the macro economy (Zhao and Zhang, 2003). The other is that the correlation is not significant or is negative (Wang and Tian, 2002). Scholars claiming this suggest China's stock markets relying on speculations more than investing based on fundamental measures. This may be related to the surprising results that as to most stock market indices, oil price shocks do not show statistically significant impact. Only the stock returns of manufacturing index and some oil companies are increased due to oil price shocks. Some "important" oil price shocks depress oil company stock prices. However increase in oil volatility does not affect most stock returns, but there is possibility that it increase the speculations in mining index and petrochemicals index, which raise their stock returns. (Rong-Gang Cong, Yi-Ming Wei, Jian-Lin Jiao and Ying 2008)

Compared to the finding obtained by Sadorsky (1999) for the contribution of the oil price shock was greater than that of interest rates on real stock returns, Cong (2008) and others found the relative importance of oil price shocks and interest rates varies across different indices and oil stocks in Chinese stock market.

Sadorsky and Basher (2006) conducted international multifactor model allowing unconditional and conditional risk factors to examine the relationship between oil prices and emerging stock markets. They found significant asymmetrical relationship between oil price and stock markets in emerging countries which was however dependent on data frequency they used. Examining monthly and daily data, oil price rise had a positive effect stock market returns in emerging markets. Studying monthly and weekly data, lowering oil price had positive and significant effect when considering emerging market stock returns.

According to Narayan and Gupta oil price is persistent and endogenous predictor variable. They found that negative oil prices predict US stock returns better than positive oil prices in time frame of 150 years. They used generalized least squares estimator in their examination of predictability. However it has to be remembered that 150 years long timeframe does not necessarily reflect the modern market conditions in the best possible way.

Wang, Wu and Yang (2013) investigated oil exporting and importing countries separately. They found that the response of stock market to oil price changes is highly depended on whether the country is oil importer or exporter and whether the price changes is driven by aggregate demand or supply. Another result of their examination was that the strength of oil prices impact to stock markets depends on how important oil is to nation's economy. Also aggregate demand uncertainty impact on stock markets was much larger in oil exporting countries than oil importing countries and oil exporting countries stock market co-movement was increased when oil price was reaching higher levels.

5. Data and Methodology

5.1. Data

The study examines the data of important economic and oil regions including United States, Europe, China, Canada, Norway and Russia. The main purpose of the study is to find the relationship between Brent oil price and stock market indices but to ensure more accurate results, control variables are also included. Those control variables are each regions local consumer price index, industrial production index and exchange rates.

The paper includes the recent 10 year period analyzing the time before and after the 2014 oil price collapse separately. The time frame before the price collapse starts from 15.1.2010 and ends 13.6.2014 and the period after the price collapse starts from 15.1.2016 and ends at 15.7.2019. All the variables in first time frame have 54 monthly observations and in the second time frame 43 monthly observations. The data has been converted to monthly returns in order to conduct the regression.

The analyzed stock market indices are provided by the company MSCI to ensure the best possible comparability. Only exceptions being China and Russia which MSCI indices were not available for use in the database. Shanghai A share and Micex 10 indices were used for China and Russia due to lack of data which might slightly effect the results on those countries. All the data is obtained from Thompson data stream.

5.2. Descriptive statistics methodology

Correlations between all the variables used in multi regression models have been calculated to ensure the model does not contain high level of multicollinearity. Independent variables cannot be correlated too strongly as it would cause multicollinearity and make the results of the regression model unreliable. The correlation matrices have been calculated for all the countries separately before and after the 2014 oil price collapse. The Results of the correlation matrices can be found in Appendix 1.

For assessing normality, or in other words, whether the data is normally distributed the Jarque-Bera test is conducted using variance, skewness and kurtosis as a components of the formula. The T-test indicating the significance of the regression requires data to be normally distributed. This is why the paper tests normality by Jarque-Bera test. Sample sizes around 50 are just enough for conducting reasonably reliable Jarque-Bara test. Frain (2006) have found that with less than 50 sample size Jarque-Bara test might be lacking power.

Null and alternative hypothesis of Jargue-bera test are conducted as follows:

H0: The residuals of the regression sample follow normal distribution

H1: The residuals of regression sample follow non-normal distribution

5.3. Methodology of two models used in the research

Firstly, the paper investigates whether there is at all significant relationship between oil price and stock market indices. For this, before anything else, the simple market model is conducted including only MSCI World and Brent price as independent variables to examine their relationship with dependent variable region's stock index. The MSCI World acts as a proxy of global markets overall returns as the model is trying to separate and analyze the Brent oil effect on particular stock market indices. The purpose of this is to find out if the Brent oil price has to be considered when investing in stock markets.

The market model of oil price and market returns has been used before for example by Sadorsky (2001) in examination of oil price impact on gas and oil industry stocks in Canada and Nandha & Faff (2008) in research on relationship of oil price and different industries stock indices globally.

