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The Oil Price and the Impact of Geopolitical Events and the VIX-index

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Abstract

The spring of 2011 unrest grew in the Middle East and North Africa, and as a result we saw a surge in oil prices. This essay conducts an evaluation on if these kinds of geopolitical events within the OPEC have affected the oil price in the past in the same way. As a contrary variable we have also assessed if the VIX-index is a good indicator of decreasing oil prices. We have used an approach where we compare Average Absolute Returns between periods of geopolitical events and the entire time period, and a linear regression study when looking at the affects of the VIX-index. We have selected a time period stretching from 1990:01.02 to 2009:12:31 and the data used is daily spot prices and quotes. Our results suggested that the geopolitical events do have a positive impact on the oil price, however this cannot be confirmed because of weak significance. The impact of the VIX-index cannot either be confirmed because of low significance and nor could sign of influence or correlation be found.

Keywords: Oil price, OPEC, VIX-index, Geopolitical events, Regression

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1. Introduction

Crude oil, the most widely traded commodity, has been the main source of energy the last fifty years and is expected to remain so for the near future.

Crude oil is mainly used for transportation fuel and is a part of the production line in most manufactured goods at some stage, whether it is production, raw material or distribution. Because of its intricate use all over the world and within almost all sectors the importance of consistent supplies and relatively stable prices is crucial for the global economy at macro and micro level. Many government GDPs are heavily linked to the oil price and the power, motor and petrochemical industries are heavily dependent on the dynamics of it (Downey, 2009).

Recent years, oil prices have surged back and forth from between US\$20-\$30 in the beginning of the decade to spikes up to \$150. The average crude oil price for the recent decade has more than doubled since the 1990s and oil price fluctuations are much greater. This increase in the oil price indicates scarcity of oil and a supply side, which cannot match the demand side, and is due because of the large growth in the emerging market economies and the developing countries. Continuing growth in these regions and lower supplies of oil will definitely lead to higher oil prices which, depending on different scenarios of the rate of depletion of oil, policy settings and adaption by industries to the new market can cause disruption in the global economy growth and especially for regions with oil intensive industries (IMF, 2011).

The increased oil price will directly create a relocation of income between oil importing countries and oil exporters generating increased capital flow reducing the real interest rates. Production costs will rise in manufacturing goods and services but also other major industries will be affected by mainly higher transportation costs. All of these factors will affect the growth of the global GDP and the inflation rate at a certain level depending on policy frameworks and development of sustainable alternatives (IMF, 2000).

The uneven distribution of the crude oil has put approximately 80 % of the world's remaining oil in twenty countries and most of that oil is located in the Middle East and in the hands of the Organization of Petroleum Exporting Countries (OPEC). The Worldwide Governance Indicators (WGI)¹ measured by the World Bank show six different indicators concerning governance and among these the majority of the OPEC members average in the lower percentile. In comparison with the Organization for Economic Co-operation and Development (OECD) region average, most of the OPEC members are drastically lower ranked and extremely notably when it comes to Regulatory Quality and Voice and Accountability, and a chart of this can be found in the appendix. These facts strongly points out that the OPEC is subjected to countries which are more or less controlled by small group of people, maintaining low grade of freedom, implementing bad policy and exposed to widespread corruption. These features have also been referred to as the signs of the oil curse and it explains why most of the members are ruled by authoritarian and strongly ideologically or religiously extremists with totalitarian governments (Downey 2009, p.67).

In the beginning of the year of 2011 a wave of unrest spread through the Middle East and North Africa, named the “Arab Spring”, causing demonstrations and protests as response to the corrupt and authoritarian regimes. As of this, worries began to grow that this instability could affect the major oil-exporting countries in region and disrupting the flow of oil from the region. Protest spread to Libya, an OPEC member where there still is an on-going revolution, and oil prices started to soar because of shortage of production occurring but mainly because of further worries on how the unrest in the region would spread (“Unrest in the Middle East”, 2011, “The Price of Fear”, 2011). These events show the vulnerability and the big influence the region, and specifically the OPEC, have on the oil price, and disruptions of this sort in this region has been a recurring issue the last decades.

The latest conflicts in the Middle East and North Africa led to increased oil price and it could be rational to assume that other types of conflicts and events the last decades in the region could have had the same or type of effect (Downey 2009, p.23).

¹ The WGI measures six broad dimension of governance: Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Rule of Law and Control of Corruption.

By studying the impact of geopolitical events within the OPEC from January 1990 to December 2009 we will examine if there is a short-term relationship between the crude oil price and political instability within the OPEC region. Since the latest crisis in the region has led to increased oil price we will assume that the conclusion of the essay will be the same. We will test this correlation by comparing the Average Absolute Return during event days to all days during the time period, a method used by Summer et al (1989). Further, a z-test will be conducted to try to substantiate a potential difference.

Since the event study will be focusing on instability on local level, within the OPEC, we will as well look at the short-term impact of the VIX- index on the crude oil price, which can be considered as a more global view of uncertainty and volatility. We will opt to regress the VIX time-series data, which will represent the same period as the event study, and will be using an econometric approach looking at daily spot prices to be able to do an unbiased comparison between the two different perspectives. As global economic instability will lead to a decline in global demand (IMF, 2011), we will assume that high levels of VIX-index will lead to decreased oil price. As an interesting comparison, and to construct a further perspective, we will also conduct tests on lower levels of the VIX-index as well the entire data by regressing them as well.

