LUND UNIVERSITY
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Oil Price Shocks Effect on Economic Growth

OPEC versus non-OPEC Economies

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Abstract

Title: Oil Price Shocks Effect on Economic Growth – OPEC versus non-OPEC Economies

Subject: Macroeconomics

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Purpose: The purpose of this thesis is to analyse how oil price shocks affect the economic growth in net-oil exporting countries. The aim is to conclude whether the economic growth in the Organisation of Petroleum Exporting Countries (OPEC) is more sensitive to oil price shocks than the economic growth in other exporting countries.

Method: The data used covers the years 1980 to 2008 and includes 19 (11 OPEC and 8 non-OPEC) countries' yearly real gross domestic products and annualised world oil price deflated by the all urban consumer price index (USD). In order to reject the presence of unit roots in the data, the Augmented Dickey-Fuller test and the Im, Pasaran and Shin test were used. The included countries were divided into two groups, OPEC and non-OPEC exporting countries, from which two separate unrestricted bivariate vector autoregressive models (VARs) were constructed. The VARs investigated the response of each group's combined economic growth to oil price shocks. The VARs were analysed through the use of impulse response functions, variance decompositions and Granger causality tests. The calculations were made using EViews.

Results: The outcomes show that a 1% increase in the change of the oil price will increase the GDP growth rate the following year with 0.145% (OPEC) versus 0.141% (non-OPEC), consequently a positive relationship was found. Moreover, 2.82% of the variation in the OPEC countries' growth rate is explained by oil price shocks, while the responding ratio for the non-OPEC countries is 2.81%.

Conclusions: OPEC and non-OPEC oil exporting countries' economic growth illustrated nearly identical responses to oil price shocks. Through the discussion it is thereby concluded that the price setters, OPEC, appear to be just as sensitive to oil price shocks as non-OPEC countries.

Keywords: Net-oil Exporters, OPEC, VAR-Model, Oil Price Shocks, Developing Countries, Economic Growth

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Thank you,

Hanna Boheman and Josephine Maxén

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Abbreviations

ADF Augmented Dickey-Fuller

AIC Akaike Information Criteria

DLRGDP Economic Growth (differentiated logged GDP)

DLRWOP Change in oil price/Oil price shock

GDP Gross domestic product

IFS International Financial Statistics

IRF Impulse Response Function

IPS Im, Pesaran and Shin

OPEC Organisation of Petroleum Exporting Countries

OECD Organisation of Economic Co-operation and Development

SIC Schwartz Information Criteria

UK United Kingdom

US United States

USD United States Dollar

VAR Vector autoregressive

WDI World Development Indicators

(-1) One year lagged value

(-2) Two year lagged value

1. Introduction

Crude oil is arguably one of the most important commodities in today's industrialised economy, as it represents a crucial energy source for many countries. Its price has been subject to various fluctuations throughout time, commencing in the 1970's when the world experienced its first substantial movements in the oil price, and thereby triggering one the relationship between oil price and economic growth. At that time, the U.S. was the dominant economy in the world, something that inevitably led macroeconomists to examine the country's relation to oil price changes. Along the way, empirical literature started expanding its horizons, and economists began studying how oil price movements affected the economic growth in other importing countries. A vast quantity of literature has since then explored the oil price-GDP relationship, the majority of these focusing on Organisation for Economic Co-operation and Development (OECD) countries. Relatively few of these studies are applicable for oil exporting and developing countries. Moreover, the existing literature on oil exporting countries usually merely focuses on a single country's or on a few countries' economies. There is hardly any literature that examines groups of exporting countries with the intention of studying potential discrepancies between them.

For the above-mentioned reasons, the purpose of this thesis is to analyse how oil price shocks affect economic growth in 19 net-oil exporting countries during the years 1980-2008. Furthermore, the aim is to conclude if the economic growth in Organization of Petroleum Exporting Countries (OPEC), compared with the economic growth in other developing oil exporting countries, differs in reaction to oil price shocks. OPEC is of specific interest when studying the oil price shock-GDP relationship, as it is widely held among economists that OPEC plays a key role in affecting the crude oil price as well as being heavily reliant on oil revenues for economic development. To our knowledge, no previous econometrical literature has studied whether OPEC reacts to oil price shocks differently than other exporting countries. Hence, the contribution of this thesis is to shed light on potential differences between the groups. This may be of interest to policy makers and investors with a connection to oil exporting countries.

In order to pursue this study, the thesis is divided into seven different chapters. Chapter two will provide the reader with a theoretical background on the subject by clarifying historic price fluctuations, explaining OPEC and its primary aims, as well as describing the current relationship between the oil price and economic growth. The third chapter continues on this path and presents previous studies conducted on the relationship between economic growth and oil price movements. Next, the data and methodology used are presented, focusing on the vector autoregressive model (VAR). Thereafter, the fifth chapter will present the results found using the previously stated methods. At the end, the results are discussed, including speculations regarding how these outcomes came to be. Lastly, concluding remarks are presented.

2. Theoretical Background

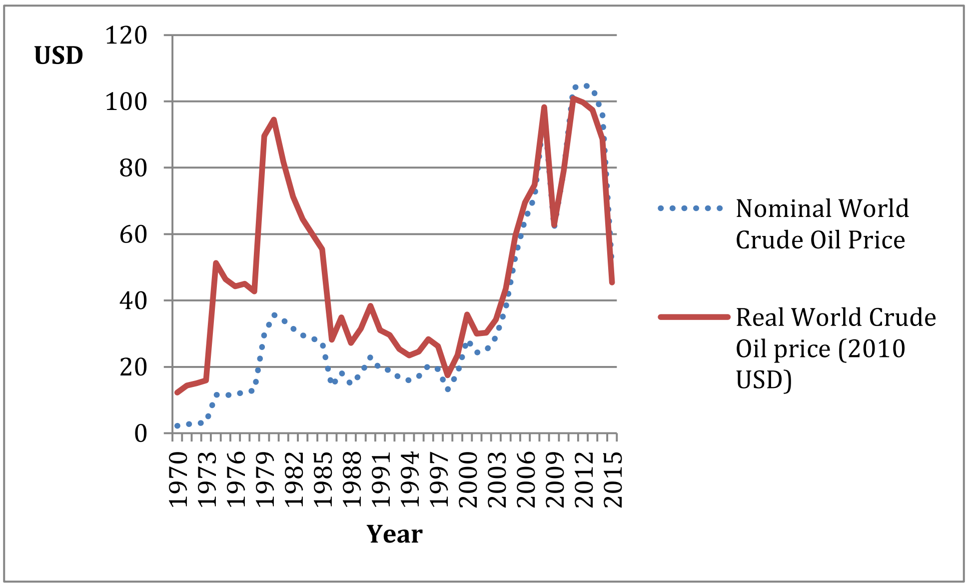
2.1 Oil price fluctuations

2.1.1 Historical Path

Following the Second World War, a massive industrialization took place, and by 1967 oil had become the main source of energy in the world. During this period OPEC began to establish itself, nevertheless without any pricing power since this power still resided in the hands of western transnational oil companies that kept the world oil price relatively stable. (Yan, 2012)

