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The Impact of Oil Price Changes on Growth for Seven OECD Countries

An Empirical Investigation

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I confirm that this master's thesis is my own work and I have documented all sources and material used.

Venice, June 15, 2016 Raphael Max

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Abstract

This thesis examines the impact of oil price changes on growth of the countries: France, Germany, Italy, Japan, Norway, the United Kingdom and the United States. Following an introduction about the composition of crude oil, its pricing mechanism and the history of the oil price, the thesis contains an empirical part in which we examine how oil price increases and decreases have an impact on GDP growth of the countries on a quarterly basis and whether the impact is symmetric, i.e. whether oil price increases and decreases have the same impact.

We found a significant impact of oil price increases and decreases on economic growth using panel data. An oil price increase of 10 USD leads to a decline of economic growth by 0.11 percentage points within a year, whereas a decline of 10 USD in oil price support economic growth by 0.35 percentage points. This findings vary however across countries. Norway benefits significantly from an increase in oil prices due to a higher revenue for the oil production sector whereas Germany, Japan, the United Kingdom and the United States seem to suffer from oil price increases. On the contrary, Norway suffers from oil price decreases whereas the mentioned countries benefits from collapses in energy prices. Italy seems to benefit from oil price increases and suffer from oil price decreases as well. We have not found a significant effect of oil price increases in case of France. Furthermore we have found, that the impact of oil price changes on GDP growth in a fixed effects regression is indeed symmetric.

The results are compared with the actual impacts of the oil price plunge since 2014 after the description of the causes of the current collapse in crude oil prices.

Keywords: Crude oil, oil price, oil price changes, OECD, GDP growth, Fixed Effects

JEL Classification: E32, Q41, Q43

Contents

1 Introduction

Crude oil is ”a strategic commodity”, a ”political power”, the ”black gold” or as Abdel Mattaleb Kazemi, the former Kuwait oil minister, used to say, ”oil is everything” (Yergin 2011).

Perhaps these descriptions are a way to exaggerated, however it is a fact, that oil is the primary energy source of the world since the 1950s, with a current share of more than 31 percent of the global total primary energy supply (IEA 2015*c*). Economies and especially oil importing OECD countries depend on crude oil as an energy source for the residential, transportation, chemical, agricultural and industrial sector. Therefore are the economies of developed countries susceptible to changes of the price of crude oil. Oil exporting countries on the other hand depend on crude oil as it is their most important source of revenue. This crucial correlation between oil price movements and the performance of economies is the topic of this thesis.

The experiences made during the energy crisis of the 1970s with dramatic responses of OECD economies led to a bunch of research concerning the oil price and its impacts on the economy. James D. Hamilton has pointed out in 1983, that seven out of eight US recessions between World War II and 1983 have occurred right after an increase in the price of crude petroleum (Hamilton 1983). He concludes, that oil price increases are neither a necessary nor a sufficient condition for recessions, highlights however the strong correlation and marked a starting point of a lot of research on this connection. In 1994, Mork et al. published a paper which underlines the statement of Hamilton and mentions the different correlation patterns for oil price increases and decreases. The statements of this papers are the basement of our work and motivated us to have a look on this pattern with more recent data using a simliar empirical method.

The general idea behind oil price changes should be the following. An oil price increase leads to an increase in input prices for the industry and hence rise of consumer prices. Higher prices for consumers reduce their income and consumption which can cause inflation and economic decline. A decrease of oil prices should cause the opposite effects and thus have a positive impact on the economies of energy importing countries like Germany, France and Italy. Norway being a net oil exporter has a different relationship to oil price movements.

The fundamental questions discussed in this thesis are whether oil price increases and decreases have an empirical impact on economic growth and whether these impacts are symmetric, i.e. whether increases and decreases have the same impact. The outcome is compared among seven OECD countries and compared with the actual development of the economies after of the oil price plunge since 2014.

In chapter 2, we sum up the most important facts about crude oil, the history of the crude oil price and the most important players in the global crude oil market at the present time. After summing up the most relevant literature in chapter 3, we describe and present an empirical measure of the impacts of oil price changes on economic growth of selected economies in chapter 4. Chapter 5 is concerned with the oil price plunge since the end of 2014 including its causes, the differences to previous oil price plunges, macroeconomic impacts and possible policy interventions as an empirical investigation of the findings in chapter 4. In the concluding remarks in chapter 6, we endorse findings of this paper and highlight, that significance of the oil price for OECD economies is constantly declining due to more energy-efficient economies.

The appendix includes a summary of all variables used in our models, the complete listing of the empirical results, the explanation of all abbreviations and the demonstration of the Stata-Code used for the measurements.
The description of the creation of all figures and tables used in the thesis can be taken from the listing of figures and tables in the end of the work.

2 The Formation, Development and Determinants of the Crude Oil Price

The price of crude oil is one of the most important macroeconomic indicators and its interpretation gives a lot of information about opportunities, risks and the current conditions of the global economy. In this section we would like to show first of all a definition of crude oil, its composition and its possible products gained by refining the initial mass. Then we give a summary of the mechanism of the pricing of oil, the historical development of the crude oil price and as a last point we mention the most important current players in the global crude oil market and analyze its market form.

2.1 The Composition of Crude Oil and Its Products

The EIA (U.S. Energy Information Administration) defines crude oil as a "mixture of hydrocarbons that exists in liquid phase in natural underground reservoirs and remains liquid at atmospheric pressure after passing through surface separating facilities." Although crude oil is generally considered to be a homogeneous good, the composition of crude oil varies between different types. Crude oil consist of 84 to 87 percent Carbon, 11 to 14 percent Hydrogen, 0.006 to 2 percent Sulfur, 0.1 to 2 percent Nitrogen and 0.1 to 2 percent Oxygen (Hyne 2001, p. 1).

Different kinds of crude oil differ in their color and their range of applications. To measure the quality and compare different kinds of crude oil, the American Petroleum Institute established in 1921 the API gravity scale ($^\circ$API). It is calculated as the ratio of the density of crude oil to the density of a reference substance (normally water). The $^\circ$API is the most commonly used density scale and classifies crude oil in the classifications light, medium, heavy and extra heavy (Hyne 2001, p. 3).