Our results show that the oil price return tend to increase during the time period of the geopolitical events, however the standard deviation is extremely high and a statistically significant difference from the entire time span can not be proved. The impact of the VIX-index could not either be verified because of weakness in the model and low significance levels.

The remaining sections of the paper are structured as follows. The following two sections will summarize previous studies and the background of crude oil and the OPEC. The theory segment will then be introduced in section four and then subsequently section five, the methodology section, presenting the hypotheses, data description and the tests. Then the results and conclusions will be presented in section six and seven and after that the references and appendix sections.

2. Previous studies

Summers et al (1989) analyses if certain unexpected events, such as macroeconomic, non-economic and domestic political news can affect a fraction of stock price movements in a significant way. They use a vector auto regression model but also study direct stock market reaction to events and conclude that significant stock movements cannot be explained by using readily available measures of new information.

Previous studies concerning the OPEC region and events, has primarily focused on OPEC meetings, scheduled and unscheduled. Draper's article (1984) takes a look into the future market of heating oil and analyses the return during OPEC meetings, pre- and post-event. He values the market model by regressing spot oil price returns against a commodity index. The tests show a pattern of positive returns prior to scheduled meetings and negative returns afterwards which can be explained by market expectations prior to the meetings and later, the outcome of it. The "extra meetings", though small trends, showed insufficient significance to prove any strong conclusion, largely because of a small sample.

Xiaowen Lin et al (2009) has made similar approach as Drake (1984) using the same methodology but looking at crude oil price instead. The article investigates the magnitude OPEC announcements has on several different kinds of crudes to see whether there a different reactions and behavior within the diverse crude oils. They conclude that the oil price do react to the news somewhat but not as direct cause. A greater factor seems to be the context in which the announcements are made such as existing price range and market condition.

Kesicki's (2009) article on oil price surges since 1970 describes the different factors behind the pricing of oil now and then. Despite geopolitical events and OPEC influence during the period, the main influence and reason in behind increased oil prices is thought to be global economic growth increasing demand and low levels of spare capacity by the producers, causing lower supply buffers.

3. Background

3.1 Crude oil

In “Oil 101”, Downey (2009) explains that the use oil was first commercially used in the mid 19th century for the use of kerosene as a substitute for whale oil as lamp fuel. Hence this discovery, distillation of oil was discovered and the fundamental of the process is still being used, heating oil and using the different condensate separately. In the beginning of the 20th century the automobile industry started flourishing and the demand for gasoline increased and during World War I the British navy began the usage of residual oil, the more inexpensive heavy oil product, in its military ships. The age of crude oil had began and during the second World War oil was used widely in the military machinery, ocean-going shipping and powered flight and it was now mainly used for transportation since lamp oil was replaced with the electric light bulb. Vast networks of roads were rapidly being built with the of cheap oil products such as Bitumen and this enabled further the expansion for the automobile industry and today 64 % of the global crude oil consumption is used for transportation.

The global oil price was until the seventies controlled by the TRC² and as a regulator they indirectly controlled most of the oil production outside the USA, which was carried out by seven major Oil companies called the Seven Sisters³ in concession with the domestic state oil organizations abroad. The posted oil price in each country was adjusted by the TRC via netback pricing which meant that the posted price was linked to the US Gulf Coast price and adjusted for freight cost (Downey 2009).

1960 the Organization of Petroleum Exporting Countries (OPEC) was formed as a counterpart against the TRC and when US oil production peaked 1970 the TRC lost their ability to manage oil prices by adding or supplying oil into the market to the OPEC. Power was now in the hands of the OPEC members and this was to be witnessed when the first big oil crisis hit the world 1973.

² Texas Railroad Commission, US state agency, which controlled the spare capacity of CO and sat the global oil prices.

³ The Seven Sisters were: Standard Oil Company of New Jersey(now ExxonMobil), Standard.

In response of the Yom Kippur War⁴ the US military sent military supplies to Israel, which was seen as a provocative by Arab nations within the OPEC. As a result the Arab OPEC members cut the global crude oil supply by 5-10 % overnight and consumer panic hit the oil market. In the midst of the crisis the International Energy Agency (IEA) was formed via the OECD to manage stockpiles of crude oil within the developed nations in case of similar oil shock scenarios.

A second oil shock followed in the joint between the 1970s and 1980s caused by various occurrences in the Middle East and the oil price soared. Due to the great increase in oil prices, demand destruction occurred creating incentive for use of lighter and less powerful automobiles and more advanced engine technology ensuing great efficiency gains. The prices later plunged mainly because of too much increase in oil production by several OPEC members; an excess oil production the market did not need.