Despite this, the oil price spiked in 1973 when OPEC decided to impose an oil embargo on certain Western European countries and the U.S., due to their support of Israel during the Middle Eastern War. As a result, the real crude oil price increased dramatically by approximately 260%, resulting in the U.S. imposing a ban on its oil exports and the world economy entering a recession. This drastic increase in oil price is illustrated in Figure 2.1. Through these series of events, OPEC came to realize the power that resided within its oil resources, which they could use as an economic and political tool to influence other countries. (Kutlu, 2015)

Figure 2.1: The nominal and real oil price in 2010 U.S. Dollars (USD)



Source: Data from (IFS, 2015)

During the Iranian Revolution in November 1978, the world experienced its second significant oil price shock, resulting in an increase of the crude oil price from around 13 to 35

USD per barrel (IFS, 2015) between the years of 1978 and 1980. Shortly after the revolution, the turmoil amplified as the Iran-Iraq War began in September 1980, causing the oil price to peak (Yan, 2012). It was only in 1986 that the oil price stabilized to levels seen before the Iranian revolution (IFS, 2015).

A third substantial oil price shock was triggered by the Asian financial crisis in 1997, causing a decrease in the global demand for oil. The decreased demand caused the price of world crude oil fall from 23 USD per barrel in Q4 1996, to 12 USD per barrel in Q4 1998 (IFS, 2015). Nevertheless, the world economy recovered once again and crude oil was trading at approximately 24 USD per barrel in the end of 1999.

After 1999, the economy flourished until mid-2008, when the oil price reached its historic high at 115 USD per barrel (IFS, 2015). As the financial crisis hit the world economy later that same year, the price plummeted to 44 USD per barrel in the beginning of 2009, resulting in the fastest crash in oil price history (Kutlu, 2015).

It took approximately four years for the economies around the world to recover from this economic recession, resulting in the world crude oil price reaching 112 USD per barrel by 2012 (IFS, 2015). Nevertheless, the demand for oil decreased during this time mainly on account of a strong dollar and a weak economic growth in Asian and European nations. Hence, the world market was slowly being flooded with an excess supply of oil (Yan, 2012).

In the middle of 2014, the world market experienced yet another oil price shock as prices fell from 106 to 51 USD per barrel in the beginning of 2015 (IFS, 2015). This downward trend continued as OPEC announced that they were not going to cut their production, in order to not decrease their market share. Currently (May, 2015), the world market price for crude oil is still wandering around 50 dollars per barrel, and its future remains uncertain.

2.1.2 Influencing factors behind oil price fluctuations

From the historic events presented, the volatile qualities of oil price can be seen clearly. When imbalances in global oil supply and demand occur, the price fluctuates. In the following section, the primary influential factors that directly or indirectly create imbalances in supply and demand are presented.

2.1.2.1 Direct Effects

The world's production capacity

In accordance with fundamental economics, an increased oil supply leads to a lowering of its price. An interesting aspect of oil is that its supply is limited to a certain degree, as it is a non-renewable resource. Since the beginning of the 1990's until 2008, no new substantial oil fields were found, and no development within transportation and refining occurred. Consequently, during this period little improvements were made in the production capacity, which was not increasing compared with the pace as the world's consumption (Zhang, 2008).

Nevertheless, in recent years the discovery of new extraction methods for shale oil has significantly changed the oil market. Through the use of fracking and horizontal drilling it has become easier to extract oil from albeit known but until recently not economically feasible reserves, which has led to a substantial increase in oil supply. (Aguilera & Roderick, 2013)

The production of OPEC

The specified amount of oil produced by OPEC countries has been shown to impact the world's oil supply, and thus its price. The member states combined are responsible for 43% of the world's total supply (OPEC, 2014), and they act cohesively by producing oil according to certain set policies. Hence, the decisions they make inevitably steer prices in specific directions. According to a quantitative analysis by Cheng (2005), the international oil price will decrease with 1.23% for every 1% increase of OPEC's production. In addition, oil price has a tendency to rise when there is an uncertainty regarding OPEC's future production plan, as the risk premium improves.

The global economic growth

Global demand for crude oil directly affects its price, a relationship that can easily be seen by analysing historic events. Yan (2012) describes how growth leads to an enlarged demand for crude oil that may outperform the supply and result in an increase in the oil price. An example of this was when the world experienced rapid development in the beginning of the 21st century, mainly as a result of expansions in newly industrialised countries (Yan, 2012). An additional example was seen during the financial crisis in the second half of 2008. When the world's economic growth stagnated and the demand of oil did the same, resulting in plummeted prices (IFS, 2015). Hence, one can conclude that there exists a clear link between demand and fluctuations in international oil prices.

Change of crude oil inventories

When the price for oil is low, producers are incentivised to increase their inventories in order to drive up the price. Subsequently they can then increase production again when the price has risen. Nevertheless, as producers enter the market, prices may be pressed down again. The decision regarding when producers decide to extract is explained using more complex theories, for example a theory by the economist Harold Hotelling (1931). The Hotelling Rule states that extractors act in a profit maximizing way, which leads to an extraction that provides no opportunities for intertemporal arbitrage, meaning that countries should be indifferent to which time period they extract in. On the other hand, as stated in previous sections, this is not always how the industry works in reality.

2.1.2.2 Indirect Effects

Practices in the future market

Speculations about the future also contribute to disruptions in prices. The price of international oil futures works as a benchmark price when evaluating the current price and for this reason the spot oil price is highly affected by the opportunistic factors on the future market. Lombardi and van Robays (2011) describe how speculations may distort price information by causing oil prices to deviate from justified levels and no-arbitrage conditions. Agents may adjust their production and consumption policies in accordance with false assumptions, which inevitably will affect the oil spot price in the short run. (Lombardi & van Robays, 2011)

Dollar Exchange Rate Fluctuations

In 1974, the oil price was officially linked with the USD, meaning that most international oil trades have thereafter invoiced, delivered and settled in USD. Hence, fluctuation in the dollar exchange rate has a direct impact on the international oil price as well as oil policies in exporting and consuming countries (Yan, 2012). In the event of a USD devaluation, the real profits of oil exporting countries would fall, and in order to cope with such an event, OPEC would try to raise the price to minimize losses. According to an analysis conducted by Cheng

(2005), a 1% increase of the dollar exchange rate makes the price of oil to drop by 3.06% in the long run.