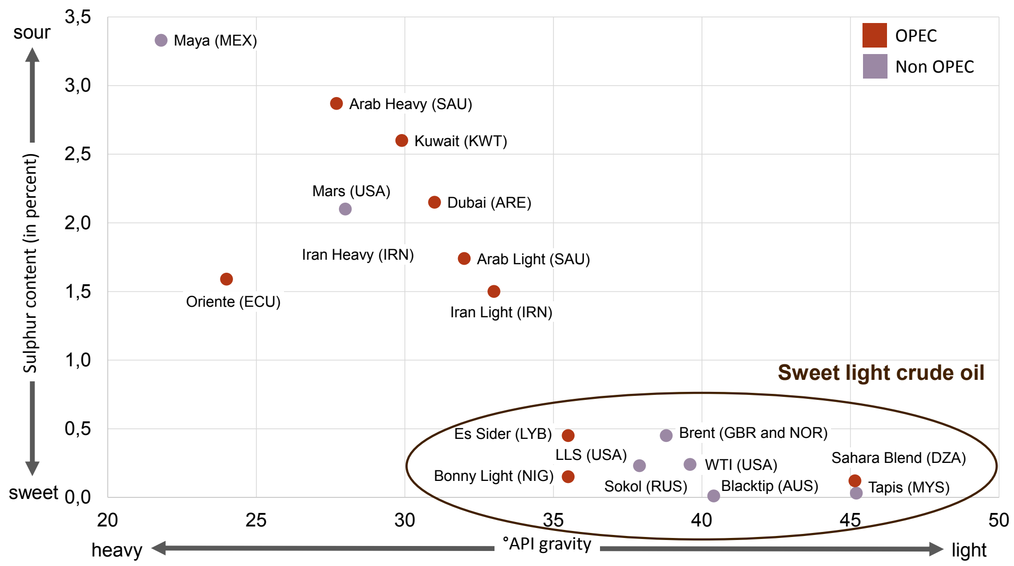
Table 2.1: Density of Crude Oil

Type of crude oil	API degree range
Light	higher than 31.1
Medium	between 22.3 and 31.1
Heavy	lower than 22.3
Extra Heavy	lower than 10.0

Another important characteristic of different crudes is the amount of sulfur. Crudes which have less than 0.5 percent sulfur by weight are called sweet crudes, between 0.5 and 1.5 percent medium sour and sour in case of more than 1.5 percent sulfur by weight (Maugeri 2006, p. 234). Because of the fact, that Sulfur causes undesired effects and hampers the extraction of petroleum products, light sweet crude oils are considered to have a higher quality and are therefore normally priced at a higher level. According to these factors it is possible to compare benchmark crude oils.
The following chart is based on a table designed by the U.S. Energy Information Administration to give an overview of the most important benchmark crudes (EIA 2016*b*).

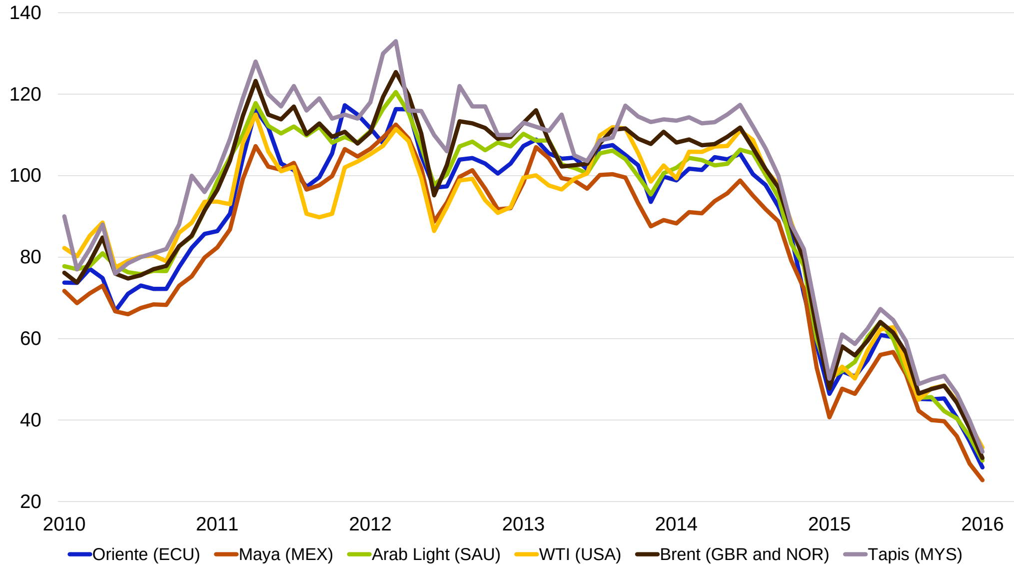
Benchmark crude oils are used as a standard to compare different kind of crude oils. We

Figure 2.1: Composition of Selected Benchmark Crude Oils



highlighted the crude oils produced and exported by OPEC countries in a red color and all the others in violet. The most important benchmark particularly in the United States is the **West Texas Intermediate** (WTI) with an °API of 38 to 40 and sulfur content of 0.24 to 0.5 percent according to different sources. The European equivalent is the **Brent Crude**, called after the brent (or brant) goose and is produced in the North Sea. Brent has a °API of 38 to 39 and 0.3 to 0.37 percent sulfur. The leading benchmark crude in the Middle East is the **Dubai Crude** with 30 to 31 degrees on the API gravity scale and around 2 percent sulfur. Dubai Crude is the most important crude of the OAPEC, the Organization of the Arab Petroleum Exporting Countries. Due to its high API gravity of around 43 degrees and very low sulfur content of only about 0.04 percent, the Malaysian benchmark oil, **Tapis Crude**, is considered to be the crude oil with the highest quality in the world. Tapis is mostly produced by the American company ExxonMobil in the South China Sea, East of Malaysia and traded in Singapore (ExxonMobil Corp 2016*b*).

Figure 2.2: Selected Benchmark Crude Oil Prices in USD/bbl



As we can seen in figure 2.2, the prices of different benchmark oil tend to deviate almost synchronously. Due to different qualities, storage conditions and produced quantities, the various benchmark oils have however slightly different prices. As seen, Tapis always constitutes to be the most expensive crude oil in the market. Although WTI for instance is considered to be of higher quality than its European counterpart Brent, the price of a barrel Brent is higher than WTI since several years. This is due to the overproduction of WTI in the American oil market and a comparatively stable production of Brent in the European oil market. This thesis will consider the price of the American benchmark oil WTI as it is commonly seen as the most important commodity indicator of energy markets.

The commonly used measurement unit of crude oil is a **barrel** (bbl). A barrel of crude oil is equal to 42 U.S. gallons, 34.97 imperial gallons or 158.9853 liters. The weight of a barrel balances about 140 metric kilograms, depending on its density (Hyne 2001, p. 7).

The direct consumption of crude oil for households is by implication not possible. Crude oil has first to be refined to produce a wide range of petroleum products as butane, propane, ethane, asphalt, lubricants and most importantly gasoline, diesel, jet fuels and heating oils. The price of crude oil has implications on the economy due to the consumption of these products gained by the refining.
Refining is a chemical engineering process in which the different products can be extracted depending on their boiling points. According to the EIA it is possible to extract the following amount of products from one barrel crude oil as seen in table 2.2. The composition varies between refineries, countries and of course the different types of crude oil. The overall outcome however is very similar.