Formula 9. Two independent variable market model:

$$R_{it} = \alpha + \beta_m R_{mt} + \beta_o R_{ot} + \varepsilon_t$$

Where:

- R_{it} -Is monthly stock index returns
- α -Is the constant
- $\beta_m R_{mt}$ -Is the market beta and markets monthly returns
- $\beta_o R_{ot}$ -Brent oil beta and the monthly return of Brent

On the first model research conducted basic market model to find out if there is relationship between oil price and stock market. The second model has been upgraded in intend to increase its explanatory power and accuracy. Independent control variable exchange rate has been included in the model since Brent is priced in US dollars. Hence fluctuations in exchange rates affect to oil prices relationship with regional stock markets indices it must be included in the model as control variable. Also local consumer price indices and industrial production rates have been concluded as control variables in the multiple variable models since these variables are known to have impact on stock markets. These control variables have also been used in previous literature covering the same theme.

By including more variables and making the model more complex, the research is testing the reliability of the analysis. The purpose is to examine if the results are still significant after other affecting variables are included. If the t-values decrease significantly, the results of the first model are questionable since the Brent price becomes non significant variable. The more complex model will give us better understanding of the Brent price relationship with stock indices even if it is not meant to be perfect and completely measure the impact without any error. (Wooldridge 2006)

Formula 10. Multiple control variable model:

$$R_{it} = \alpha + \beta_m R_{mt} + \beta_o R_{ot} + \beta_x R_{xt} + \beta_{inf} R_{inf t} + \beta_{ip} R_{ipt} + \varepsilon_t$$

Where:

- $\beta_x R_{xt}$ -Is the beta and monthly return of exchange rate
- $\beta_{inf} R_{inf t}$ -Is the beta and monthly return of consumer price index
- $\beta_{ip} R_{ipt}$ -Is the beta and monthly return of industrial production index
- ε_t -Is the error term

(Wooldridge 2006)

6. Empirical results and findings

6.1. Descriptive statistics results

The correlation matrices have been conducted to ensure there is not harmful multicollinearity in the model. Independent variables should not be too strongly correlated with each other to ensure the reliability of the models results.

Analysts opinions on what is strong correlation varies but generally over $\pm 0,70$ and definitely over $\pm 0,80$ is a strong correlation which should be avoided among independent variables. The results of the correlation matrices indicate that there is not strong correlation between the independent variables. This means that the regression may be conducted using the variables.

The Jarque-Bera test have been conducted for all the countries in the study to find out if the data is normally distributed. Normal distribution is needed for conducting the t-tests and the regression reliably.

The Jarque-Bera p-values for both periods and for all the countries examined give value between 0.30-0.93 which is far greater than significance level of 0.01, 0.05 or 0.1. The results indicate that null hypothesis H_0 : The residuals of the regression sample follow normal distribution can be accepted. Jarque-Bera test indicates that the residuals of the regression follow normal distribution with both samples and for all countries.

6.2. Result table of model with two independent variables

Table 3. Result table of simpler models before 2014-2015 price collapse:

	USA	Canada	Europe	Norway	China	Russia
Brent	-0.0098 (-0.2357)	0.2977*** (4.1415)	-0.0142 (-0.2198)	0.1774*** (2.7869)	0.342** (2.3738)	0.5019*** (3.3635)
World	0.8726*** (14.8906)	1.0276*** (10.1942)	1.2133*** (13.3604)	0.7424*** (8.3153)	0.4919** (2.4345)	1.1462*** (5.4777)
R-Squared	0.8745	0.8477	0.8486	0.7723	0.3755	0.6732
Adjusted R-Squared	0.8696	0.8418	0.8427	0.7633	0.3511	0.6604

Table 4. Result table of simpler models after 2014-2015 price collapse:

	USA	Canada	Europe	Norway	China	Russia
Brent	-0.0164 (-0.8554)	0.2069*** (3.737)	0.0328 (1.0718)	0.2071*** (5.3643)	0.0105 (0.1256)	0.2772 (2.7799)
World	1.0083*** (17.5756)	0.836*** (5.0384)	0.9586*** (10.4454)	0.8335*** (7.2037)	1.2809*** (5.0891)	1.1765 (3.9366)
R-Squared	0.8989	0.6202	0.7811	0.7701	0.4415	0.4897
Adjusted R-Squared	0.8939	0.6013	0.7702	0.7586	0.4136	0.4642

6.3. Result tables of model with multiple control variables

Table 5. Result table of more complex model before 2014-2015 price drop:

	USA	Canada	Europe	Norway	China	Russia
Brent	-0.0518 (-1.0806)	0.185 (1.6419)	-0.0633 (-1.256)	0.1807** (2.6197)	0.3572** (2.345)	0.3200** (2.2584)
World	0.9048*** (14.8541)	1.0210*** (9.2616)	1.0987*** (15.2069)	0.7447*** (8.0703)	0.4525** (2.0848)	0.8025*** (3.8634)
FX rate	-	-0.3083 (-0.9313)	-0.543 (-6.3914)	0.0357 (0.2891)	-1.0679 (-0,8644)	-1.1008*** (-3.8081)
CPI	1.7486* (1.9027)	0.6092 (0.5871)	-0.3319 (-0.8125)	0.2088 (0.3291)	-0.6070 (-0,4738)	1.0962 (0.7374)
IPI	0.2913 (0.7567)	0.623 (0.8821)	-	0.0775 (0.8629)	-0.1222 (-0,3289)	-0,054 (-0.9671)
R-Squared	0.8725	0.8538	0.9176	0.7768	0.3878	0.7538
Adjusted R-Squared	0.8648	0.8385	0.9108	0.7535	0.3241	0.7282

Table 6. Result table of more complex model after 2014-2015 price drop:

	USA	Canada	Europe	Norway	China	Russia
Brent	-0.0199 (-0.9010)	0.0428 (0.4964)	0.0277 (1.0561)	0.2046*** (4.9777)	-0.0099 (-0.1269)	0.1216 (1.543)
World	1.0083*** (16.4247)	0.7685*** (4.7979)	0.9050*** (11.4759)	0.8197*** (6.6292)	1.0616*** (4.4774)	0.4781* (1.9014)
FX rate	-	-0.9999** (-2,6729)	0.5032*** (-4.0842)	-0.0595 (0.1504)	1.5619*** (-3.3431)	-1.2337** (-5.9837)
CPI	0.4564 (0.3760)	-0.6841 (-0.4324)	0.0352 (0.0831)	0.0659 (0.0786)	-0.9015 (-0.6366)	0.8162 (0.3481)
IPI	0.0139 (0.0412)	1.7503 (1.6057)	-	-0.0350 (-0.3019)	0.4630 (0.6573)	-0.003 (-0.0685)
R-Squared	0.8993	0.6893	0.8516	0.7715	0.5809	0.7476
Adjusted R-Squared	0.8887	0.6474	0.8360	0.7406	0.5243	0.7135

6.4. Regression results interpretation

The two different regression models from two different time periods in 2010s found significant positive relationship between oil price and stock markets in some of the oil exporting countries. H1 stating that relationship between oil price and stock markets can be accepted in the case of some regions. H2 stating that oil price have decreased impact on stock markets in lower levels after the price collapse can be accepted in some regions but rejected in other having a mixed results. All the regions having significant positive relationship are oil exporting countries indicating that also H3 claiming the oil exporter countries having positive relationship between oil price and stock markets can be accepted in part of the regions. However the research did not find any significant negative relationship between the oil importing countries in 2010s which leads to a rejection of H4 claiming that the oil importing countries have negative relationship between the oil price and the stock markets.

Results of the models have been somewhat expected with some surprises. Regressions are far from perfect in the complex environment of the global economy and the stock markets. Great numbers of different complicated aspects are affecting stock market indices all over the world making the reliable analysis harder to maintain. However the results of the regressions give reasonable guidance and good overview of the currents relationship of Brent and major stock indices in the current decade. R-squared and adjusted R-squared imply the percent of variance explained. R-squared and adjusted R-squared were relatively high in all the regressions but little weaker when examining China. The Jarque-Bera test was also conducted to measure the normality of the regression residuals. The Jarque-Bera test gave P values between 0.30-0.90 indicating that the residuals of the sample are normally distributed. Prob (F) statistics test the overall significance of the regression model. The prob (F) value is 0 in all the regressions so we can reject the null hypothesis and assume the independent variables are not purely random with respect of the dependant variable.

Expectedly The World index showed significant relationship between all the countries stock indices excluding Russia in period after price collapse in two

independent variable model. In the second multi control variable model consumer price index and industrial production index did not show significant relationship with any stock index except USA before the price collapse in the significance interval of 10%. Fx rate as control variable shows more significant relationships.

The United States is interesting country to examine the relationship between oil prices and stock index since it has recently made a shale oil revolution and become the largest oil producer in the world. However the results of both models before and after the oil price drop are similar and showing that Brent does not have significant impact on US stock markets. Instead the MSCI World index shows significant beta around 1 with significance interval of 1 % meaning that when world index increases the MSCI USA index increases somewhat similarly. This is quite obvious since the US stock markets are the largest market in the MSCI World index. Brent's nonexistent impact on US stock index is not surprising even after the United States has become biggest oil producer. This is because US economy and the stock markets are so large that oil industry's impact on it is still relatively small. In addition to that USA has the highest oil consumption in the world offsetting benefits of oil price increase for the oil exporting country.

Canada has been a large and important oil producer for a long time before shale oil production became successful. This can be seen in the results of the first two independent variable model where Brent shows significant and positive impact to stock index in Canada. The significance of the model is in the interval of 1 %. The relationship is strong and indicates that before the price collapse every 1 percent increase in Brent price increases the stock index by 0,30 % and at time period after the collapse still 0,21 %. However when the more complex model with exchange rate, consumer price index and industrial production as control variables was conducted, Brent's impact to stock market was not significant anymore. With the second model concluding multiple control variables at time before the price collapse, the beta coefficient of Brent was 0,18 and close to be significant at the interval of 10%, with p-value of 0,1071. However as the results are not significant they are disregarded. Especially after the price collapse Brent seems not to have any impact to the stock market index at all in Canada even if it is considered to be oil exporting country with relatively large oil industry.

Researcher's previous expectation on the MSCI Europe is that it should receive much spillover effects from the USA markets and should act somewhat similarly. Europe does not have large scale oil production and the research expects to find none or negative impact of oil price on stock markets. Negative relationship could stem out from the increasing costs of higher oil price experienced by the companies. Higher costs would lower the profit margins of the companies affecting negatively to stock market returns. There would not be positive impact on oil price increase as Europe lacks large scale oil production. The results of the regression considering Europe are similar to USA. Brent oil price does not have significant effect on the stock markets which is not that surprising considering the number and complexity of the catalysts impacting stock markets. Analysis considering stock market of Europe does not have industrial production included as control variable because of the lack of data.