Geopolitical turbulence

Geopolitical risks add a risk premium to the international crude oil price, making the price higher. Numerous of the world's oil reserves are situated in politically troubled areas and many of the world's key oil suppliers are regarded as turbulent countries such as Iran, Iraq, Nigeria, Venezuela and Russia. There are both direct and indirect impacts of political and social conflicts affecting the oil price. For example, the U.S. invasion of Iraq was a direct impact that caused the Iraqi oil production to decrease. Another example of direct impact is the commonly seen sabotages of the Nigerian pipelines. Events that have had indirect impacts on the oil price are for example the lack of solutions to the conflict between Israel and Palestine, and the tension surrounding Iran's nuclear program (Keppler, 2008).

2.2 Organization of Petroleum Exporting Countries (OPEC)

Previously, the policies set by OPEC were mentioned as one of the key influential factors behind oil price fluctuations. OPEC was founded in 1960, and today it consists of 12 member countries that are considered to be among the lead oil-exporting nations in the world. The organization was established by Iran, Iraq, Kuwait, Saudi Arabia and Venezuela, and today it also comprises Algeria, Angola, Libya, Nigeria, Ecuador, Qatar and the United Arab Emirates (Dunsby et al., 2008). OPEC is considered to be an oil cartel even though its primary aim is to create a more stable oil market for both consumers and producers. This is accomplished by trying to avoid price fluctuations on the market by controlling a substantial share of the total supply of crude oil (Dunsby et al., 2008).

2.2.1 Oil Production

OPEC is in control of 43% of the world's oil production, and it furthermore stands for 81% of the world's proven reserves (OPEC, 2014). Additionally, OPEC states that 60% of the exported oil in the world comes from OPEC's member countries. This considerable market share entails that they are able to influence the direction of international crude oil prices through the policies that they set (Kaufmann et al., 2004). For example, the oil production in Saudi Arabia particularly affects the world oil price since the country is the largest producer within OPEC.

Within OPEC, each member is expected to supply a specific amount of crude oil in accordance with a mutually made decision. In order to accomplish this collaboration, the member states meet twice a year to discuss the outlook of the petroleum market as well as their potential production target. The policies are then set accordingly (OPEC, 2000). Despite this, the question remains whether each member abides to the policies set, thus generating the desired price and production.

Oil production has become a vital source of income for the OPEC economies, where large shares of their total GDP consists of revenues from their crude oil production. A reduction of these revenues would lead to a considerable decline of each country's GDP, for example in Libya, where today 39% of the GDP stems from oil production (WDI, 2015).

2.2.2 Organizational Structure

In order to create stability and to reach common goals, it is crucial that the cartel consists of a cohesive group of countries. OPEC's ability to influence prices is only as powerful as each member's willingness to oblige to the targeted production. Therefore, countries willing to join the organization can do so only if they are considered to be significant net-exporters of oil, have similar interests to the other members', and are considered to be developing countries. A majority vote of three-fourths must reside among the members, in addition to acceptance from all founding nations (OPEC, 2015).

2.2.3 Economic diversification in OPEC countries

For many years, the economic structure of the OPEC countries has, first and foremost, focused on the petroleum industry, as this is their primary source of income. Their heavy dependency on oil revenues has prevented these countries' economies from devoting both financial and intellectual capital to the development of other industries (Karl, 2005). Hence, many of the OPEC economies have failed to hedge themselves enough against the possibility of a reduced demand for crude oil or a considerable decrease in price. At the moment, many OPEC economies are experiencing an economic decline because of the currently low oil price, especially Venezuela and Nigeria (Carlson, 2014).

Nevertheless during recent years, member countries have gained increased awareness to their dependency on oil. The principal adjustments were made after the financial crisis in 2008, when high oil prices enabled the OPEC countries to develop other sectors of their economies. (Yan, 2012). Many countries have begun developing their non-oil industries with the ambition to expand these sectors' share of the GDP. A successful economic diversification within the OPEC countries would enable the economies to grow despite potential fluctuations in oil price.

2.3 Economic Growth and Oil Price Fluctuations in Oil Exporting Countries

Crude oil is a crucial commodity for both importing and exporting nations, as it is either an important input factor or source of income. A rise or fall in price is therefore of interest to these economies and can affect various macroeconomic variables, such as economic growth.

The prevailing view among economists is than an increase in oil price, ceteris paribus, tends to have a positive effect on oil exporting countries. This is based on the idea that a boost in oil price, generates a change in terms of trade as income is transferred from importing to exporting nations, resulting in an increased national income. Following a price rise, the exporting economies potential gains are however diminished because of the decreased demand for oil from importing economies. This series of events is depicted in historic occurrences, for example during the price shock in 1984 when oil prices increased substantially, decreasing the demand from importing countries that later entered economic recessions (Pindyck, 1991).

On the other hand, changes in oil price might not always be considered to be positive for exporting countries, even when they lead to a higher price. Large fluctuations entail increased uncertainty, often leading to diminished incentives for investment. Moreover, it becomes more challenging for these economies to plan ahead, and they may become subject to costly reallocation of resources (Bernanke, 1983).

It is important to note that there is a difference in studying the relationship between *oil price volatility* and GDP growth compared to the relationship between the *oil price shock* and GDP growth. The former aims to investigate how countries' economic growth reacts during times of price uncertainty, while the latter, questioned in this thesis, examines how economic growth reacts when a sudden increase in the yearly percentage change of oil price occurs.

Countries dependency on oil exports is inevitably crucial when studying how different economies react oil price shocks. Many of the world's net-exporters suffer from what is referred to as the ”resource curse” or “Dutch disease”. These terms were coined to depict the negative relation found between a heavy reliance on natural resources and economic growth. Countries with vast natural resources, such as oil, tend to develop their markets through revenues gained from producing this resource (Karl, 2005). Oil exports lead to an inflow of foreign currency, which increases demand for the exporting country's currency, making it appreciate. This makes the country's other products less price competitive on the export market leading to a tendency to further invest in the competitive export sector, i.e. the oil sector. On account of this, a highly developed oil sector increases wages, thus increasing wages in other industries as well, further lowering these sectors competitiveness (Karl, 2005). Therefore, economies suffering from the “resource curse” inevitably experience huge income losses in the event of a decreased oil price. Because of the high volatility of oil price, other industries should be considered in order to hedge the country's economic growth.

3. Previous Research

Crude oil is of great importance to the world's economy, as it is an important source of income and input factor for many countries. Therefore it is not surprising that price fluctuations and its impacts on growth has been widely studied among economists.

The first strand of literature written on the subject of oil-price-GDP relationship, focuses mainly on the U.S. economy. In 1983, Hamilton found that most of the post-World War II recessions in the U.S. could be explained by oil price increases. This relationship was found through Granger causality tests, and thus concluding that there was a link between the U.S. GDP and oil price. This connection was later confirmed by Burbridge and Harrison (1984), Gisser and Goodwin (1986) as well as Ferderer (1996), among others. Mork (1989) established that an increase in the price of crude oil had a negative effect on U.S. production, and that a decline in oil price showed no statistically significant effects, indicating an asymmetric relationship. This was later verified by Hamilton (2003).