Table 2.2: Products Extracted of One Barrel of Crude Oil

Products	in percent	in liters
Finished Motor Gasoline	45.3	72.0
Distillate Fuel Oil (Diesel and heating oil)	29.8	47.4
Kerosene-Type Jet Fuel	9.7	15.4
Petroleum Coke	5.3	8.4
Still Gas (Methane, ethane, butane, propane, etc.)	4.1	6.5
Liquefied Refinery Gases (Ethane, propane, butane, etc.)	3.7	5.9
Other as asphalt, naphtha or Lubricants	8.4	13.4
in total	106.3	169.0

The most important products gained by refining crude oil is gasoline, diesel and heating oil. These products are normally consumed directly by households and are mostly used for transportation or heating. The fact that the total output of a barrel crude oil exceeds 159 liters as shown in table 2.2, is due to the fact, that the extracted products have a lower

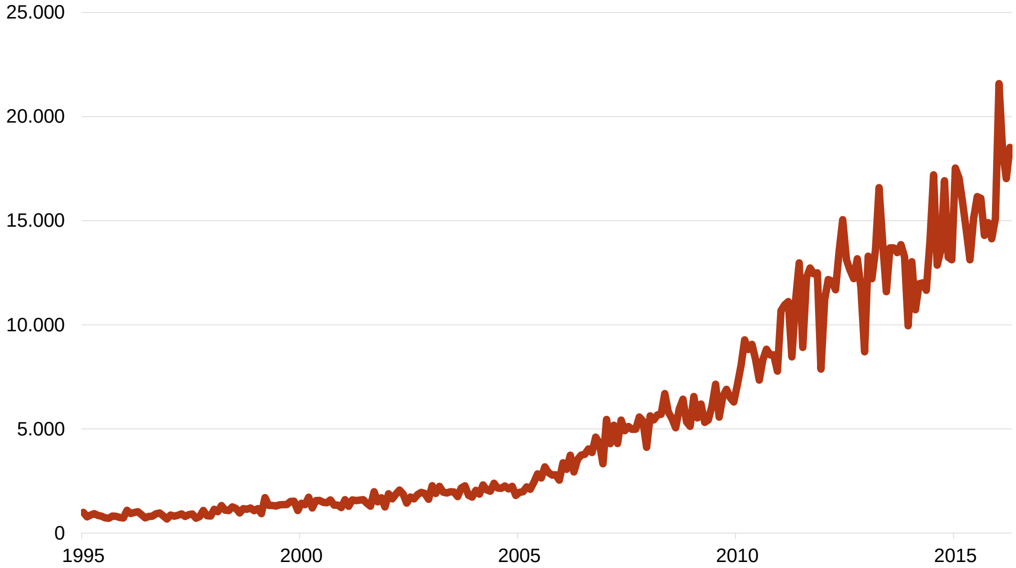
specific gravity than crude oil. Hence the average processing gain is about 6.3 percent (EIA 2016*f*).
The products shown in table 2.2 are fundamental elements of our current energy consumption. This mentioned facts make crude oil a major commodity and hence raises the significance of its pricing method. In the following sections, crude oil will be used as a synonym of the sort West Texas Intermediate.

2.2 The Pricing of Crude Oil

Until the 1970s energy crisis, the price of oil has been determined by the Seven Sisters, a cartel formed by the largest international oil companies. The price was a fictional price formed on the basis on the production costs of the oligopolists. Although this pricing mechanism changed during the years of the two oil crisis, the price of oil has always been connected to fundamental data, i.e. to physical supply and physical demand of crude oil. Until the mid-2000s, the paper oil market was therefore subordinate and played an inferior role. Since the mid-2000s however, the paper oil market is dominant and quite de-linked from physical deliveries and fundamental data. Private and institutional speculators, including the non-oil economy, dominate the market and are the basis of the pricing of oil. Today the price of oil is determined ”by financial instruments at non-oil paper markets via oil-related financial derivatives” (Goldthau 2013, p. 488).
In figure 2.3, we show the development of Brent futures traded every month at the International Exchange Inc. (ICE) since 1995. A futures contract trade unit is 1000 barrels and hence around 19 MMMbbl of crude oil are currently traded every month just at the ICE. This amount is almost seven times higher than the monthly physical production of crude oil of the entire world (around 2.7 MMMbbl) (BP plc 2016*b*). Having a look likewise on other futures exchanges (e.g. NYMEX, HKEx, SICOM or TOCOM) would even tighten this argument.
It is furthermore clearly visible, that the trend had an abrupt change in early 2005. Since 7 April 2005, the system of the ICE was shifted completely to electronic trading. This step resulted in a huge rise of the number of futures traded and increased tenfold within just 10 years.

An important underlining physical indicator for the determination of the oil price is ob-

Figure 2.3: Monthly Traded Crude Oil Futures at the ICE (in Thousand)



servable at the major trading hub of the United States in Cushing, a small city close to Oklahoma City (Energy Charter Secretariat 2007, p. 28). The price of oil in our thesis is not the futures price of oil at the ICE or NYMEX, but the FOB spot price of WTI used at the petroleum hub of Cushing.

2.3 Historical Overview of the Oil Price

The current situation of low oil prices since the end of 2014 has to be interpreted in an historical context. The oil price has seen several positive and negative shocks in the last decades. The decrease of more than 70 percent in less than 20 months down to 27 USD per barrel in February 2016 however can be considered to be historical. To get an overview of the movements of the oil price and the different reasons, we draw a historical overview to understand the current price movements.

2.3.1 The Oil Price Until the 1970s

Oil as a source of energy is known by human beings since the beginning of civilization. Petroleum as it is used today has been produced since the 1850s. On 27 August 1859, Edwin L. Drake and William Smith discovered petroleum in Titusville, Pennsylvania in the United States. Shortly after, the oil found ”its way to market refined as kerosene” (Yergin

2011, p. 28) and revolutionized not only the energy market of the United States but within some years of the entire world. John D. Rockefeller, an American business man made petroleum to the main input of domestic lightning within some decades and became the richest man on earth as the head of his company Standard Oil. In the following years, petroleum raised also the attention of several governments. The most important decision of a government concerning the usage of crude oil was made by Sir Winston S. Churchill, serving as the First Lord of the Admiralty of the United Kingdom during the outbreak of World War I. In 1911, he decided that the Royal Navy should use oil as primary fuel for its ships and not coal anymore, which served in the decades before. Warships running with oil have a 40 percent larger cruising radius, a higher maximum speed and it was primarily possible to refuel ships on the high sea. The Imperial German Navy, the competitor and future enemy of the Royal Navy, needed to plan to have always at least 25 percent of their ships going back to the coal bunker to refuel their tanks during a battle whereas the British ships fight with a maximum degree of capacity utilization. This and several other points lead the British government to change their energy policy (Yergin 2011, p. 201). World War I ended with a victory of the Allied Powers including the United Kingdom. One of the main reasons has been the victory on the sea against the Imperial Germany Navy due to the superiority of their ships.
Because of comparable decisions and an increasing demand both from governments and private users, oil has become the most important energy source by 1950 and replaced coal as the former primary energy source (Yergin 2011, p. 544).

Until the 1970s, the global oil market was mainly controlled by a group of seven companies. The group consisted of the Anglo-Persian Oil Company, Gulf Oil, Standard Oil of California, Texaco, Royal Dutch Shell, Standard Oil of New Jersey and Standard Oil Company of New York. This companies controlled around 85 percent of the known global oil reserves. Enrico Mattei, the head of ENI in the 1950s, coined the term ”Seven Sisters” to describe this oligopolistic group.
In September 1960 in Bagdad, several countries founded the Organization of the Petroleum Exporting Countries (OPEC) as a counter player of the ”Seven Sisters”.
As a consequence of very few players in the market, a strict public restriction of production level (e.g. by the Texas Railroad Commission) and a conceivable demand, prices have been stable until 1972 and experienced almost no volatility (Ebrahim et al. 2014).