Norway is part of MSCI Europe, but is still included in the study separately, because it has such a large oil industry compared to the small total size of Norway's economy. Norway stock index is expected to have positive relationship with the Brent price as Norway is an important oil exporting country relative to its size. It is interesting to see if the oil price collapse has increased or decreased Brent oil price impact to Norway stock index. On the basic two independent variable model oil price is significant variable both before and after the oil price collapse. On contrary to H2 the oil prices effect to Norway stock index has only increased after the oil price collapse. Every 1% rise on the oil price increased the stock index return from 0,18% before the price collapse to 0,21% after the price collapse. More complex model with control variables gave similar results implying Brent oil price has significant positive impact on Norway stock exchange and it has only increased after the price collapse with beta coefficient of almost same 0,18 before the price collapse and 0,20 after. We can reject the H2 in the case of Norway and state that according to the research in time after the oil price collapse the importance of oil price to MSCI Norway stock index returns has only increased. On the other hand H1 and H3 can be accepted as oil price indeed have positive impact to Norway's stock markets.

China stock markets are tricky to examine as they are known to have large volatility. Volatility stems from China stock market being younger and not as

established stock market as in western economies and it is often based on the factors of behavioral finance. China is also important oil producer but at the same time it has also generally large economy and the stock markets, which similarly than in USA should weaken the impact of the oil price changes on the stock markets. Both models with and without the control variables gives rather surprising results at the time before oil price collapse, stating significant relationship between Brent price and shanghai A share index in the significance interval of 5 %. The positive impact of oil price to stock market is strong with 1 % increase in oil price leading to the returns of around 0,35% in Chinese stock markets. As expected the MSCI world index relationship with Chinese stock markets is weaker than examining most other regions but still significant with 5 % interval and with beta coefficient of only 0,49. Also weak adjusted R-squared of 0,32 before the price collapse stands out in comparison with other regions. The weak R-squared indicates that the model does not explain the relationship as completely as in analysis concentrating on other regions. These results might be little questionable and has to be interpret with some suspicion, especially because at the time after the price collapse of 2014-2015 the Brent price does not have significant relationship with the stock index anymore. After the price collapse the beta coefficient is around zero and not significant, but the R-squared is larger at 0,52. Also at the time after price collapse the Chinese stock index has stronger relationship with world index with significant beta coefficient of 1.06 in examination with control variables. The results vary from each other greatly which is surprising. Surprising results of the regression might be explained by the difficult attributes of the Chinese stock markets and high stock index volatility in China at the time of analysis. Nonetheless the results are interesting.

Russia is another important oil exporter which oil industry is relatively big compared to size of its economy and stock markets. It is the third largest oil producer in the world after USA and Saudi Arabia. Russia's stock market is expected to be slightly more separated from the global stock markets than markets in western cultures. This can be seen in the second period after the oil price collapse when the Micex 10 has less relationship with world index. Regression results show that before the price collapse, the Brent price has significant positive relationship with the Micex 10 index. When multiple control variables are added

the results expectedly weaken but are still significant. When the Brent price increase 1 % the Micex 10 increases 0,5 % in simpler two independent variable model and 0,32 % with the more complicated model concluding many control variables before the price collapse. As expected the R-squared increase from 0,41 to 0,52 with more complicated model meaning it explains more of the relationship. After the oil price collapse the Brent positive relationship is weakened and is significant only in simpler model. With the multiple control variable model Brent price impact on Micex 10 is not significant anymore, implying that oil price has weaker impact on stock markets on lower price levels in Russia. According to this H2 could be accepted in case with Russia.

All in all the results shows that countries with relatively big oil industry compared to economy and stock markets have tendency to have positive relationship with the Brent prices but not in every case. Larger regions USA and Europe with larger economies and stock markets did not have any relationship between oil price and stock markets on 2010's excluding China before the oil collapse.

6.5. Comparing results to previous literature

According to the Sadorsky (1999) oil price has impact to the stock markets but stock markets do not have impact on oil prices. On the paper the stock market impact on oil prices are not discussed, however the regression showed similar results on oil price having an impact on stock market still in 2010s. Sadorsky's estimated results stated that shocks of oil price depress real stock returns. In contrary this research finds only partial positive impact as only some of the regions stock markets have significant positive relationship with oil prices. The countries having positive relationship between oil price and stock markets were all oil exporting countries with relatively big oil industry compared to the size of total economy. Only exception was China which had also positive relationship before the oil price collapse.

Park and Ratti (2008) claimed that the oil prices have negative effect on oil importing countries and positive effect on oil exporting countries. Research agrees partly with Park and Ratti, also finding positive relationships examining part of

the oil exporting countries. On the other hand as said earlier the paper does not find any significant negative relationship between oil prices and stock markets in oil importing regions. Park and Ratti found a significant negative relationship on all European countries when allowance had been made on USA spillover effects when this paper does not find any significant relationship on European region. On USA the results were in line since both Park and Ratti nor this paper found any relationship between Brent and stock market.

Pescatoris (2008) found that the oil price only occasionally had impact to stock price levels and the relationship was weak. His sample discovered that no correlation exist with confidence level of 95%. Results of the regression on MSCI USA are in line with Pescatoris (2008) results suggesting that oil price did not have significant relationship with S&P 500 on confidence level of 95%. This paper did not find any kind of significant relationship on confidence level of 10% either in 2010s even when the United States has become the largest oil producer in the world due to shale oil production.