The second strand of literature considering the relationship between oil price movements and GDP, widened the previous perspective by including other developed countries in addition to the U.S., the majority of these being net importers of oil. Examples of such studies are Mork et al. (1994), Papapetrou (2001), Jiménez-Rodríguez and Sanchez (2005) and Lardic and Mignon (2006). These empirical studies included large OECD economies, and in most cases determined a negative relationship between oil price and GDP. Moreover, through the use of a multivariate vector autoregressive (VAR) analysis, Jiménez-Rodriguez and Sánchez (2005) found that oil price increases have an impact on GDP growth, whereas declines do not. Hence, confirming the existence of an asymmetric relationship, earlier found by Mork (1989) and Hamilton (2003).

In more recent years, Rentschler (2013) examined the significance of oil price volatility in a number of countries, including developed, developing, importing and exporting countries. These include Germany, India, Japan, the Republic of Korea, Malaysia, and the United States. Using a VAR, Rentchler's paper concludes that an increase in oil price volatility can have negative consequences for the economies of both oil exporting and importing countries. He also states that an economy that greatly depends on oil trade is more likely to be affected by price shocks.

As for developing countries, fewer empirical studies exists. Berument, Ceylan and Dogan (2010) examined how oil price shocks affect the output growth in some net-exporting and net-importing countries in the Middle Eastern and North African (MENA) region, with the GDP figures ranging from 1952-2005. They suggest that oil price shocks have a significantly positive effect on the outputs of Algeria, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Syria and United Arab Emirates, of which the majority are OPEC countries, except Oman and Syria. Meanwhile, oil-price shocks showed no impact on the outputs of Bahrain, Djibouti, Egypt, Israel, Jordan, Morocco and Tunisia, all of which are net-importers. They also acknowledged the existence of an asymmetrical relationship between GDP and oil price. Similar results were also presented by Dées et al. (2005), and Medoza and Vera (2010).

Furthermore, Mehrara and Oskoui (2007) examined output fluctuations in Iran, Kuwait, Indonesia and Saudi Arabia (all OPEC members at the time), and aimed to conclude the driving forces behind output fluctuations. By imposing long-run restrictions on a VAR-model, four structural shocks were identified: nominal demand, real demand, supply, and oil price shocks. Oil price shocks were identified as the main driving force behind fluctuations in GDP in Saudi Arabia and Iran, while supply shocks had the biggest impact in Kuwait and Indonesia. The authors believe Kuwait’s well-managed savings fund and Indonesia’s limited resource-based production to be the reasons for these results.

Noticeably, numerous studies have been conducted on the subject, where the economic effects of an oil price increase, correspondingly decrease, have been examined. These studies have tended to focus more on developed oil importing countries and have in many cases concluded that the result of a price increase affects GDP and other macroeconomic indicators negatively. This paper will focus more on developing net-exporting countries, as there is a missing gap in published research for this. More specifically it will discuss whether oil price shocks has a greater effect on OPEC countries’ economic growth than on similar non-OPEC countries, using the popularly used VAR-model in order to portray the relation between the two.

4. Methodology and Data

4.1 Data

Selection of Countries

The objective is to investigate if economic growth in 11 OPEC countries is more sensitive to oil price shocks compared to 8 other net oil-exporting countries, during the period of 1980-2008. All OPEC members are considered to be developing countries, hence all the selected non-OPEC countries are also developing (ISI, 2015), this is to make the groups comparable. In order to justify the comparison further, all countries included in the study have average oil revenues that account for at least 10%, and no more than 45%[1] of the countries GDPs. To confirm that the countries have been highly dependent on oil rents[2] during the entire relevant time frame, their average oil revenue, as a percentage of GDP, are calculated for the time span 1980-2008. The original data series (oil rents % of GDP) are obtained from the World Bank, World Development Indicators (WDI, 2015), from which an average is determined. See Table 4.1.

Table 4.1

OPEC Countries	Time Span	Average oil rent (% of GDP)	Non-OPEC Countries	Time Span	Average oil rent (% of GDP)
Algeria	1980-2013	18.8	Azerbaijan	1990-2013	29.6
Angola	1985-2013	44.2	Brunei	1980-2013	29.3
Ecuador	1980-2013	12.9	Chad	1980-2013	31.6
Iran	1980-2013*	21.7	Gabon	1980-2013	39.7
Kuwait	1980-2013	44.2	Kazakhstan	1990-2013	24.0
Libya	1990-2013	40.7	Oman	1980-2013	35.8
Nigeria	1980-2013	33.0	Russia	1989-2013	13.0
Saudi Arabia	1980-2013	40.4	Yemen	1990-2013	28.2
UAE**	1980-2013	22.4			
Venezuela	1980-2013	24.8			
Qatar	1980-2013	33.9			
Average		**30.6%**			**28.9%**

*Russia, Kazakhstan, Yemen, Azerbaijan, Angola and Libya, differ in the covered years because they lack data due to certain political and regional tensions. *Interpolation for 1991 & 1992, **United Arab Emirates*

[1] We wanted the group of countries to have the relatively same dependence on oil rents, therefore, countries with substantially different average oil rents were not included, for example Congo, Rep.

[2] The difference between the value of produced crude oil at world prices and total costs of production

Thus, the focus is on developing net oil exporting countries that are heavily reliant on revenues from oil. The non-OPEC countries included in this study are chosen based on this rationale, resulting in a selection of 8 countries: Azerbaijan, Brunei, Chad, Gabon, Kazakhstan, Oman, Russia and Yemen. Additionally two more countries were considered, Equatorial Guinea and Turkmenistan, nevertheless, they were ultimately not included as they lacked sufficient data. Regarding the OPEC countries, 11 out of the 12 members are included, namely: Algeria, Angola, Ecuador, Iran, Kuwait, Libya, Nigeria, Saudi Arabia, UAE, and Venezuela. Iraq, one of the member countries of OPEC, lacked data from 1991 until 2003, and was therefore eliminated. See Figure 4.1.

Figure 4.1

Included OPEC countries

Included non-OPEC countries

In the econometric analysis, the countries are divided into two groups. The average oil revenues (% of GDP) are then calculated for each group in order to see if these are relatively similar, and thus comparable. The values for both groups are displayed in Table 4.1 and show similar levels of dependency.

Economic Growth

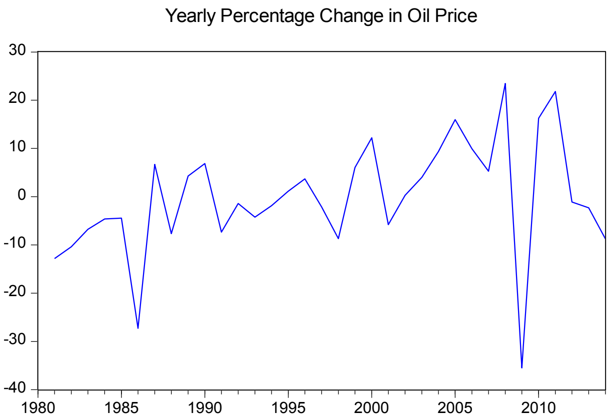
Concerning a measure for economic growth, the differentiated natural logarithm of real GDP is used as a proxy. The reason behind choosing real GDP was to generate an accurate relationship between the variables, independent from price changes.