The political events in the Middle East in late 1973 and the developments of the global oil market however brought changes to the global economies that last until today.

2.3.2 The Two Oil Price Shocks 1973-1982

In 1967, Israel gained a victory in the Six-Day War (or June War) against Egypt, Jordan and Syria and captured the Gaza Strip, the West Bank, the Golan Heights and the Sinai Peninsula. On Yom Kippur in 1973, the holiest day in Judaism, an Arab coalition led by Egypt and Syria attacked Israel to regain the lost territories. Due to the huge military success of the Arab countries within the first days, Western countries decided to come to the aid of Israel. As a result of the direct and indirect support by sending weapons, financial aid or the expression of political sympathy, the OAPEC (Arab members of the OPEC plus Egypt and Syria) reacted in late 1973 with proclaiming an oil embargo after raising the posted prices of crude oil by 70 percent up to 5.11 USD per barrel. The "Arab oil embargo", lasting from October 19th, 1973 to March 18th, 1974, consisted of two main elements. First the OAPEC members cut coordinated the supply, which had an impact on the entire market. Furthermore the OAPEC established a total ban on export of oil to the United States, the Netherlands and later to Portugal, South Africa and Rhodesia. During these crucial weeks, total world oil supply decreased about "4.4 million barrels per day, or about 9 percent of the total 50.8 million barrels per day that had been available in the 'free world' two months earlier" (Yergin 2011, p. 1397). As a consequence of these cutbacks and an increase of around 7.5 percent of the world oil consumption in the year before, this usage of the so called "oil weapon" lead to an increase of the oil price of 180 percent from 3.56 USD per barrel in July 1973 to 10.11 USD in early 1974 in nominal terms. In real 2015 terms, this corresponds to an increase from 19 USD to 61 USD. This sharp increase within short time is remembered as the first oil crisis. Many European countries and North America faced severe cutbacks that resulted in recessions, high inflation and increased unemployment. Western countries realized to which extent their economies depended on cheap crude oil. In the years after this energy crisis, Western energy policy changed and topics like energy efficiency and energy security became the essential concerns.

In the late 1970s, the world oil market had to undergo another crisis and a sudden rise in crude oil prices. Due to the Iranian Revolution in 1979, a raise of posted price of 14.5

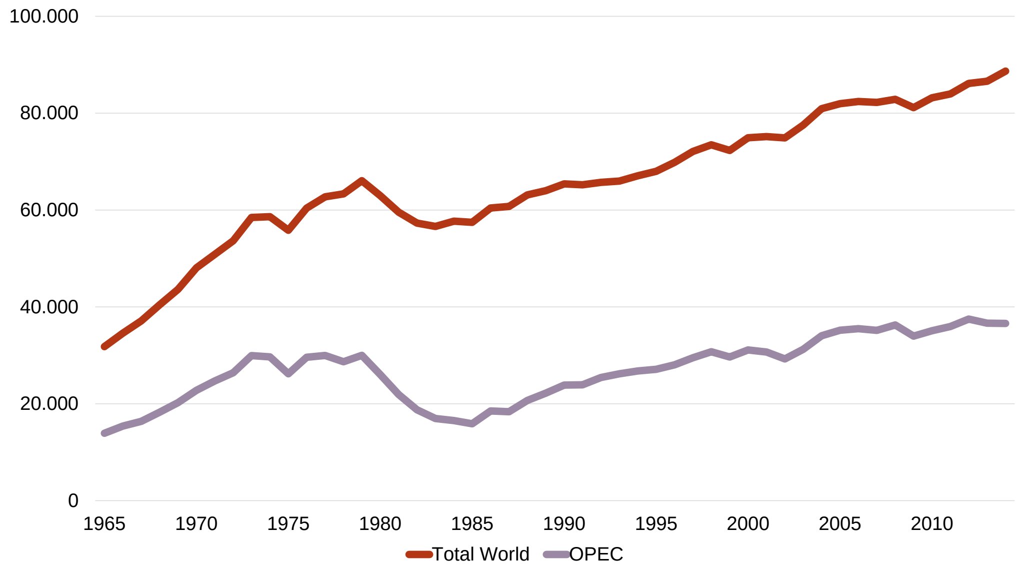
and later again 15 percent by OPEC, the abrupt cutoff of the Iranian oil supply and the outbreak of the Iraq-Iran War, prices raised from 14.85 USD per barrel in January 1979 to 39.50 USD in April 1980. Although the real cut in supply was not that significant, panic-fueled reactions on international commodity markets lead to an increase in such a manner. The impacts of the second oil crisis were kind of similar and worsened the situation of the countries that mostly had not recovered from the last crisis. High unemployment, inflation and far-ranging recessions followed. These two crisis lead to a change in energy policies in the western world. Many countries decreased their oil input and tried to use less energy in general. As a consequence of the desire to become more independent of oil suppliers in the Middle East, new technologies and sources were exploited like offshore pliable platforms. Decision maker in politics and business were much more concerned about the oil price in the following time.
After the second oil shock, it was commonly assumed, that high prices will last forever. The sharp decrease of the late 1980s, that lead to low oil prices again, yet changed this opinion.

2.3.3 Oil Glut, Markets and Operation Desert Storm 1983-1995

In the early 1980s, the oil market faced high prices and therefore many new players especially companies and countries saw the possibility to enter the market. New energy sources as offshore pliable platforms in Alaska and the North Sea or productions in the Caucasus or the Caspian Sea for instance became profitable. A huge number of different suppliers and demanders made the price somewhat independent of the decision of single players and these circumstances lead to the fact that it was possible to talk about an international oil market. Ronald Reagan and Margret Thatcher, the president of the United States and its counterpart, the Prime Minister of the United Kingdom, celebrated their ”attachments to free markets” and because of the increasing production in their countries, they also showed their ”indifference to whether oil prices were high or low” (Yergin 2011, p. 748).

The high prices in 1980 and 1981 were of course a desirable situation for countries like Saudi Arabia which were reliant on revenues of the oil exports. The glut of oil, especially by Non-OPEC countries and the ongoing drop of world oil demand however led to slightly falling prices. To keep prices high, OPEC members of the Persian Gulf region reached several agreements about cutting production to stable the price at a high level. As demon-

Figure 2.4: Global Crude Oil Production (1965 - 2014) in Mbbl/day



strated in figure 2.4, Non-OPEC countries kept production stable or could even increase it. In 1981 the OPEC lost its preeminent position and Non-OPEC members had the first time since decades a higher share of the total global oil output. In summer 1985, Saudi Arabia produced even less oil than the United Kingdom in the North Sea (Yergin 2011, p. 748). This remarkable development lead to the fact that OPEC lost a huge amount of their political and economic strength. Saudi Arabia was not anymore influential enough to change the prices by their own political decisions. After not finding a solution between the OPEC members, Saudi Arabia decided to increase their production again with the intention to avoid losing even more market share.
The result of the flooding of the global oil market was a plunge of 70 percent of the WTI oil price from a peak at 31.75 USD in November 1985 to around 10 USD in few months (Yergin 2011, p. 749). As shown in chapters 5, the sharp decrease of 2014 and 2015 has several parallels to the drop of 1985 and 1986 that was mainly driven by fundamental data, i.e. the enlargement of global oil supply within a short period.