Downey (2009) further writes that more transparent pricing arose with the introduction of trading within future exchanges. In the mid 1980s most of the crude oil was traded within the two biggest exchanges; the New York Mercantile Exchange (NYMEX) and the International Petroleum Exchange (IPE), which was later acquired by the Intercontinental Exchange (ICE). Oil was now priced using crude oil formula pricing, prices set by the closing of each business day, and is still being used today. The crude oil producers trade on an open and free market with different crude oil benchmarks or a combination of them. The price of crude oil is set to a benchmark oil price such as the ICE Brent⁵ Crude Oil futures weighted average and then adjusted for the difference.

Linking of oil prices to different kinds of specific benchmarks help traders to categorize oil easier and has made the oil market more competitive and liquid. The recent decades oil prices have remained relatively low mainly because OPECs spare capacity, but in the beginning of the new century demand caught with the glut and the surplus capacity as the shock absorbing capacity was gone.

⁴ Arab-Israeli war 1973 fought from October 6 to 25 lead by Egypt and Syria.

⁵ ICE Brent crude oil is the second most liquid market for CO after the NYMEX Brent crude oil. It is a blend of twenty separate oil fields in the North Sea.

Not having enough excess has a tendency to building up a premium into the oil price, increasing volatility resulting and slower respond to short term disruptions, but mainly a sign of producers not being able to jack up production in respond to high prices.

Oil, being the most traded commodity in the world with immense influence to the modern way of life has a limited timespan as an energy source and discussions of peak oil⁶ is a commonly linked when discoursing the topic. Global reserves data are difficult to estimate and often unreliable but it has been concluded that the peak of oil discovery was in the early 1960s and a common statement by most of the biggest publications is that the global proven reserves are as big as the entire consumption since the mid 19th century of which 90 % was consumed since 1960. Numerous models have been applied to predict the event of global peak oil and a consensus opinion is that it will or has appeared between 2005 and 2020.

3.2 The OPEC

The recent years OPEC⁷ has produced about 40 % of the global crude oil production and is the biggest influence in the pricing of it. Since the founding of the organization 1960 as an opposite to TRC, it has taken the responsibility to control the production rate of its members. They are mainly crude oil producers and not very big in refining largely since it has not been a very lucrative business, but also because the huge investments being necessary require stabile physical locations that are secure.

The quota of oil production is decided among the members based on reserve estimates and population sizes of which reserve estimates have been a ground to amplify and inflate earlier estimations. The issue was enlightened in the mid 1980s in the so-called quota wars and it was ignited when Kuwait increased their proven reserve estimates by 40 %.

⁶ The peak oil theory describes how the rate of oil production decreases after maximum rate and moving towards total decline in similarity to a bell curve.

⁷ The cartel nations are: Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, UAE and Venezuela. Sudan has expressed interest in joining the organization.

Thus, to remain status quo and retaining the quotas, all other major OPEC members then began to report larger proven reserves without stating findings of any additional oil. Most of the nations within the OPEC are highly oil revenue dependent and have their geopolitical power based on oil production capacity, consequently the incentives for having vague and ambiguous estimates are high.

3.3 The VIX-index

The Chicago Board Options Exchange Market Volatility index, often referred to as the VIX, is an increasingly popular barometer of investor fear and market volatility (Conway 2011, Kearns and Vannucci, 2011). The VIX measures the implied volatility in trading of the S&P 500 as an index computed in real-time every trading day.

Whaley (2009) describes how the VIX is a forward-looking index in the sense that it characterizes the market volatility expected in the future market over the next thirty calendar days.

It measures how much the market is willing to pay for options, especially “put” options, which are expected that the asset will drop.

It was introduced 1993 and was then deriving from the S&P 100 index option prices, the most traded index at the time. The usefulness of the VIX, and any other volatility index, is strongly based on a deep and active index option market, which is why in 2003 the index shifted to using the S&P 500 as the underlying market instead of the previous, S&P 100. The index can be seen as an indicator for increased hedging against a drop in the stock market, and the more insurance that is demanded, the higher the price and this is what the VIX explains - the demand for, or the price of, hedging against the S&P 500.

Further, Whaley (2009) explains how the VIX-index does not have a clear-cut level, which explains low or high levels of volatility, but the general opinion is that levels above thirty are associated with high volatility, while levels below twenty are considered linked to a more steady markets.

The VIX is often used as a contrarian indicator, where an increased VIX often is a sign of a more bearish market and vice versa which easily gives a basic sense of what direction the market is moving toward.

4. Theory

4.1 Demand, Supply and the Pricing of Oil

The pricing of oil is like most other products mainly determined by the supply and demand. The demand is based on factors such as innovations, expectations, state of the world market such as global growth and strongly the emerging economies like China and India. The supply side determined by production and refining capacities, oil discoveries, geopolitical instability, political influence and speculation. All of these factors are weighed in when the market is setting the price of oil and it tells us why the price of oil changes (Kesicki, 2010).