A large number of previous studies have used quarterly data (see: Jimenez-Rodriguez and Sanchez, 2008) to illustrate the effects of sudden changes in oil price on growth rate, but since the majority of the countries included in this particular study lacked quarterly information of GDP, yearly data was used. The countries' yearly real GDPs are obtained from the World Bank, World Development Index (WDI, 2015), and ranged from 1980-2013. This timespan varies between the selected countries depending on availability of data, as illustrated in Table 4.1.

Oil Price Shock

The figures for world crude oil price are obtained from the International Monetary Fund, International Financial Statistics (IFS, 2015), and consist of a yearly average of the world crude oil price. These were then deflated though the use of the all urban Consumer Price Index (CPI) gathered from Bureau Labor Statistics (BLS, 2015). These were also logged with the natural logarithm and differentiated in order to portray the change in oil price, see Figure 4.2. In this way, an oil price shock is in the VAR represented as an increase in the yearly percentage change in the oil price.

Figure 4.2



Source: Authors own calculations, based on IFS (2015)

Time Period

The timespan of 1980 to 2008 is chosen largely because there was little data to be found on the individual countries' GDP before 1980, problematizing the execution of an econometrical study before this date. Moreover, it is apparent from Figure 4.2, that the oil price has been very volatile after 2008, an aspect that might lead to the vector autoregressive (VAR) model assuming a false relationship between the oil price and economic growth for years after 2008. Therefore, data covering the years 2009-2013 was excluded, which hopefully will demonstrate a more accurate relationship between the variables.

In summary, the analysis consists of a total of 19 countries, 11 OPEC and 8 non-OPEC, all of which are developing nations that are dependent on oil production revenues. Furthermore, our proxy for oil price shocks is represented through changes in world oil price, and economic growth which is represented through changes in logged real GDP.

4.2 Method

4.2.1 Econometric Overview

In this econometric analysis a vector autoregressive model (VAR) is used to examine the behavioural relationship between oil prices shocks and the economic growth in the two groups of countries. To be able to compare the sensitivity between the two groups, two separate VAR-models for the OPEC countries and non-OPEC countries are used. To further deepen the analysis of the VARs, the Granger causality, impulse response functions and variance decompositions are examined.

In order to be able to use the VAR, all data must be tested to see if they contain a unit root. This is accomplished through an augmented Dickey–Fuller (ADF) test and an Im, Pesaran and Shin (IPS) test.

4.2.2 Unit Root Test

Time series containing unit roots are supposed to not be stationary. Non-stationary series leads to statistically spurious relationships, meaning that accurate conclusions cannot be drawn from the data as it includes means and variances that are not constant over time. Moreover, the persistence of for example an oil price shock will be infinite for a non-stationary series. Therefore, a VAR cannot be constructed if the data contains unit roots. In order to test the null hypothesis, that there is a presence of unit roots in the data, the ADF and IPS tests were used.

The ADF test is used when trying to find unit roots in a time series. It presents different results depending on if the time series is assumed to have a time-trend and/or an intercept. A time-trend should be included in the model if a long-term incline or decline exists in the data, which can easily be discovered by observing a graph of the data. Moreover, an intercept needs to be included if the mean of the series is far from zero (Verbeek, 2008)

When considering a model with 2 lags (AR(2)) where both time-trend and intercept are included, the equation used for the ADF is constructed as following:

$$\boldsymbol{y_t = \mu + \beta t + \gamma y_{t-1} + \gamma_1 \Delta y_{t-1} + \gamma_2 \Delta y_{t-2} + \varepsilon_t} \qquad (1)$$

$\boldsymbol{\mu}$ = Intercept, $\boldsymbol{\beta}$ = time trend.

The unit root test is carried out under the null hypothesis that all $\boldsymbol{\gamma_i} = 0$, if this hypothesis is rejected (i.e. $\boldsymbol{\gamma_i} < 0$). This means that the presence of a unit root can be rejected. (Verbeek, 2008)

Since the samples of the two groups' GDP growths are in panel, a unit root test applicable on panel data has to be used for these variables. This is done by using the Im, Pesaran and Shin (IPS) test (2003). The IPS test is based on the ADF test by creating an average from the ADF statistics, across the groups. Similar to the ADF test, the IPS is constructed with time-trend and/or an intercept, depending on the qualities of the data. The null hypothesis of the IPS test is that all series in the panel has a unit root, whilst the alternative hypothesis is that some individual series have unit roots and others do not.

4.2.3 Cointegration test

If the unit root tests determine some of the data to be non-stationary, the Johansen (1990) test for cointegration will be used on this data. Two non-stationary time series are said to be cointegrated if the linear combination of them is stationary. In order to use the Johansen test, the VAR will need to be turned into a vector error correction model, from which the number of cointegrating vectors can be determined. (Brooks, 2008)

As it turns out, the unit roots tests conclude that all of the variables are stationary. Hence, no cointegration test will be necessary and an unrestricted VAR on both the OPEC and non-OPEC group can be executed.

4.2.4 Vector Autoregressive Model (VAR)

Mentioned in the preceding sub-section, the response of GDP to oil price shocks is analysed through the use of an unrestricted bivariate VAR. To be able to compare the sensitivity between OPEC and non-OPEC countries, two separate VAR-models are constructed for the groups. This model was first advocated by Sims (1980), and has today become popular among economists for studies like these as it is a relatively easy model to use when analysing multivariate time series (Luetkepohl, 2011). The variables treated in the VAR-model are all seen as endogenous, with no imposed structural relationships or restrictions. Verbeek (2008) describes the framework behind a first-order VAR as following:

$$Y_t = \delta_1 + \theta_{11} Y_{t-1} + \theta_{12} X_{t-1} + \varepsilon_{Yt} \qquad (2)$$

and

$$X_t = \delta_2 + \theta_{21} Y_{t-1} + \theta_{22} X_{t-1} + \varepsilon_{Xt} \qquad (3)$$

where ε_{Yt} and ε_{Xt} are independent of the lags of Y and X and denote white noise. Verbeek continues by stating that if the coefficient θ_{12} is not equal to zero, then this means that the lagged values of X help explain Y (2008). In other words, the VAR coefficients help clarify the extent of the relationship.

Through a multivariate framework, this model captures how changes in a particular variable are related to changes in its own lags, as well as to changes in other variables and their lags. Therefore, before implementing a VAR, the optimal lag length need to be determined.