The following years are characterized by increasing volatility and a reorder of the oil market caused by the fighting for market share. In the end of May 1990, the Iraqi leader Saddam

Hussein complained that the production of Kuwait exceeded the OPEC quota by around 700.000 barrels a day and saw in that point an "economic warfare" (Hayes 1990). The conflict between Iraq and Kuwait included other issues as well like the missing payback of debts, resulted in the invasion of Kuwait by the Iraqi military on 2 August 1990 (Tucker 2010, p. 619).
The starting Gulf War ended in an immediate rise from an average oil prices of around 17 USD in the summer of 1990. The peak was at about 36 USD in October, but went down again due to the instant military success of Operation Desert Storm in January 1991, the military intervention led by the United States against Iraq to protect Saudi Arabia (Tucker 2010, p. 367).

The end of the Cold War, that opened the market again for new players and the continuous fight for market share of the OPEC, led prices to keep relatively low at a level from 15 to 25 USD per barrel.

2.3.4 Breakdown and Recovery 1997-2003

After some years of relative stable prices, an oil demand shock caused by the East Asia Crisis brought the period to an end. During the second half of the 20th century, many countries in Asia like India and especially China have experienced a huge economic growth. This large economies had an increase of more than 2 percent in oil consumption per year in the period from 1994 to 1997 (Hamilton 2011, p. 19). In summer 1997, many countries in Asia got into economic difficulties due to financial issues, because of the fact that many investors developed doubts of the economic strength of the East Asian countries. The start of the so called East Asian Crisis, brought the picture of the "Asian Tigers" with large growing economies to an abrupt end and led oil prices fall again because of the drop of demand caused by economic recessions. The oil price at its bottom in June 1998 was at the lowest price since 1972 with less than 12 USD per barrel in average (Hamilton 2011, p. 20).
The crisis however has not lasted very long and the Asian countries resumed to grow again in the following years. The world oil demand appeared to be very strong in 1999 and 2000 and thus, combined with some cutbacks of OPEC procuders, resulted in the recovery of crude oil prices until late 2000.

During winter 2001-02, oil prices declined again from around 30 USD per barrel to less than 15 USD per barrel due to a decline in demand of crude oil as a consequence of an extraordinary warm winter 2001-02 in the United States with a new historical record for the highest average temperature for the 3-month period November 2001 to January 2002. The average temperature has been 39.34 degrees Fahrenheit, which equals 4.08 degrees Celsius and made the heating of households less important than in usual winters (US NOAA 2016).
Another reason for the collapse has been the decrease in passenger loads of airlines after the terrorist attacks of September 11th, 2001 in the USA. The fall in demand lead to a collapse of US jet fuel price by 15 percent in two months (Cranfield University 2012, p. 3).

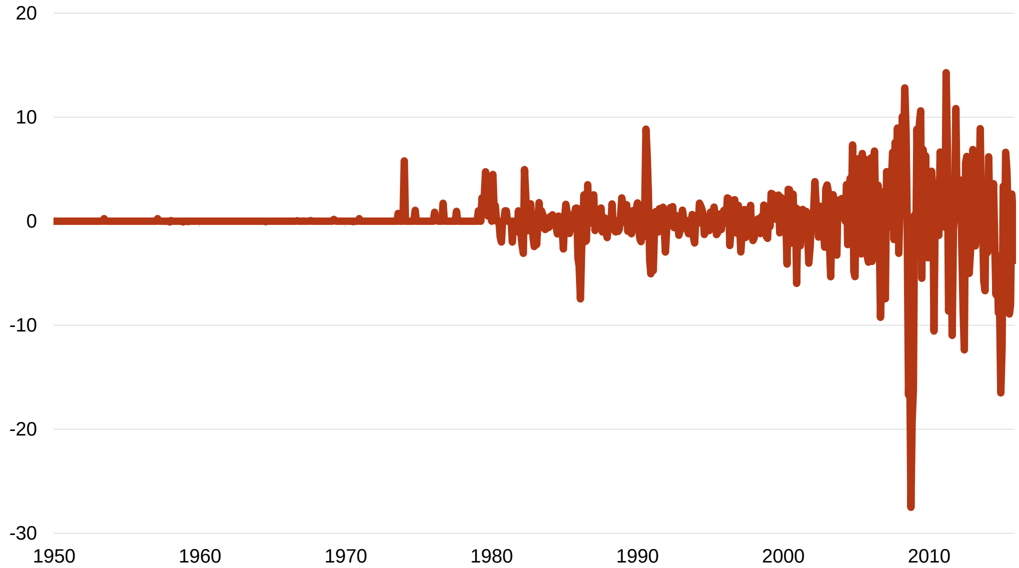
2.3.5 High Volatility, Financial Crisis and High Prices 2003-2014

The last decade is characterized by a high volatility and historically high oil prices due to several reasons. Generally it is important to distinguish between geopolitical and market specific reasons. Geopolitically crucial have been the aftermath of the September 11 attacks with the War in Afghanistan, the Iraq War of the United States against Ba'athist Iraq in 2003, the 2006 conflict between Israel and Lebanon and natural catastrophes like the hurricanes Katrina, Ivan and Cindy. These events had either impacts on the fundamental factors of the global oil market, i.e. either large changes in supply of demand of crude oil or just an increase in uncertainty. The war between Israel and Lebanon had for instance no perceptible changes in the oil supply, because of the fact that neither Lebanon nor Israel are part of the major players of the crude oil market mentioned in the following paragraph. Increasing uncertainty about the future and abrupt decreases of supply led therefore to a high volatile oil market.

Market specific reasons are a change in the pricing mechanism of crude oil stated in section 2.2. Until the beginning of the last decade, financial instruments in the oil market were merely used to hedge risks in the physical market.
Since ten years, the mechanism is quite different. ”The paper oil market is now dominant and is de-linked from physical deliveries, speculators dominate, including from non-oil sectors of the global financial market” (Goldthau 2013, p. 488). According to Ebrahim et al. this distortion can be expected to be one of the main reasons of the huge increase of the

oil price volatility in recent years. As it can be seen in figure 2.5, the monthly change in the crude oil price has increased almost symmetrically since the first oil price crisis in 1973. According to the degree of uncertainty generated by the volatility of the oil price, this de-