Varian (2007, pp.207) states a simplified model for the pricing of depletable resources such as crude oil where the price level is determined by the rate of interest and the demand side of the market:

$$\text{Equation 1} \quad T = \frac{S}{D}$$

D denotes the world demand in barrels a year and S is the total world supply in barrels and T represents years of crude oil left. We assume that when all oil has been consumed another sort of alternative energy must be used as a replacement; we name it C , which has a cost of C dollars per barrel and is a perfect substitute to oil. T years from now when all oil is about to be depleted the price of oil must be the same as C dollars per barrel, the price of its perfect substitute, C . This gives us the price of oil today through this equation:

$$\text{Equation 2} \quad P_0(1+r)^T = C \quad \text{or} \quad P_0 = \frac{C}{(1+r)^T}$$

This explains that the price of oil today, P_0 , must grow at the rate over the next T years to be the same as C . Having this function we can now assume that discoveries of large oil fields would increase T , which would accordingly decrease P_0 . And increased usage of oil would decrease T and therefore yield into higher P_0 .

4.2 The Effective Market Hypothesis

The Efficient Market Hypothesis, a theory summarized by Fama (1969), argues that a market is truly efficient when prices reflect all known market information. Securities quickly incorporate news and events into the price thus; implements to predict prices by using different analysis methods are no more successful than randomly selecting a portfolio of securities with comparable risk. The efficient market hypothesis is closely related to the theory of random walk that suggests that prices are random since news is in effect. Today's price change reflects the news today and therefore the price change tomorrow is merely subject to tomorrow's news, which by definition is random and unpredictable. The efficient market hypothesis does not imply that that all market is always efficient but by different scales, and the grade of effectiveness that appear is so because professionals are there to quickly uncover the news to reflect a truthful and unbiased price (Malkiel, 2003).

4.3 Classical Linear Regression Model

4.3.1 The Econometric Model

The econometric model is described by Joakim Westerlund (2005) and Brooks (2008) as a model explaining how a certain variable, y , is affected by a systematic and a random disturbance term. The systemic, explaining variable, $f(x)$ affects the y term while the disturbance term, e , illustrates the behaviour that cannot be explained by the $f(x)$ function. This regression model equation can then, after modification, be written as follow:

Equation 3
$$y_i = \beta_1 + \beta_2 x + e_i$$

The model is stochastic, meaning that the random disturbance obstructs the forming of a graphically straight line. The values of the regression parameters, β_1 and β_2 , are unknown and only estimated and since the error term is random it can be used to try to explain risk or chance of having estimates that are close to the true parameters we are trying to estimate.

The econometric model we now have helps us to transform the information of a data sample to estimations of the exact parameters.

4.3.2 The Assumptions Underlying the Linear Regression Model

The linear regression model can only be completed if six different assumptions regarding the data are true. Violated assumptions lead incorrect results based on the model and the data, which then gives false deduction. The estimates, β_1 and β_2 , gives us the intercept and slope, and a standard approach to approximate these is through the ordinary least square estimator (OLS). The OLS-estimator minimizes the sum of the squared residuals, which helps the regression model to get the most out of the data. But to make sure that the OLS-estimator is optimal, for estimating the parameters, six assumptions regarding the regression and data must be true (Brooks 2008, pp. 130)

The assumption are as following:

1. *The regression model must be stated as Equation 3*

This first assumption states that the true model that describes the underlying population is linear and can be constructed as Equation 3.

2. *The average value of the errors is zero.*

$$E(e_i) = 0$$

The second assumption tells us that that the true regression function looks like: $E(y|x) = \beta_1 + \beta_2x$ and if a constant term is included in the regression equation the assumption will not be violated. If a regression does not include a constant the average value will be non-zero, which leads to a series of complications, such as a sample average that implies that “y” describes the variation of itself better than the explanatory variables.

3. *The variance of the errors is constant.*

$$\text{Var}(e_i) = \sigma^2$$

This is also known as the assumption of homoscedasticity. If the assumption is violated the errors are considered heteroscedastic, which can cause estimates to no longer be Best Linear Unbiased Estimator (BLUE), thus no longer having the minimum variance among the group of unbiased estimators.

4. *The covariance between the error terms over time is zero.*

$$\text{Cov}(e_i, e_j) = 0 \text{ for } i \neq j$$

It is here assumed that the data sample is random and uncorrelated to one another, meaning that each observation must be considered as independent from the other ones. If the assumption is violated autocorrelation is present, which has the same effect as heteroscedastic, and the coefficient estimates derived are not BLUE which could lead to wrong inference about whether a variable is important or not in describing the variation in y .

5. *The explanatory variables, x_i , are non-stochastic.*

The fifth assumption concerns the values that the explanatory variables, x_i , can consist off, and if one of them is correlated with the error term, the OLS-estimator will be inconsistent.

6. *The disturbances are normally distributed*

$$e_i \sim N(0, \sigma^2)$$

Violating the last assumption is not as serious as the others if the size of the sample is sufficiently large. Since the average of a sample is random, the sample will congregate into the population mean, and according to the law of large numbers and the central limit theorem, and the mean can be converged to normal distribution. This means that the assumption is relatively negligible.

When the first five of these six assumptions now stated are true, we can use the Gauss-Markov theorem as verification of the quality of the OLS-estimator. When the Gauss-Markov theorem criteria are fulfilled, the OLS-estimator has the least variance among all most other estimators and is subsequently BLUE (Westerlund 2005, pp. 96).