The regression results examining China disagrees with Rong-Gang Cong, Yi-Ming Wei, Jian-Lin Jiao and Ying Fan (2008) in first timeframe before the oil price collapse as this paper on contrary to Rong-Gang Cong et al. finds oil price having significant positive impact on stock markets. However after the price collapse the results are similar indicating that relationship between oil price and China stock market is not significant. However before the price collapse regression gave surprising results of strong significant relationship on confidence level of 5% disagreeing with Rong-Gang Cong et. al. The results might be affected by behavioral characteristics of the Chinese markets and high volatility caused by the negative performance of the Chinese economy and the stock markets at the time of study. Nevertheless the results are still interesting.

Jiménez-Rodríguez (2013) finds also that oil importing countries have negative relationship between oil price and stock markets which is not found in 2010s examination in this thesis. The results of this research suggest that Brent price do not have any significant impact on neither Europe nor USA stock markets stating the regions have similar response to oil prices. Jimenez-Rodriguez on contrary claims that the negative impact is not only significant but also stronger in Europe

than in USA. Jiménez-Rodríguez also states that impact of oil prices to stock markets are larger in stable market environment, which however is not particularly examined in this study.

Similar results of relationship between oil price and stock markets being dependant on if country is oil exporter or oil importer have been previously found by Wang, Wu and Yang (2013). Also similar results on the magnitude of oil price effect to stock market being dependent on the importance of oil to the country. Countries which oil industries have known to be especially important for the economy in this research are Norway, Russia and Canada and they showed also most significant positive relationship with the oil prices.

All in all many previous literature results were quite similar with the results of this thesis even if the paper did not find any significant negative relationship between oil price and oil importing countries stock markets as many previous studies did.

7. Possibilities for further research

The strength of this research is comprehensive analysis made examining regions with most important oil industries and stock markets. The recent data continues and gives an added value to the previous research. The separation of timeframes on 2010s around the great oil price collapse of 2014-2015 is interesting. The paper shows how the stock markets have reacted to the drastically decreased price of oil in the new era.

Further examination could be made from different regions like for example emerging markets. Particular countries could also be examined more carefully. Also oil price impact to different industries separately would be interesting to examine.

The research could be extended by conducting the same analysis by VAR-model. It might add some value and accuracy to this research when talking about macroeconomic variables. It would be interesting to see if and how the results change if made by VAR-model. Results of this research are not meant to be perfect which is always the case in scientific regressions, many different researches has to be examined objectively to gain the best possible knowledge on the oil prices impact to stock markets. However this research gives a general overview how the situation on the relationship between the oil price and stock markets is on the recent market conditions in many of the world's most important regions.

8. Conclusion

The purpose of the study is to introduce relationship between oil price and stock markets in the 2010s comparing the timeframes before and after 2014-2015 oil price collapse. The study concentrates on analysis finding or denying correlation between the oil price and the stock markets in USA, Canada, Europe, Norway, China and Russia. It aims to explain if there is any correlation, what the possible correlation is and why it could be happening? First the theory and the previous researches were investigated widely from both emerging markets and developed markets. Secondly, the empirical research by two different kind of regression model from two different timeframes was conducted with data from 2010s.

As the oil is one of the most important commodities, many variables are affecting to its price. Oil supply and demand are probably the most crucial variables affecting the price. The oil supply shifts by technical and environmental reasons. Technical reasons affect to production costs and efficiency when the environmental to the quantities and availability. The oil is an exhaustible resource which affects to its supply and demand even after the new shale oil production has changed industry. Demand of oil is affected by the macroeconomic factors. For example GDP-increase impact positively to oil demand and raises oil price. Transportation rates are also affecting crucially to demand of oil as transportation is responsible for around half of the world's oil consume. Politics have a great influence to oil prices as well. Wars may disturb the production or supply routes, wars also raise the price indirectly because they consume high amounts of oil. Oil prices may be used as a weapon to weaken the producing or consuming countries. Geopolitical conflicts and forces seem to be greatest in the Middle East where the largest oil reserves are. OPEC has power to manipulate the oil markets to it benefit to some extent, although the power has decreased by the new drilling methods and producers in the markets.

For investigating of the oil price impact to stock markets we need to examine shares pricing. Financial ratios are used to make the comparison of companies' value easier. They compare variables to each other to represent performance. Comparison may include variables as for example share prices comparison to earnings, sales, book value, growth, dividends, liquidity, debt or operational

performance. There is also pricing models which use the relationship between risk and revenue. One of them is the CAPM-model which can be used to find how much a certain risk contained investment should profit. The investment return exceeds the risk-free revenue in the amount of risk premium. The CAPM model relies on simplified circumstances which are not viable in real markets. Other models are single index model and arbitrage pricing theory. The single index model is a simple asset pricing model to measure both the risk and the return of a stock; it has only one variable which determines the result. APT is an asset pricing model based on the idea that an asset's returns can be predicted using the relationship between that same asset and many common risk factors. Valuation models include for example dividend discount model, free cash flow model and residual earning model. Dividend discount model calculate the stock price using predicted dividend rates in future. Dividend is the only actual revenue investor will receive, so it represents the profits accurately. The models weakness is that dividends are harder to predict as further we go in time. Free cash flow model discounts the free cash flow instead of dividend. Dividend decisions and other accounting items don't affect to this model. However growing and investing companies' valuation is hard to determine by cash flow as it might be even negative. Residual earnings model valuate company by the added value to equity for each year based on the book value. All of the pricing models have their benefits and weaknesses. Several pricing models must be used to get the best results possible. Even then they are inaccurate and give only inadequate evidence of the shares real value.