Figure 2.5: Monthly Changes of the Crude Oil Price in USD/bbl



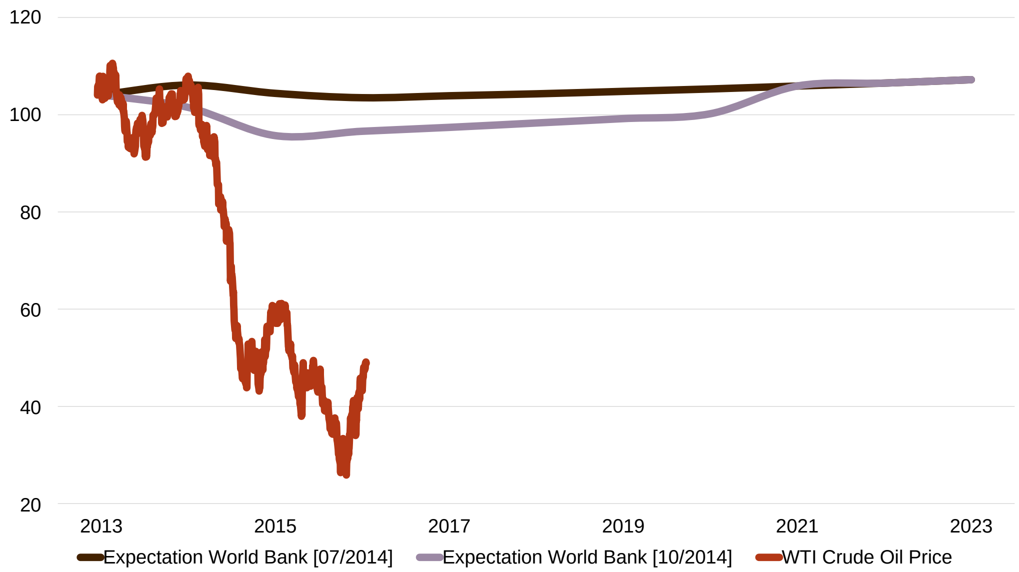
velopment has damaging and destabilizing macroeconomic effects (Ebrahim et al. 2014, p. 11).

During the Financial Crisis of 2007 to 2009, the crude oil price reached its all-time high at 147.27 USD per barrel on July, 11th 2008 (Read 2008). The main drivers of this rally have been a huge increase in global demand of oil and a stable supply from 2005 on. The peak has been reached however as a result of speculation. From July 2008 to November 2008, the oil price collapsed until a bottom of less than 40 USD per barrel due to a collapse in demand caused by the economic crisis in the main consumer countries and a general downward spiral at the financial markets.

In the years from 2010 to 2014, the crude oil price stabilized and remained at a stable level around 100 USD per barrel. Although a high volatility seemed to be a permanent problem, huge changes in prices had appeared to be a thing of the past.

The commodity price forecasts of the World Bank in July and October 2014 for the following years prove exactly this miscalculation. As almost all research institutes, the World Bank Group expected a slightly increasing but stable oil price of around 103 to 108 USD per barrel for the years 2014 till 2025. The figure 2.6 indicates the forecasts made by the

Figure 2.6: Expectations and the Actual Development of the Crude Oil Price in USD/bbl



World Bank Group in July and October 2014 and the actual price development in 2014, 2015 and 2016. It is clear visible, that the plunge of the oil price from autumn 2014 ongoing has not been forecasted and expected by research institutes. The IMF has even stated in late September 2014, that the likelihood of WTI prices falling below 60 USD per barrel is about 2.5 percent and the likelihood for WTI prices below 60 USD per barrel within 3 months 0.0 percent (IMF 2014). These forecasts have definetly not hold true. The crude oil price fell above 60 USD per barrel on 12 Dezember 2014 and collapsed down to 27 USD per barrel in February 2016.

The reason for the collapse of the crude oil price and its implications will be mentioned in chapter 5.

2.4 Major Players in the Oil Market

Few players in the global oil market are able to change significantly demand, supply or the price of oil. Although the market of crude oil has changed radically in the decades after World War II, it is still a market dominated by a small number of players and policymakers who's decisions have huge impacts. The most important parties on the demand side are firms depending largely on crude oil for their business as ocean carriers, airlines or the chemical industry. Because of the large number of firms and households consuming oil, no individual is actually able to influence the price of oil individually. This fact leads to reason to concentrate on the supply side.

On the supply side we face a different situation. The supply side is much more concentrated than the demand side. Hence few individual firms are able to have a significant impact on the global oil market.

Firstly, it is important to mention, that we have to distinguish between private companies and state owned companies. State owned companies, that means government-owned **National Oil Companies (NOCs)**, handle around 75 percent of proven oil reserves and around 60 percent of the global oil production. NOCs are owned at least 50 percent by the government and follow the political decisions of the government and offer for instance lower prices to citizens than to the global oil market. Energy subsidies also have to be mentioned in this relation (EIA 2016*h*). Their vulnerable effects for economies in major oil exporting countries will be mentioned again in 5.4.1.
Table 2.3 highlights the most important NOCs of the world.

Table 2.3: National Oil Companies (NOCs)

Company	Country	Year of foundation	Revenue (2015)	Reserves †
CNPC	CHN	1988	427 billion USD*	3,7
Saudi Aramco	SAU	1933	378 billion USD*	261,1
SINOPEC	CHN	2000	311 billion USD	3,05
Petrobras	BRA	1953	144 billion USD	4,3
PDVSA	VEN	1976	128 billion USD*	77,5
Gazprom	RUS	1989	93 billion USD	4,51
Pemex	MEX	1983	68 billion USD*	9,71*

*: Data of 2014, †: Proved and undeveloped reserves in MMMbbl

The NOCs follow the policy of the politicians and sovereigns. The objective of NOCs is basically to provide tax revenue for the state and come along with geopolitical targets of the governments rather than market targets. If it is said, that Saudi Arabia has decided to cut production, the Saudi Arabian oil company, Saudi Aramco, does so. Generally all players of the OPEC are National Oil Companies. Some NOCs like Petrobras (Brazil) or

Statoil (Norway) act independently of their government and follow primarily economic targets instead of geopolitical objectives (EIA 2016*h*).

On the other hand we have private companies, i.e. **International Oil Companies (IOCs)**. IOCs are investor owned companies that follow basically the target to maximize their share-

Table 2.4: International Oil Companies (IOCs)

Company	Country	Year of foundation	Revenue (2015)	Reserves †
Exxon Mobil	USA	1870	269 billion USD	1,90
Royal Dutch Shell	GBR/NLD	1890	265 billion USD	3,36
BP	GBR	1908	223 billion USD	4,69
Total	FRA	1924	165 billion USD	3,80
Chevron	USA	1984	130 billion USD	4,26
Phillips 66	USA	1917	99 billion USD	‡
ENI	ITA	1953	74 billion USD	1,23

†: Proved and undeveloped reserves of the companies and their associates in MMMbbl

‡: Phillips 66 does not have an own upstream sector

holder value. The decisions of the board of IOCs are generally based on economic targets rather than geopolitical factors. This companies are among the largest companies of the world by revenue. Table 2.4 indicates the largest seven IOCs that all have their headquarters in OECD countries, i.e. in the United States, the United Kingdom, the Netherlands, France and Italy.

As a result of the small number of players dominating the oil market, decisions of few policymakers and managers have a large impact on the price of crude oil.
This setting is equal to an **oligopoly**, i.e. a market with a small number of sellers and a large number of buyers.