5. Methodology

5.1 Hypothesis

First Hypothesis: Geopolitical events will have a positive impact on the oil price

Based on the recent events in the Middle East and North Africa (“Unrest in the Middle East”, 2011, “The Price of Fear”, 2011) leading to a surge of the oil price, and the World Economic Outlook by the International Monetary Fund (2011) view on the impact of geopolitical events on ditto, we expect an increase of oil prices when testing for correlation with the data within the time period. Thus, the average absolute return on event days should be significantly higher than during average days.

Second Hypothesis: Large VIX-index movements towards higher percentage quotes should have negative impact on the oil price

The VIX-index gives a measure of the implied volatility of the S&P 500 index options and can be considered an indicator of global economic health, and large spikes in the index can therefore be interpreted as decline or slowdown of global growth. According to the World Economic Outlook (IMF, 2011) and Keciki’s article on oil price surges (2009), decreased level of economic growth and development leads to depressed demand resulting into lower oil prices. Thus, a significant negative correlation should be found between VIX-index spikes and the oil price.

5.2 Data Description

Our data will stretch from 1990:01:02 to 2009:12:31 and this is due to limitations of the VIX-index data and the event data. The VIX-index was founded 1993, however calculated data is available from 1990:01:02 and to have a sample that is as large as possible we used this as a starting point. The set end date of the time span is 2009:12:31 because of the data on geopolitical events only stretches to this date.

5.2.1 Oil

The Cushing, OK WTI Spot Price FOB (Dollars per Barrel) is collected from the Energy Information Administration (EIA), which is the statistical and analytic agency within the US Department of Energy and can be considered a reliable source.

The data is the daily spot price, which is crucial when approaching a daily-based event study. The data is transformed from prices to returns to try to avoid non-stationarity, which can affect the inference. The equation used for transforming is the following:

$$\text{Equation 4} \quad r_t = 100 * \ln \left(\frac{p_t}{p_{t-1}} \right)$$

5.2.2 VIX

The data collected for the daily VIX-index was gathered through Thomson Datastream Advance, which is one of the largest financial statistical databases. The methodology for setting price of the VIX was modified in 2003 but a version of historic data with the new revised methodology was available. The VIX-index data is also transformed to return rather than the actual percentage quota, and the same formula, equation 4, is used.

As mentioned earlier in the background section, there is no distinct definition of high or low levels of the index, so we have chosen the 90th percentile of the values to represent spike values and the 10th percentile to denote low values.

5.2.3 Events

The data representing geopolitical events and conflicts is gathered from three different databases:

The Center for International Development and Conflict Management (CIDCM)

The CIDCM is a research center at the University of Maryland seeking to understand the interplay between conflict and development. The International Crisis Behavior (ICB) within the CIDCM is a project aiming to shed light on world politics. Their database on “military-security crisis” contains both quantitative and qualitative based research on interstate crisis and protracted events. This database includes thirty observations and will from here on be denoted as ICB.

The Peace Research Institute Oslo (PRIO)

PRIO is a renowned research institute situated in Oslo, Norway. Within the organization the Centre for the Study of Civil War (CSCW) conducts research on “Onset of Armed Conflict” together with the Uppsala Conflict Data Program (UCDP). The database defines a conflict as a “clash between two parties, of which at least one is a government or state, concerning government or territory”. This database includes sixteen observations and will from here on be denoted as CSCW.

The Polity IV Project

The Polity project, a collaboration between the Center for Systemic Peace (CSP) and the Center for Global Policy (CGP), conducts quantitative analysis on political regime changes and coup d'état, overthrow of governments. The project is one of the most widely used data resources for studying regime changes.

A coup d'état is defined as a forceful appropriation of the policymaking authority, by an opposition or rebels, within the country, leading to substantial change in leadership and policies. The data series include both successful and unsuccessful (attempts) coups. The Political Regime Characteristics and Transitions time-series is an event based annual dataset. It registers regime changes in all independent countries and rates the level and type of governing authority. These two data series databases include nine and thirty-five observations respectively and will from here on be denoted as POLITY: COUP and POLITY: TRANSITION.

5.3 Testing the Data, VIX

To test for correlation between our two variables, oil and VIX-index, we must first test in against the assumptions we made in the theory section. The different regression diagnostic tests examine our data to find errors in accordance to the Gaus-Markov theorem and the OLS-estimator, which are also explained in the theory section. Our linear regression model equation can be described like this:

$$\text{Equation 5} \quad y_t = a + \beta_1 V_t + e_t$$

The y_t term in equation 5 represents the dependant variable oil, and the explanatory variable VIX is represented by V_t . We will not use lags in our regression due to the theory of effective market hypothesis, which was described in the theory section.

5.3.1 Non-stationarity

When using a regression model it is important to have stationary variables to avoid having a nonsense regression that gives misleading inference. When a series of values have covariance because of the specific time observed and not the time span of the data, non-stationary can occur. The non-stationary data will affect the R^2 , DW and t-statistics and the coefficient, indicating strong significant linear correlation when it is actually can be the opposite.