The results from previous research examined were diverse. Majority of them indicate that the significant correlation between oil price and stock markets exists, even though some of the researches deny it. Pescatori's measurements of SP 500 index claims that there is no correlation between oil prices and the index. All of the examined results which found significant impact of oil price to stock markets claim that oil price shocks have negative effect to stock markets except if considering the oil producing countries or companies which have strong positive relationship. An oil shock in a stable price environment is more likely to have stronger impact on stock returns than one in a volatile price environment. The research outcome suggests that the European stock markets are more affected by the oil price than

the North American stock markets. Also the price impact for smaller countries is weaker. In emerging markets oil price beta has found to have significant effect to half of the countries stock markets and oil exchange rate coefficient to 80% of the countries stock markets, as only conditional model found no significant relationship. In China stock markets the oil price shocks do not show statistically significant impact to stock markets, which could derive from China's stock markets which are considered to be highly speculative and not correlating with macro economical changes as strongly as western markets. The results indicates also that impact of oil price shocks to variability in real stock returns in the U.S. and most other countries is greater than that of interest rate. Oil price has an effect to the stock markets. However the causal relations between oil price and stock markets are complex and vary over the time periods.

The empirical research of this thesis was conducted by two different kind of regression model from two different timeframes. The paper examines the impact of oil prices to stock markets in the 2010s, comparing and analyzing the timeframes before and after 2014-2015 oil price collapse. First the simpler two independent variable market model was conducted to find out if oil prices had any effect on stock market indices. Positive relationship was relatively strong on oil exporting countries Canada, Norway and Russia before the oil price collapse. Also China showed little surprisingly very strong and significant positive relationship before the oil price. USA and Europe do not show any relationship between oil price and stock markets. In the simpler model after the oil price collapse the impact of oil price to stock markets seems to be little smaller as only Norway and Canada shows significant positive relationship anymore. Hypothesis 1 indicating that oil price impacts stock markets can be accepted in part of the regions. Also more complicated models with control variables exchange rate, consumer price index and industrial production is conducted in effort to get more reliable and robust results. On the multiple control variable model the results are somewhat similar but little milder. In the first timeframe before the price collapse Norway China and Russia show relatively strong significant positive relationship. In more complex model the positive relationship in Canada is not significant anymore. In the timeframe after the price collapse on more complex model only Norway shows significant relationship anymore. The relationship have weakened after the price

drop resulting that the thesis hypothesis 2 on oil priced reduced impact on lower price levels can be accepted according to the study exception being Norway which has stronger relationship after the price collapse. The research could be interpreted to point towards the conclusion that oil prices impact to stock market might be slightly decreased in the recently experienced lower prices levels. Study found positive relationship between oil price and stock markets only in oil exporting countries indicating that in part of the regions hypothesis 3 on oil exporting countries having positive relationship can be accepted. However paper did not find any significant negative relationship between oil price and stock markets in oil importing countries which leads to a rejection of hypothesis 4 claiming negative relationship in oil importing countries.

9. References

- Bernanke, BS. (1983). Irreversibility, uncertainty and cyclical investment. *QJ Econ* 98(1):85–106.
- Bernanke, BS., M. Gertler & M. Watson (1997). Systematic monetary policy and the effects of oil shocks. *Brook Pap Econ Act* 1:91–157.
- Bilkadi, Zayn (1995). The Oil Weapons. *Saudi Aramco World*, January–February, pp. 20-7. University of California, Berkeley.
- Chevillon, Guilio & Giovanna Paladino (2010). Oil price dynamics and speculation: a multivariate financial approach. *Energy Economics* 32(2), 363-372.
- Chisholm, Hugh, ed. (1911). Petroleum. *Encyclopædia Britannica (11th ed.)*. Cambridge University Press.
- Coleman (2011). Explaining crude oil prices using fundamental measures. *Energy Policy. Volume 40 pages 318-324*. Department of Finance. University of Melbourne.
- Frain, John (2006). Small sample power of tests of normality when the alternative is an α -stable distribution.
- Garside, M. (2019). Grude oil production share of leading oil-producing countries 2018 [online].
<https://www.statista.com/statistics/236605/share-of-global-crude-oil-production-of-the-top-15-oil-producing-countries/>
- Gevorkyan, Arkady & Willi Semler (2016). Oil price, overleveraging and shakeout in the shale energy sector — Game changers in the oil industry. *Economic Modelling Volume 54, April 2016, Pages 244-259*
- Glen Arnold (2005). Corporate financial management. *Financial times professional limited. Fourth edition. p.354*