The concentration of a market can be measured by the *concentration ratio*. The concentration ratio CR_x is defined as "the percentage of industry sales (or assets, output, labor force, or some other factor) accounted for by x number of firms in the industry" (Arnold 2015, p. 662). A number above 80 is usually seen as an oligopoly, whereas 100 means, that the market is a monopoly.
In a research study of 2004 in the United Kingdom, the following concentration ratios has

been estimated for the oil sector as percentage of the output and gross value added:

Table 2.5: Concentration Ratios for Oil Industry in GBR (2004)

	Output	Gross Value Added
CR_5:	57	59
CR_{15}:	82	84

The shown CR_{15} in table 2.5 proves, that the oil industry is a high concentrated oligopoly. If firms are explicitly agreeing on specific parameters, as for instance the produced quantity or their prices, the oligopoly is even a cartel.
As discussed in section 2.3.1 and 2.3.2, the "Seven Sisters" and the OPEC in the 1970s have been a efficient cartels.

In a cartel, quantity and prices are set like in a monopoly. Using the example of Boyes et Melvin (2012) demonstrated in figure 2.7 and 2.8, we can see the difference between a cartel and an oligopoly. In a perfect competitive market, all firms would be price-takers ($p = MC$) and would make zero economic profits.

Figure 2.7: Cartel

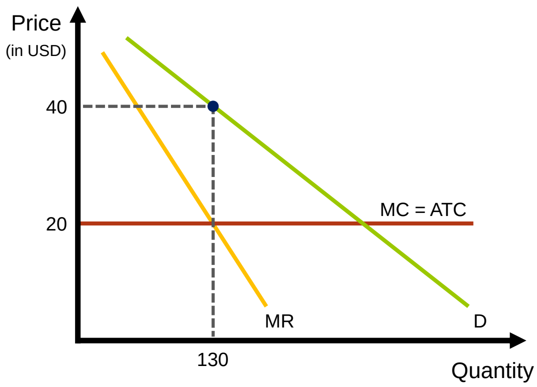
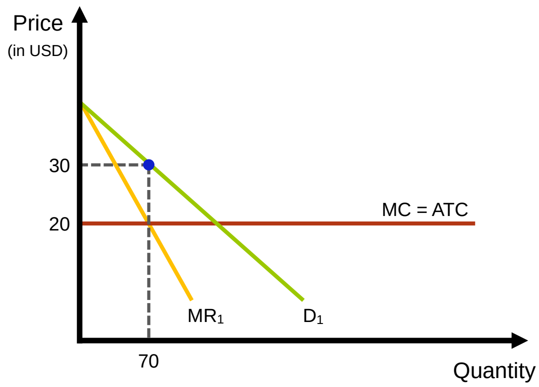


Figure 2.8: No Cartel



We assume to have two identical firms, firm 1 and firm 2. If they would act like a cartel, they agree on a specific profit maximizing quantity and could earn in our example:

$$1300\,USD = \frac{130 \times (40\,USD - 20\,USD)}{2} \tag{2.1}$$

In the case of an oligopoly (in this case a duopoly), the two firms would be competitors. Due to the competition in the market, both firms will set a quantity that would be slightly higher than in the case of a cartel, i.e. 70 instead of 65 as seen in figure 2.8. The new setting will however obligate the firms to set a much lower price, here 30 USD instead of 40 USD. The new profit of firm 1 (and firm 2) is 700 USD.

$$700\,USD = 70 \times (20\,USD - 10\,USD) \tag{2.2}$$

In case of a monopoly the profits would be therefore $1300\,USD$ for each firm or $2600\,USD$ combined whereas in a duopoly just $1400\,USD$ combined.
This is an example for a standard Cournot-Duopoly one shot game.

Instead of fixing prices, it is common in an oligopoly to use a "cost-plus" or "markup-pricing" strategy. This means, that the firms compute their average costs of producing their product and then set the price of the product at a specific amount above its actual cost. If all firms are setting an similar markup, it sometimes appears to be a matter of an explicit price fixing strategy (Boyes & Melvin 2012, p. 238).
Having the setting of a cartel, a firm could have an incentive to exploit the advantages and cheat on the agreed quantity. If firm 1 would for instance produce 70 instead of 65, its profits could rise to $1400\ USD$ ($70 \times (40\ USD - 20\ USD)$). If firms are however not following the policy agreed in a cartel, other members could terminate the cooperation and suspend the member. Such a decision could though lead to a loss of market power of the entire cartel in the long run. This scenario is comparable with the situation of OPEC in mid-1980s as discussed in section 2.3.3 and the current dispute between the Kingdom of Saudi Arabia and the Islamic Republic of Iran mentioned in section 5.1.3.

As there are few suppliers and a large number of buyers in the global oil market, it is reasonable to conclude that the market has the form of an oligopoly. The amount of suppliers and their different backgrounds shows however, that there are no efficient cartels anymore and therefore we assume oil prices to be exogenous.

Following the method of the pricing of oil (cf. section 2.2), we also have to mention the group of traders, hedgers, investors and speculators as important players in the oil market.

Hedge funds, banks, pension funds and individuals are trading in the oil paper market and have therefore influences on its development. Every participant thus has limited power to change global oil prices individually.

The impact of changes of the oil price is part of the following chapters 3 and 4. First, we mention the relevant literature dealing with the linkage of oil price changes and economic growth. Secondly, we describe the method and results of our empirical measure based on the paper written by Mork et al. (1994) and in a chapter 5 we compare our findings with the actual changes of the GDP in major OECD countries after the plunge of the price of oil since the end of 2014.

3 Literature Review

Large increases in oil prices within a short time have historically led to recessions and inflation in many countries. This observation caused a lot of research dealing with the link of the price of crude oil and economic activity and inflation. Following the research, this thesis deals with the impact of oil price movement on economic growth of selected OECD countries.

As mentioned in chapter 1, the most relevant paper on this topic has been published by James D. Hamilton in 1983. Hamilton investigated the questions whether the correlation between oil prices and recessions is just an coincident or whether there is another third impact that occurs always with oil price changes and is actually causing the changes both in GDP growth and in oil prices. Hamilton found evidence to reject the null hypothesis of a non existing relation between oil price changes and real economic output. Furthermore Hamilton points out that the changes of GDP occur after a specific time period, i.e. 3-4 quarters after the oil price changes (Hamilton 1983, p. 246).

The most important underlining source for our investigations is the paper of Mork et al. (1994). We are following partly the procedure of Mork et al. using more recent data and adding Italy as a sample country to the regression to have a larger sample of European countries. Mork et al. found a weak but significant correlation between oil price changes and economic growth. The most notable correlations are visible in Germany and Norway. Moreover oil price increases and decreases are not symmetric but however tend to have an opposite sign (Mork et al. 1994, p. 34).

Jimenez-Rodriguez et Sanchez (2004) found a significant interaction between the oil price and macroeconomic variables in at least one direction of all countries in their sample and both directions for most of the underlining countries using a Granger causality-type analysis. Other than Mork et al., Jimenez-Rodriguez et Sanchet used just four instead of five lags (Jimenz-Rodriguez & Sanchez 2004, p. 26).

Barrell et Pomerantz (2004) points out that a permanent oil price shock should always reduce output in the long run due to the changes in the terms of trade and the real interest rates of OECD countries (Barrell & Pomerantz 1983).