Lag length selection

There are numerous methods that can be utilised to select the appropriate numbers of lags. Two approaches are of main focus here: firstly, the lag exclusion Wald test is employed, followed by the traditional lag order selection information criteria procedure. The Wald test works by testing the null hypothesis that the variables in the VAR are jointly zero at a given lag. Where the null hypothesis is rejected, the test indicates that the lag should be included. Turning to the lag order selection criteria, it proposes the optimal lag according to different recognised methods. Two of the most commonly used information criteria are Akaike information criteria (AIC) and Schwartz information criteria (SIC) (Verbeek, 2008). These two propose the optimal number of lags according to their calculations, which thereafter are compared in order to choose the optimum lag length for the series. The optimal lag is often chosen based on reasonable thinking; in other words, when deciding which of the optimal lags presented to choose, AIC or SIC, the one that is most likely to capture the real relationship in the model is selected. In addition, Verbeek (2008) explains that in most cases, the AIC or SIC with the smallest value is preferred.

Ordering of variables

When constructing a VAR, the ordering of the variables is important as it may affect the results. When one of the variables in the VAR is struck by a shock, the model assumes that the other variables also will be affected. To which extent this is true, depends on the level of correlation between the residuals (Brooks, 2008). For this reason, it is important to assume an ordering, so that a potential impulse to the system affects the variables in the right direction. Moreover, the ordering has to correspond to the mathematics chosen behind the VAR. In this thesis, the equations within the VAR are analysed through a matrix called Cholesky decomposition (Kilian, 2011). To follow the qualities of this matrix, the variable selected first should be the one with the most potential immediate impact on the other variable following a shock in its residuals (Kilian, 2011). In the VAR used, the growth rate is ordered first, followed by the oil price change. The motive behind the chosen order is that a shock in growth is assumed to have an *immediate* impact on the change in oil price, whilst a shock in the oil price would not have an *immediate* impact on the growth rate, as a country's GDP have a tendency to change slowly.

After having implemented the VARs, the analysis is continued through the use of Granger causality tests, Impulse Response Functions and Variance Decompositions.

4.2.4.1 Granger Causality Test

A Granger causality test is a formal way to assess whether one variable has a tendency to succeed another. X is said to granger cause Y if X is useful in forecasting Y. This implies that X granger causes Y, if historical values of X are able to increase the accuracy of the prediction of the present Y. Granger causality differs from normal causality in that if X is said to granger cause Y, this does not mean that X will lead to Y. Instead this implies that historically, when X occurs, Y has followed. Granger causality test uses an F-test to see whether lagged information on variable Y provides statistically significant information about variable X, as seen in Equation 3, or whether lagged information on variable X provides statistically significant information about variable Y (Equation 4):

$$X_t = \alpha_0 + \alpha_1 X_{t-1} + \ldots + \alpha_m X_{t-m} + \beta_1 y_{t-1} + \ldots + \beta_m y_{t-m} + \varepsilon_{Xt} \qquad (4)$$

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots + \alpha_m Y_{t-m} + \beta_1 x_{t-1} + \ldots + \beta_m x_{t-m} + \varepsilon_{Yt} \qquad (5)$$

H_0: if all $\beta_i = 0$ = no granger causality
H_1: $\beta_i \neq 0$ = granger causality exists

4.2.4.2 Impulse Response Function (IRF)

The IRF is a complement to the Granger causality test and an extension to the VAR. It provides information about the timing as well as the extent of the relationship between variables. The IRF captures the responsiveness of endogenous variables to a shock in each of the variables included in the VAR (Brooks, 2008). More precisely, the IRF shows how and for how many subsequent time periods, one standard deviation shock in one variable's residuals affects the other variables, and for how long the shock has an effect on the variables.

To increase understanding for this model, an example is presented through the use of the following equation:

$$Y_t = \delta_1 + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \varepsilon_{Yt} \qquad (6)$$

Suppose that a shock occurs in the residua lε_{Yt-1}, the Y_{t-1} will then change according to the equation. Due to lags in the model, the changed Y_{t-1} will affect Y_t, even if the shock occurred in the previous period's residual. Consequently, the impulse response function expresses for how many periods a shock in ε_{Yt} has an effect, meaning that it determines how many periods it takes until Y returns to equilibrium. (Greene, 2003)

Moreover, an IRF depicts if the relationship is negative or positive (Brooks, 2008). After conducting this test, the statistical reliability of the IRF has to be assessed. This is accomplished by analysing whether the two standard error bands framing the function, cover the zero or not.

The results of the IRF are of interest, as they can illustrate if there are any differences between how the two groups' economies react to an oil price shock.

4.2.4.3 Variance Decomposition

The variance decomposition is an extension of the VAR and determines how much of the movements in one variable can be explained by its own shocks versus exogenous shocks to the other variables. According to the method, a shock in one variable will inevitably affect that variable, but through the dynamic structure of the VAR, it will also be transmitted to all of the other variables in the system (Brooks, 2008). As previously mentioned, the ordering of the variables is important for calculating variance decompositions.

5. Results

In this chapter we implement a VAR in order to examine the relationship between oil price and GDP. The results for each step are presented below.

5.1 Unit Root Test

The data examined by the ADF test, consists of the differentiated logged real world crude oil price. The estimated lag lengths used are obtained by the Schwarz information criteria. When testing the presence of a unit root in oil price neither time-trend nor intercept were included. This specification was chosen since it has the highest statistical significance among the available specifications. Additionally it has a Durbin-Watson value near 2 that indicates that there is no autocorrelation among residuals. The ADF test found no unit roots in the investigated data, and consequently determined the differentiated oil price to be stationary.

Regarding the panel data consisting of the OPEC and non-OPEC countries' differentiated logged real GDP, the Im, Pesaran and Shin (IPS) test was used to test for unit roots. The IPS determined that both time-trend and intercept should be included, as this specification rejected presence of unit roots in both the OPEC and non-OPEC sample.

The variables tested in the ADF and IPS were in first difference and through the tests determined to be stationary. Therefore it was concluded that second order differentiating was not necessary in order to make the variables stationary; first order differentiation was sufficient. The results from the unit root tests are presented in Table 5.1 and 5.2 in the appendix.

5.2 Vector Autoregressive Model (VAR)

Lag length selection

The lag exclusion Wald test showed that two lags were statistically significant for all variables. Furthermore, the Akaike information criteria (AIC) suggested 8 lags for both models while Schwartz information criteria (SIC) suggested 2 lags for the OPEC and 5 for the non-OPEC. It is not reasonable to believe that an oil price shock would affect the economy for 8 or 5 years, therefore 2 lags were chosen in accordance with Wald, and additionally with SIC for OPEC.