- Hamilton, James D. (2008). Understanding crude oil prices. *University of California Energy Institute. Energy Journal*.
- Hansen , Petter, Vegard, Lars, Lindholt (2010). Statistical review of world energy. BP.
- Hansen, Petter, Vegard, Lars, Lindholt (2008). The market power of OPEC 1973-2001. *Applied economics* 40 (22) 2939-2959
- Huang, Roger D., Ronald W. Masulis, Hans R. Stoll (1996). Energy Shocks and Financial markets. *Journal of Futures Markets, Vol. 16, No. 1, pp. 1-27, 1996*
- Jiménez-Rodríguez, Rebeca (2014). Oil price shocks and stock markets: testing for non-linearity. *Empirical Economics* 48(3).
- Kaufman, Robert K., Stephane, Dee, Audrey, Gasteuil, Michael, Mann (2008). Oil prices: the role of refinery utilization, futures markets and non linearities. *Energy Economics* 30, 2609-2622.
- Kilian L. (2008). A comparison of the effects of exogenous oil supply shocks on output and inflation in the G7 countries. *Eur Econ Assoc* 6(1):78–121
- Nandha & Faff (2008). Does oil move equity prices? *Energy economics* 2008 vol.30, issue 3, 986-997
- Narayan, Gupta (2014). Has oil prices predicted stock returns for over a century? *Energy economics, Volume 48*.
- Park J., RA. Ratti (2008). Oil price shocks and stock markets in the U.S. and 13 European countries. *Energy Economics*.
- Pescatori, Beth Mowry (2008). Do Oil Prices Directly Affect the Stock Market?
- Sadorsky, Basher (2006). Oil price risk and emerginf stock markets. *Global Finance Journal, volume17, issue 2*.

- Sadorsky, Perry (1999). Oil price shocks and stock market activity. *Energy Economics, Elsevier, vol. 21(5), pages 449-469, October.*
- Sadorsky, Perry (2001). Risk factors in stock returns of Canadian oil and gas companies. *Energy Economics, 2001, vol. 23, issue 1, 17-28*
- Simmons, Matthew R. (2005). *Twilight in the desert – The coming Saudi oil shock and the world economy.* New Jersey: John Wiley & Sons.
- Weiner, Robert J. (2005). Speculation in international crises: report from the gulf. *Journal of international business studies 36 (5) 576-587.*
- Wooldridge (2006). *Introductory Econometrics: A Modern Approach. 3rd Edition*
- Wang, Wu, Yang (2013). Oil price shocks and stock market activities: Evidence from oil-importing and oil-exporting countries. *Journal of comparative economics, Volume 41, Issue 4.*

Appendix 1. Correlation matrices

Correlation matrices with p-values for all the variables used in the study. Correlation matrices are presented before and after 2014 oil price collapse separately for each country.

Before price collapse:

United States

Correlation Probability	USA	BRENT	WORLD	US_CPI	US_IPI
USA	1.000000 ----				
BRENT	0.573503 0.0000	1.000000 ----			
WORLD	0.935077 0.0000	0.623100 0.0000	1.000000 ----		
US_CPI	0.268056 0.0500	0.579325 0.0000	0.262377 0.0553	1.000000 ----	
US_IPI	-0.347960 0.0099	-0.153434 0.2680	-0.365236 0.0066	-0.160406 0.2466	1.000000 ----

Europe

Correlation Probability	EUROPE	BRENT	WORLD	CH_FX	EUR_CPI	CH_IPI
EUROPE	1.000000 ----					
BRENT	0.564584 0.0000	1.000000 ----				
WORLD	0.921124 0.0000	0.623100 0.0000	1.000000 ----			
CH_FX	-0.193630 0.1606	-0.126619 0.3616	-0.165853 0.2307	1.000000 ----		
EUR_CPI	-0.058860 0.6725	0.120965 0.3836	-0.079425 0.5681	0.241626 0.0784	1.000000 ----	
CH_IPI	0.193375 0.1612	0.114486 0.4098	0.178108 0.1976	-0.055716 0.6890	-0.065013 0.6405	1.000000 ----

China

Correlation Probability	CHINA	BRENT	WORLD	CH_FX	CH_CPI	CH_IPI
CHINA	1.000000 ----					
BRENT	0.550436 0.0000	1.000000 ----				
WORLD	0.553671 0.0000	0.623100 0.0000	1.000000 ----			
CH_FX	-0.191280 0.1659	-0.126619 0.3616	-0.165853 0.2307	1.000000 ----		
CH_CPI	-0.055319 0.6911	0.104923 0.4502	-0.150209 0.2783	-0.051328 0.7124	1.000000 ----	
CH_IPI	0.074852 0.5906	0.114486 0.4098	0.178108 0.1976	-0.055716 0.6890	-0.194735 0.1582	1.000000 ----

Canada

Correlation Probability	CANADA	BRENT	WORLD	CAN_FX	CAN_CPI	CAN_IPI
CANADA	1.000000 ----					
BRENT	0.733105 0.0000	1.000000 ----				
WORLD	0.892475 0.0000	0.623100 0.0000	1.000000 ----			
CAN_FX	-0.683243 0.0000	-0.708278 0.0000	-0.648588 0.0000	1.000000 ----		
CAN_CPI	0.182926 0.1855	0.288467 0.0344	0.075149 0.5891	-0.026808 0.8474	1.000000 ----	
CAN_IPI	0.347092 0.0101	0.566231 0.0000	0.199822 0.1474	-0.141904 0.3060	0.521849 0.0001	1.000000 ----