To test for non-stationarity we will use the ADF-test. We test both of the variables in the model, the dependent and explaining, and conclude that a variable can be considered as stationary when the ADF-test shows that the series does not contain a unit root (Brooks 2008, pp.318)

5.3.2 Heteroscedasticity

When estimating our parameters in the regression model we proceed from that we are using the OLS-estimator, mentioned earlier in the theory section. If the sequence of the random variables has the same variance for all observations, we have homoscedasticity, which is what is assumed based on the classic linear regression model required when using the OLS-estimator. But if heteroscedasticity occurs the minimum variance among the group of unbiased estimator will be withheld and the estimates will no longer be BLUE (Westerlund 2005, pp.173).

When testing for heteroscedasticity we use the White test, which uses a variance-covariance-matrix that is robust and tests both positive and negative heteroscedasticity. The White test uses a chi-square distribution and we can only reject a homoscedasticity hypothesis if the F-value is larger than the critical F-statistic. If the random disturbance is known heteroscedastic we can instead use the Generalized Least Square estimator (GLS) that transforms the original regression model and clears the heteroscedasticity without disturbing the inference (Brooks 2008, pp.133).

5.3.3 Autocorrelation

Autocorrelation is often more common when using time-series data, which is in chronological order, such as our data. When the error terms is showing tendencies of not being completely stochastic, but having covariance separated from zero we have autocorrelation and in that way not fulfilling assumption number four in the assumptions underlying the linear regression model. The effects of autocorrelation are very much similar to those of heteroscedasticity, and with that the OLS-estimator is no longer efficient and BLUE (Westerlund 2005, pp.185).

The Autocorrelation of first order can be tested by using the Durbin-Watson test. The Durbin-Watson test equation can be written as:

$$\text{Equation 6} \quad DW = \frac{\sum_{i=2}^N (\hat{\epsilon}_i - \hat{\epsilon}_{i-1})^2}{\sum_{i=1}^N \hat{\epsilon}_i^2}$$

The DW-statistic is able to reject the hypothesis of autocorrelation when its value is near 2, above the upper-and lower DW-critical value. More simplified the equation 6 can be written as follows:

$$\text{Equation 7} \quad d \approx 2(1 - \hat{\rho})$$

However, the DW-test only examines whether uninterrupted errors are related to one another and therefore, we can use the Breusch-Godfrey test which is more general and can test for autocorrelation up to infinite order. Following equation is used for modeling the errors used for the test:

Equation 8

$$u_t = p_1 u_{t-1} + p_2 u_{t-2} + p_3 u_{t-3} + \dots + p_r u_{t-r} + v_t \quad v_t \sim N(0, \sigma_v^2)$$

The Breusch-Godfrey test follows a F-distribution and when the F-statistic value is smaller than the critical value we can reject autocorrelation. If we want to deal with the autocorrelation we can again use the GLS procedure as we mentioned in the heteroscedasticity section or the Newey-West estimator what can be used to improve the original OLS-estimator. The Newey-West estimator is similar to the White test which is conducted if the data is heteroscedastic but with a more complicated formula (Brooks 2008, pp.148).

5.3.4 Adopting the wrong functional form

If the function form for of our regression is incorrect and differing from what we are assuming the two first assumptions underlying the regression model are broken and subsequently the OLS-estimator is no longer BLUE. To test for this occurrence we can use the Regression specific error test (RESET), which is constructed to test for existence of inappropriate omission of variables and incorrect functional form. The method uses higher order of terms in an auxiliary regression and by this, we can reject the hypothesis of appropriate functional form if the t-statistic is above the critical value. If the functional form appears to be inappropriate we can choose between switching to a non-linear model, and then use a different estimator, or transform the data into logarithms (Brooks 2008, pp.174).

5.4 Testing the Data, events

When approaching the effect of geopolitical events on the oil price such as considering the events as explaining variables, and the oil price as dependent, we use the methods of Summers et al (1989). Summers et al (1989) method on examining the correlation between big news and big stock price movements can be applied by changing the asset, stocks, to oil. We choose to bias our sample by choosing series of events that are proven important and notable in within the OPEC organisation and we should therefore be able to find a result that is biased towards large price movements.

The geopolitical events should affect the future policy price expectations and thus, build in and risk premium that should affect the pricing of our asset. This type of method should be able to explain short-term price shock as a part of the “propaganda mechanism” that is mentioned by Summers et al (1989) and importance of these kind of factors. By calculating the Average Absolute Return and the Standard Deviation of the Returns during the events and then during the entire period, we should be able to find some type of correlation.

Afterwards, we will be using a Z-test, which will statistically test the results. The Z-test compares the different Average Absolute Returns and will then determine if there is a significant difference. The test statistic is assumed to have a normal distribution and known standard deviation (Körner and Wahlgren 2006). The hypotheses will be defined as followed:

Equation 9 $H_0: \text{Average Return for events} = \text{Average Return entire period}$

$H_1: \text{Average Return for events} \neq \text{Average Return entire period}$

And our z-value is calculated by using this equation:

Equation 10 $Z = \frac{M - \mu}{SE}$

We will choose the α to be 0,05 and because it is a two-tailed test the calculated z-value must be $1,96 < z\text{-value}$ or $z\text{-value} > -1,96$ to reject the null hypothesis.