The bivariate VAR used is consequently denoted as following:

$$GDP_t = \delta_1 + \theta_{11}GDP_{t-1} + \theta_{12}OP_{t-1} + \theta_{11}GDP_{t-2} + \theta_{12}OP_{t-2} + \varepsilon_{GDPt} \quad (5)$$

and

$$OP_t = \delta_2 + \theta_{21}GDP_{t-1} + \theta_{22}OP_{t-1} + \theta_{21}GDP_{t-1} + \theta_{22}OP_{t-2} + \varepsilon_{OPt} \quad (6)$$

OP = change in oil price
GDP = economic growth

The option to rearrange the bivariate model into a multivariate model was not desirable as the objective was to isolate the effect of oil price changes on economic growth. Moreover, including additional influencing factors could reduce the precision of the VAR and potentially generate misleading results.

The results from both VAR-estimations can be found in Table 5.3 and 5.4 and are explained below. Being crucial for this study, a particular focus is set on exploring whether the coefficients explaining how the lagged change in oil price (DLRWOP -1, -2) affect the current GDP growth rate (DLRGDP).

Regarding the OPEC countries, the results indicate that if the change in oil price increases with 1%, then the GDP growth rate will increase with 0.145% the following year. Moreover, the coefficient for how a change in the previous year GDP growth rate affects the change oil price, implies that a 1%, increase in real GDP growth rate leads to approximately a 0.21% increase in the change in oil price.

Table 5.3 Vector Autoregression (VAR) Estimates, OPEC

1980-2008		
	DLRGDP	*DLRWOP*
DLRGDP (-1)	**0.1682**	**0.2071**
t-statistics	2.4588	2.2140
DLRGDP (-2)	0.0645	0.1658
t-statistics	0.9714	1.8275
DLRWOP (-1)	**0.145**	-0.0665
t-statistics	2.8817	-0.9669
DLRWOP (-2)	0.0156	-0.0949
t-statistics	0.3127	-1.3935
R^2	0,1045	

Critical values: -1.96, 1.96 (two-tailed), significant values in ***bold***

From the non-OPEC VAR below, the estimates note that a 1% increase in change in oil price will increase the GDP growth rate with 0.142%.

Table 5.4 Vector Autoregression (VAR) Estimates, non-OPEC

1980-2008		
	DLRGDP	*DLRWOP*
DLRGDP (-1)	**0.3561**	0.1123
t-statistics	4.0124	0.7897
DLRGDP (-2)	0.1291	0.2425
t-statistics	1.5583	1.8259
DLRWOP (-1)	**0.1418**	0.0220
t-statistics	2.4690	0.2385
DLRWOP (-2)	-0.0637	**-0.1932**
t-statistics	-1.1223	-2.1226
R^2	0.2705	

Critical values: -1.96, 1.96 (two-tailed), significant values in ***bold***

Earlier the decision was made to exclude data from 2009 to 2013. In order to see what the relationship would have looked like between 1980 and 2013, a VAR was implemented, and insignificant and weak results were found. These results can be seen in the appendix in Table 5.5.

To further increase the understanding of a sudden change in yearly oil price and economic growth, the results from the Granger causality test, the impulse response function and variance decomposition are presented. All of these tests are extensions from the existing VAR- model.

5.2.1 Granger Causality Test

The upshots from the Granger causality test are presented below and can be found in Table 5.6 in the appendix.

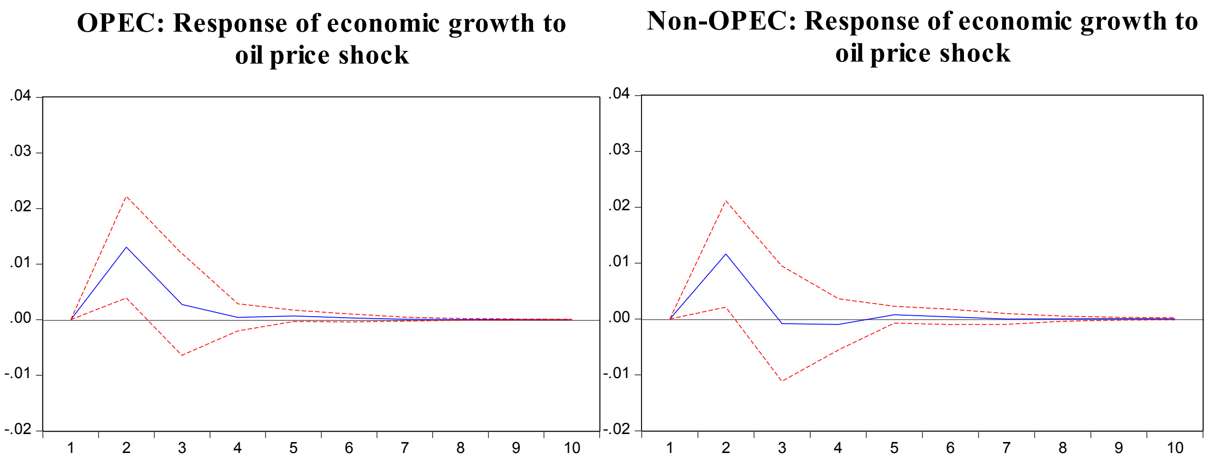
For the given time frame, a two-way causality is found in both OPEC and non-OPEC economies. At a 5% level of significance, oil price shocks granger cause the growth rate of the OPEC countries as well as the non-OPEC countries. In addition, at 5% significance level, the growth rate in OPEC granger cause oil price shocks, and in non-OPEC countries the growth rate granger causes oil price shocks at a 10% level of significance.

5.2.2 Impulse Response Function (IRF)

The results of the IRFs depict how one standard deviation shock in the change in oil price, affects the OPEC and non-OPEC economies respectively, and if they differ in any aspects.

In accordance with the VAR-model, significant results were found for the first period after an oil price shock for both OPEC and non-OPEC countries during 1980-2008. The upshots show similar responses across the groups, illustrating that economic growth reacts positively one year after the shock. During the second year, both groups' reaction functions diminish to levels seen before the oil shock. Furthermore, the non-OPEC reaction function declines steeper reaching negative levels. Nevertheless, none of the results in the second period are significant.

Figure 5.1: Impulse Response Functions



Dotted red line (---) = standard error bands, Blue line (---) = IRF

5.2.3 Variance Decomposition

The outcomes from the variance decomposition tests can be found in Table 5.7 and 5.8 in the appendix. Neither group's variation in growth rate can be explained by an oil price shock in the same period as the shock occurs. In the following period, a shock in oil price accounts for 2.82% (OPEC) and 2.81% (non-OPEC) of variation in growth rate. Noticeably, these results do not differ substantially from the results presented in the VAR, as the values for each group are practically identical.

5.3 Results summary

The VAR exhibited that a 1% increase in the change of the oil price will increase the GDP growth rate the following year with 0.145% (OPEC) versus 0.142% (non-OPEC). Moreover, 2.82 % of the variation in the OPEC countries' growth rate is explained by oil shocks, while the responding ratio for the non-OPEC countries is 2.81%. The results from the VARs and IRFs depict that a positive relationship reside between oil price shocks and economic growth, a relationship only found to be significant one year after the shock occurs.