Norway

Correlation Probability	NORWAY	BRENT	WORLD	NOR_FX	NOR_CPI	NOR_IPI
NORWAY	1.000000 ----					
BRENT	0.680792 0.0000	1.000000 ----				
WORLD	0.858818 0.0000	0.623100 0.0000	1.000000 ----			
NOR_FX	-0.377586 0.0049	-0.479040 0.0002	-0.396719 0.0030	1.000000 ----		
NOR_CPI	0.196576 0.1543	0.194392 0.1590	0.177165 0.2000	-0.118063 0.3952	1.000000 ----	
NOR_IPI	0.062810 0.6518	0.010511 0.9399	-0.000447 0.9974	0.022462 0.8719	0.048852 0.7257	1.000000 ----

Russia

Correlation Probability	RUSSIA	BRENT	WORLD	RUS_FX	RUS_CPI	RUS_IPI
RUSSIA	1.000000 ----					
BRENT	0.693532 0.0000	1.000000 ----				
WORLD	0.775081 0.0000	0.623100 0.0000	1.000000 ----			
RUS_FX	-0.736393 0.0000	-0.581252 0.0000	-0.595162 0.0000	1.000000 ----		
RUS_CPI	0.251454 0.0666	0.156495 0.2584	0.245315 0.0738	-0.139556 0.3142	1.000000 ----	
RUS_IPI	-0.242803 0.0769	-0.150626 0.2770	-0.239278 0.0814	0.087932 0.5272	-0.210206 0.1271	1.000000 ----

After the price collapse:

United States

Correlation Probability	USA	BRENT	WORLD	US_CPI	US_IPI
USA	1.000000 ----				
BRENT	0.344401 0.0237	1.000000 ----			
WORLD	0.947156 0.0000	0.405115 0.0070	1.000000 ----		
US_CPI	0.213342 0.1696	0.491794 0.0008	0.227355 0.1426	1.000000 ----	
US_IPI	-0.342088 0.0247	-0.287996 0.0611	-0.369575 0.0147	-0.172222 0.2694	1.000000 ----

Europe

Correlation Probability	EUROPE	BRENT	WORLD	EUR_FX	EUR_CPI
EUROPE	1.000000 ----				
BRENT	0.429091 0.0041	1.000000 ----			
WORLD	0.880251 0.0000	0.405115 0.0070	1.000000 ----		
EUR_FX	-0.424420 0.0046	-0.096514 0.5381	-0.183617 0.2385	1.000000 ----	
EUR_CPI	0.127153 0.4165	0.382296 0.0114	0.191261 0.2192	0.224147 0.1485	1.000000 ----

China

Correlation Probability	CHINA	BRENT	WORLD	CNY_FX	CH_CPI	CH_IPI
CHINA	1.000000 ----					
BRENT	0.282688 0.0662	1.000000 ----				
WORLD	0.664300 0.0000	0.405115 0.0070	1.000000 ----			
CNY_FX	-0.543171 0.0002	-0.218771 0.1587	-0.298572 0.0518	1.000000 ----		
CH_CPI	-0.177585 0.2546	-0.111196 0.4778	-0.194188 0.2121	0.035712 0.8202	1.000000 ----	
CH_IPI	0.083376 0.5950	-0.182015 0.2427	-0.009860 0.9500	-0.061508 0.6952	0.135136 0.3876	1.000000 ----

Canada

Correlation Probability	CANADA	BRENT	WORLD	CAN_FX	CAN_CPI	CAN_IPI
CANADA	1.000000 ----					
BRENT	0.615827 0.0000	1.000000 ----				
WORLD	0.698315 0.0000	0.405115 0.0070	1.000000 ----			
CAN_FX	-0.597738 0.0000	-0.539076 0.0002	-0.381303 0.0116	1.000000 ----		
CAN_CPI	0.235392 0.1286	0.393831 0.0090	0.100315 0.5221	-0.213360 0.1695	1.000000 ----	
CAN_IPI	-0.011002 0.9442	0.266629 0.0839	-0.073566 0.6392	0.503690 0.0006	0.326419 0.0327	1.000000 ----

Norway

Correlation Probability	NORWAY	BRENT	WORLD	NOR_FX	NOR_CPI	NOR_IPI
NORWAY	1.000000 ----					
BRENT	0.686855 0.0000	1.000000 ----				
WORLD	0.777596 0.0000	0.405115 0.0070	1.000000 ----			
NOR_FX	-0.360741 0.0175	-0.316750 0.0385	-0.322404 0.0350	1.000000 ----		
NOR_CPI	0.000822 0.9958	-0.037916 0.8093	0.024419 0.8765	-0.005631 0.9714	1.000000 ----	
NOR_IPI	-0.024688 0.8751	0.048405 0.7579	-0.042571 0.7863	-0.068429 0.6628	0.136609 0.3824	1.000000 ----

Russia

Correlation Probability	RUSSIA	BRENT	WORLD	RUS_FX	RUS_CPI	RUS_IPI
RUSSIA	1.000000 ----					
BRENT	0.540429 0.0002	1.000000 ----				
WORLD	0.625430 0.0000	0.405115 0.0070	1.000000 ----			
RUS_FX	-0.836202 0.0000	-0.485580 0.0010	-0.572502 0.0001	1.000000 ----		
RUS_CPI	-0.057180 0.7157	-0.200352 0.1977	-0.186414 0.2313	0.035221 0.8226	1.000000 ----	
RUS_IPI	0.094271 0.5476	0.084116 0.5918	0.090475 0.5639	-0.120353 0.4420	-0.282127 0.0668	1.000000 ----