6. Results

6.1 Results, VIX

6.1.1 Non-stationarity

Our ADF test show that our VIX and oil variable is stationary at all levels. This was expected since we used returns rather than the price or percentage quota, and the result is therefore in line with the OLS estimator.

Table 1

SAMPLE	ADF
VIX HIGH	-18,50***
OIL HIGH	-22,56***
VIX LOW	-13,36***
OIL LOW	-22,88***
VIX ALL	-32,12***
OIL ALL	-54,67***

These are the results for the ADF test, and *** denotes significance at 1 % level. VIX HIGH denotes the sample with only high VIX-index values and subsequently the OIL HIGH denotes the oil price during these dates. The LOW and ALL samples are segregated in the same way but represents low and all of the values.

6.1.2 Heteroscedasticity & the Functional Form

The White test shows that the all of the samples are homoscedastic and subsequently heteroscedasticity is not disturbing the BLUE efficiency. The RESET test result shows us that the model probably is correctly specified without missing variables.

Table 2

SAMPLE	White	RESET
HIGH	0,3700	0.1881*
LOW	1,7049	1.3231*
ALL	0,2427	1.0722*

Here are the results of the White and RESET test presented. The critical value for the White test is 2,7, and none of the VIX levels have F-statistic that implies non-linearity at 10 % level. * Denotes significance at 10 % level. The samples are partitioned the same way as the previous test.

6.1.3 Autocorrelation

First order autocorrelation is rejected by the Durbin-Watson test, while the more general test, Breusch-Godfrey, rejects autocorrelation of infinite order as well. These results give us a robust answer and assure us that we are not violating the OLS estimator assumptions by having any autocorrelation.

Table 3

SAMPLE	Durbin-Watson	Breusch–Godfrey
HIGH	1,94	0,2031
LOW	1,97	1.3231
ALL	2,00	6,2996

The Durbin-Watson critical values are $d_L= 1,653$ and $d_U= 1,693$ and the Breusch-Godfrey test critical value is 20.59. The samples are partitioned the same way as the previous test.

6.1.4 The Regression Model

The HIGH and LOW sample coefficients are both marginally positive which means that a VIX-index increase of one unit increases the return of the oil price by coefficient size, which we can see is not much. The ALL sample regression shows the opposite, that an increase in the VIX-index yields lower oil price return. The Adjusted R^2 describes to what extent our variable, VIX-index, explains the responding variable, and we can clearly see that our variable is very weak in explaining. We can also see that our regressions are very much insignificant thus, the coefficients cannot be interpreted as reliable.

Table 4

SAMPLE ^(observations)	C-coefficient ^(p-value)	VIX-coefficient ^(p-value)	Adj.R ²
HIGH ⁽⁵⁴⁴⁾	-0,0789 ^(0,77)	0,0119 ^(0,58)	-0,0012
LOW ⁽⁵⁴³⁾	0,3006 ^(0,37)	0,0094 ^(0,77)	-0,0016
ALL ⁽⁵⁴²⁰⁾	0,0267 ^(0,44)	-0,0024 ^(0,67)	-0,0001

The regression model is given by $y_t = a + \beta_1 V_t + e_t$ where y_t is the oil price, a is the constant coefficient, β_1 is the VIX-index coefficient, V_t is the VIX-index level and e_t is the error term. C denotes Constant. The samples are partitioned the same way as the previous test.

6.2 Result, events

6.2.1 Average Absolut Returns

The event data is presented sample-by-sample and is sorted by specific geopolitical events as well as all events bundled. We can see that the returns are generally higher during the most of the event types and also when all events are put into one single data-series. We can also see that the Standard Deviation is larger during the events in oppose the entire period and this could indicate a more volatile market during the event period as well as sign of smaller samples.

Table 5

Sample ^(observations)	Average Absolut Returns	Standard Deviation of Return
During entire period ⁽⁵⁴²⁰⁾	0,02	2,61
During all events ⁽⁹⁰⁾	0,44	3,89
Specific events:		
ICB ⁽³⁰⁾	-0,50	4,30
CSCW ⁽¹⁶⁾	0,56	2,84
POLITY: COUP ⁽⁹⁾	1,93	3,28
POLITY: TRANSITION ⁽³⁵⁾	0,10	2,35

The Average Absolut Return and Standard Deviation of Returns is presented in percentage form. The samples are separated between a sample with all of the events altogether and another with the entire period. There are also four samples representing the all the events but separated by type of event.

6.2.2 Z-test

The z-test shows us that none of the tests can reject our null hypothesis and thus there is no statistically significant difference between the event periods and the entire period.

Table 6

Sample	During all events	ICB	CSCW	POLITY: COUP	POLITY: TRANSITION.
Z-value	0,11	-0,12	0,19	0,58	0,03

The calculated z-value must be $1,96 < z\text{-value}$ or $z\text{-value} > -1,96$ to reject the null hypothesis.

7. Conclusions

The aim of this thesis was to see if geopolitical events could lead to an immediate increase in the oil price and if high levels of the VIX-index could lead to the opposite.