6. Discussion

Through the use of various econometrical methods, the economies of OPEC and non-OPEC countries showed equivalent responses after an oil price shock. There are several potential reasons for why changes in oil price have similar impacts on the economic growth in OPEC and non-OPEC countries. First of all, as previously taken into consideration in this thesis, the two compared groups are alike in numerous aspects. They consist of developing countries that are highly dependent on oil revenues, thus it is reasonable to assume that the two groups will react in a similar manner to oil price shocks. Consequently, it is likely to assume that the policies set by OPEC that aims to create a stable oil market and thus stable growth within their member countries, are also desirable for the non-OPEC economies. According to these assumptions, an increase in the change of oil price could affect the countries' GDP in a similar manner. The question that remains is why non-OPEC countries have chosen not to become members of OPEC, given their mutual interests.

Firstly, non-OPEC countries may benefit from the decisions made by OPEC, independent from whether they are members or not (Falola & Genova, 2005). Through this, they are able to savour the benefits from OPEC's work, as "free riders", and at the same time not have to adhere to decided production levels. This is, on the other hand, only beneficial if OPEC is strong enough to maintain prices at an elevated level. For example, if the non-OPEC countries decide to keep a high level of supply, this makes it difficult for OPEC to maintain control over oil prices. An additional advantage for remaining outside of OPEC, may be the instability associated with the organization, a reputation gained through various regional conflicts among the Middle Eastern economies.

An equally interesting finding is the positive relationship between oil price shocks and economic growth. The observed relationship could stem from an asymmetric relationship between oil price shocks and economic growth mentioned in previous empirical literature (see: Berument, Ceylan & Dogan, 2010, Medoza & Vera, 2010, Jimenez-Rodriguez & Sanchez, 2005, and Mork, 1989). In these studies it was noted that an increase in oil price affects output more than a decrease does. Furthermore, the general view among economists is that oil-exporting countries' economic growth is positively (negatively) affected by an increase (decrease) in oil price. Therefore it would be feasible to believe, given the existence of an asymmetric relationship, that the net-effect of a sudden change in prices would be positive.

6.1 Further Research

The main focus has been on the time frame 1980-2008 because of the presumed inexplicable variability in data following this time period. Even though a drastic change in oil price after 2008 can be observed, no econometric test was used to strengthen the assumption used in this thesis. This could be accomplished by for example testing for structural breaks through the Chow test. A structural break is an abrupt change in a time series, and by knowing its existence and when it occurs, an increased understanding can be gained about the data. Furthermore, time will tell whether the insignificant relationship found during 1980-2013 is permanent or only a temporary deviation caused by the financial crisis in 2008. Therefore, it would be of great interest to conduct a similar study in the future when the world economies have fully recovered from the large fluctuations in oil price that have occurred after 2008.

Another aspect that is worth to investigate further is the bivariate approach taken in this thesis. It could be of interest to see if a multivariate framework would capture any additional aspects of the oil price shock-GDP growth relationship. Variables that could be of interest to include could for example be exchange rates or interest rates.

7. Conclusion

This thesis sought to analyse if there is a difference in how the economic growth, in 11 OPEC and 8 non-OPEC oil producing economies, react to sudden changes in oil price. The analysis was accomplished through an unrestricted bivariate VAR-model and covered the period 1980 to 2008. Moreover, the objective was to fill an existing gap in empirical literature, as there is insufficient research on the effect of an oil price shock on the economic growth in developing oil producing countries, and none that compare OPEC with non-OPEC countries. From the results, the following conclusions could be drawn: firstly, that OPEC, the price setters, and non-OPEC economies are equally sensitive to oil price shocks. Secondly, that the relationship between oil price shocks and economic growth is positive for developing oil exporting countries.

We believe that an analysis similar to the one seen in this thesis is of future interest. Many of the underlying circumstances will change in the near future, for example the oil price, the world's oil inventories, the number of developed countries in the world, and consequently the world's demand. A small change to any of these could potentially lead to dramatically different conclusions.

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Appendix

Table 5.1: Augmented Dickey-Fuller test, differentiated logged real world oil price

Null Hypothesis: D(LRWOP) has a unit root (ADF-test)

		t-Statistic	Prob*.
Augmented Dickey-Fuller test statistics		-6.1589	0.0000
Test critical values:	1% level	-2.6369	
	5% level	-1.9513	
	10% level	-1.6107	

*MacKinnon (1996) one-sided p-values

Table 5.2: Im, Pesaran and Shin test, differentiated logged real GDP

Null Hypothesis: each series in the panel has a unit root (IPS test)

OPEC	Statistic	Prob.
Im, Pesaran and Shin W-stat	8.113	0.0000
Cross section Average t-Stat	-4.3144*	
Non-OPEC		
Im, Pesaran and Shin W-stat	-653238	0.0000
Cross section Average t-Stat	-4.2249*	

* Same critical t-stat as in table 5.1.

Table 5.5: Vector Autoregression (VAR) Estimates, time span 1980-2013

	Non-OPEC: 1980-2013		***OPEC: 1980-2013***	
	DLRGDP	*DLRWOP*	*DLRGDP*	*DLRWOP*
DLRGDP (-1)	-0.0199	0.1229	**0.2402**	0.0469
t-statistics	-0.316	1.5624	2.7592	0.3625
DLRGDP (-2)	0.0879	0.1071	0.0684	0.109
t-statistics	1.3785	1.3434	0.836	0.8959
DLRWOP (-1)	**0.1119**	**-0.1502**	0.0319	-0.1055
t-statistics	2.2262	-2.3904	0.5344	-1.1884
DLRWOP (-2)	0.0466	-0.1195	-0.0277	**-0.1791**
t-statistics	0.9349	-1.9154	-0.04866	-2.1196
R^2	0.0318		0.088	

Table 5.6: Granger causality 1980-2008

Null Hypothesis	Prob
$DLRGDP_{OPEC}$ does not granger cause Oil price shocks	0.01
Oil price shocks does not granger cause $DLRGDP_{OPEC}$	0.0157
$DLRGDP_{non\text{-}OPEC}$ does not granger cause Oil price shocks	0.0582
Oil price shocks does not granger cause $DLRGDP_{non\text{-}OPEC}$	0.0191

Table 5.7: Variance Decomposition of Oil price shocks: OPEC (1980-2008)

Period	***DLRGDP***
1	0.0000 %
2	2.8219 %
3	2.8889 %
4	2.8809 %
5	2.8863 %
6	2.8874 %

Table 5.8: Variance Decomposition of Oil price shocks: non-OPEC (1980-2008)

Period	***DLRGDP***
1	0.0000 %
2	2.8134 %
3	2.6813 %
4	2.6450 %
5	2.6358 %
6	2.6318 %