Our tests on all geopolitical events showed us that the return during all events (0,44) is a lot greater than during the entire period (0,02) while the standard deviation is extremely high. The z-test could not prove any statistically significant difference between the event period and the entire time span, which tells us that our first hypothesis is not possible to accept. The high standard deviations could be an indication of a small sample, but since the “entire period” sample is relatively large we can maybe assume that it is representative for the oil price in general. By that, we can deduce that the oil price in general is quite volatile in comparison with the average return, and this can possibly be another factor to why the standard deviation is larger during the event period: the market is more volatile during the event period, which causes more fluctuating prices. Another aspect that could be affecting the average return negatively could be that the events are somewhat anticipated by the market in advance. The market will then react immediately accordingly to the effective market hypothesis thus, a premium is built into the price before the actual event occurs. This could be related to the conclusion of the Drake (1984) which found that expectations before the actual events that were studied was more significant to the result than the events themselves. We can also detect big returns for the geopolitical events when classified individually, but since the sample is very little we cannot consider them significant in any way, though most of them tend to move in favour of our first hypothesis.

All of our tests on the data for our regression model gave us results that pleased our assumptions underlying the regression model, and we could therefore use the OLS method to estimate the unknown parameters. Despite of these affirmative results our regression turned out to be far from significant. The p-value for both of the coefficients and all the samples were very high and with no exception for our sample with 5420 observations.

The adjusted R^2 value is extremely low which indicates that that our fitted model is almost completely inadequate in explaining the oil price return regardless of sample. The extremely small tendency of the VIX-coefficients is even contradictory to our second hypothesis and we can with that broadly conclude that the result of our regression model is exceptionally weak and dissonant in verifying any kind of correlation between the VIX-index and the return of the oil price.

What we can determine from our result though is that the elements of the oil price are multifaceted and complex. Primarily the oil price, which is based on a depletable resource, is defined by the supply which is very much limited despite the demand and this can be confirmed by the demand and supply segment.

Another factor, which could have been misleading is the usage of the VIX-index as a global volatility index. Since the VIX measures the volatility of the S&P 500 in the US, and US only, and our assumption that it could be used as a global volatility index might be incorrect. Kesicki's (2009) claims that the oil demand lately mainly has been driven by the emerging markets and subsequently an index on the fear of the US stock market maybe is not the best indication on increased global volatility which was what we assumed could lead to a decreasing oil price. Xiaowen Lin et al (2009) resolve in their report on events that the context of which when the study is made could be more powerful than the event itself, and this statement could be a describing a further issue that was not taken into account when conducting this study.

In conclusion, our study shows us the complexity of the oil price, and its influence by geopolitical events is difficult to substantiate explicitly. The contrary study, with the usage of the VIX-index, turned out to be more problematic and challenging to outline via a regression model than expected.

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9. Appendix

Worldwide governance indicators: Researched by the World Bank (2009) from:

<http://info.worldbank.org/governance/wgi/index.asp>

(Accessed 23 august 2011)

Voice and Accountability

Country	Sources	Year	Percentile Rank (0-100)	Governance Score (-2.5 to +2.5)	Standard Error
ALGERIA	15	2009	17.5	-1.04	0.11
ECUADOR	16	2009	40.3	-0.26	0.12
IRAN	11	2009	8.1	-1.49	0.12
IRAQ	11	2009	13.7	-1.17	0.14
KUWAIT	11	2009	31.3	-0.54	0.13
LIBYA	12	2009	2.8	-1.89	0.12
NIGERIA	17	2009	24.2	-0.85	0.11
QATAR	14	2009	22.7	-0.89	0.12
SAUDI ARABIA	13	2009	3.8	-1.77	0.12
UNITED ARAB EMIRATES	11	2009	23.7	-0.87	0.13
VENEZUELA	17	2009	26.1	-0.79	0.12
OECD	N/A	2009	91.6	+1.33	N/A

Expand All

Collapse All

90th-100th Percentile

50th-75th Percentile

10th-25th Percentile

75th-90th Percentile

25th-50th Percentile

0th-10th Percentile

Regulatory Quality

Country	Sources	Year	Percentile Rank (0-100)	Governance Score (-2.5 to +2.5)	Standard Error
ALGERIA	10	2009	20.5	-0.94	0.17
ECUADOR	10	2009	6.2	-1.36	0.17
IRAN	8	2009	3.3	-1.74	0.18
IRAQ	6	2009	15.2	-1.04	0.22
KUWAIT	8	2009	55.7	+0.20	0.20
LIBYA	9	2009	17.1	-1.00	0.18
NIGERIA	11	2009	25.7	-0.70	0.16
QATAR	9	2009	71.0	+0.62	0.19
SAUDI ARABIA	8	2009	56.7	+0.22	0.20
UNITED ARAB EMIRATES	8	2009	68.6	+0.56	0.20
VENEZUELA	11	2009	3.8	-1.69	0.17
OECD	N/A	2009	90.4	+1.41	N/A

Expand All

Collapse All

90th-100th Percentile

50th-75th Percentile

10th-25th Percentile

75th-90th Percentile

25th-50th Percentile

0th-10th Percentile