Carabenciov et al. (2008) included an US bank lending tightening variable to estimate financial-real linkages. An oil price plunge of 10 percent leads according to Carabenciov et al. to a change in GDP growth of 0.2 percent in the USA and around 0.06 percent in the Euro area (Carabenciov et al. 2008). An important concern for this paper is, that the regressions have been made without data of the financial crisis and the huge plunge of commodity prices in fall 2008. The findings could therefore be less representative.

Peersman et van Robays (2010) alludes to the importance of handling demand and supply driven oil price shocks in different ways. Oil demand shocks are driven by global economic developments. These shocks lead to a real GDP decline in all oil importing countries whereas oil exporting countries could even gain. Furthermore Peersman et van Robays underline the fact that countries which are investing in their energy portfolio and are reducing energy dependency became much less vulnerable to demand driven and especially supply drivenoil price shocks (Peersman & Van Robays 2010).

Ghalayini (2011) demonstrates a negative impact of oil price increases and economic growth for oil importing countries and a positive impact for major oil exporting countries by using a Granger causality-test. The main findings demonstrate, that this relation does hold just true for the G7-group Ghalayini (2004).

Although the specific subject of the research and the methods vary among the papers, all projects found a negative and significant correlation between oil price changes and real GDP growth for oil importing countries. Taking this as a basement and combining the already mentioned peculiarities, we measure the impact of oil price movements in the following chapter 4.

4 Empirical Measure of the Impact of Oil Price Changes

Following the explanation of the composition of crude oil, its pricing mechanism and the historical oil price development over the last decades, we examine in this chapter, which impact changes in oil prices have on the growth of selected economies. Similar to Mork et al. (1994), we have chosen the OECD member countries Germany, France, Italy, Japan, Norway, the United Kingdom and the United States. Norway, the United Kingdom and the United States are essentially interesting, because the countries are large oil producers and exporters and therefore changes in oil price can be expected to have different impacts on the growth of their gross domestic product (GDP) than on the GDP of major energy importing countries like Germany, France, Italy and Japan.

Table 4.1: Net Energy Imports (Percent of Energy Use) in 2014

DEU	60.89
FRA	43.58
ITA	75.38
JPN	94.03
NOR	-543.71
GBR	39.60
USA	10.30

Table 4.1 highlights the share of net energy imports to the energy use in percent in 2014 taken from the WDI database of the World Bank. This table is an indicator of the importance of crude oil for the different economies in our sample.

It is clearly visible, that the seven countries are depending on crude oil in a different way. Norway produces around 1.6 MMbbl per day, which is much more than it actually needs. The net energy imports in percent of their energy use are therefore strongly negative. Although the United Kingdom produces around 0.9 MMbbl per day, it is not able to cover all the energy used in the country and has to import around 40 percent. Most of the oil imported by the United Kingdom is coming from Norway. From 1981 to 2005, the United Kingdom though has been a net exporter of crude oil (UK Department of Energy and Climate Change 2015).

The United States are with currently more than 9.1 MMbbl per day one of the largest crude oil producers in the world (BP plc 2016*b*). This amount however is not even sufficient to cover the energy needs of the American economy. The United States import moreover around 10 percent of their energy use.

France, Germany, Italy and Japan are net energy importing countries. As Japan is importing 94 percent of its energy use from other countries, it can be assumed, that a change in energy prices has a more significant effect on the Japanese economy than for instance on the French, with imports just around 44 percent. Furthermore we have chosen Italy instead of Canada as Mork et al. 1994 did, to have a larger sample of European countries.

The three major questions that tried to be answered in this chapter are:

Is the correlation between oil price changes and GDP growth positive or negative?

Is the finding the same for oil price increases and decreases?

Does the pattern vary among the countries in the sample?

To give answers to these questions, this chapter is composed of five parts. First we explain the theoretical model behind the estimations, then we show our empirical strategy leaned on the procedure of Mork et al. (1994) and moreover we make mention of the source of the data taken for the regression. In the end we show and comment the results of the empirical measure.

4.1 Theoretical Model

Based on Hansen (1985), Christiano et Eichenbaum (1991), Kim et Loungani (1992) and Mork et al. (1994), we designed the theoretical model as follows.

We have a neoclassical, dynamic standard real business cycle model. Besides labor and capital, energy enters as a third input into the model. The price of oil is determined at the global oil market and enters therefore as an exogenous variable (cf. section 2.4) . As productivity shocks being exogenous as well, Kim et Loungani (1992) motivate to keep them in the error term. Since the cost of energy has a different effect on various economies, the amount of energy imports and an additional variable for the level of industry have to be added to the model as well. Kim et Loungani (1992) assume that the nominal wage is rigid just in the case of oil price increases.

An oil price increase has therefore the following effect on GDP:

$$GDP_{opinc} = -e\left(\frac{1}{1-cs_{cap}} - \sigma\right) \tag{4.1}$$

The value ratio of oil imports to GDP is e. In the case of Norway, this ratio will be negative. As stated in table 4.1, Japan will have the highest ratio. The variable σ is the elasticity of substitution between labor and energy as input factors for production and cs_{cap} is the cost share of capital in the production. If $\sigma < (1/(1-cs_{cap})$, the effect of an oil price increase on GDP will be negative.

On the other hand we have the effect of oil price decreases on GDP, with η being the elasticity of labor.

$$GDP_{opdec} = -e\eta \tag{4.2}$$

If $\eta > 0$ and $\sigma+\eta < 1/(1-cs_{cap})$, GDP_{opdec} will be smaller in absolute value than GDP_{opinc}. The effect of an oil price increase should be negative on GDP for contries in which the energy production sector does not have a significant size. Vice versa, a decrease in oil prices will have a positive impact. A positive or negative correlation for both scenarios is just possible, if the elasticity of labor supply is small enough and the energy sector of the economy is very large (Mork et al. 1994).

In the next paragraph we explain the empirical strategy to measure the mentioned correlations.

4.2 Empirical Strategy

Following the procedure of Mork et al. (1994) the measure is split into different parts. First we measured the bivariate correlation between oil price changes and the GDP growth on a quarterly basis. Secondly, the bivariate correlation is tried to be explained by using a multivariate vector autoregressive model and as a third step we checked the correlations by a panel regression using the fixed effect method.

4.2.1 Bivariate Correlations

The regression function for the bivariate correlations is the following:

$$gdpg_t = a_0 + \sum_{j=1}^{5} a_j \; gdpg_{t-j} + \sum_{j=0}^{5} b_j^{+} \; opinc_{t-j} + \sum_{j=0}^{5} b_j^{-} \; opdec_{t-j} + u_t \tag{4.3}$$

The formula includes a constant, the first five lags of the quarterly GDP growth rate, the first five lags of the price increases and decreases and an error term with j being the respective lags in quarters.

The first regression includes the following variables:

$gdpg_t$: Growth rate in real GDP
$opinc_t$: Absolute change of the price of oil if this value is positive
$opdec_t$: Absolute change of the price of oil if this value is negative

The underlining $opchange_t$ is the difference of oil prices between two quarters in the country specific currency.

$$opinc_t = \begin{cases} |opchange_t| & \text{if } opchange_t > 0 \\ 0 & \text{otherwise} \end{cases} \tag{4.4}$$

$$opdec_t = \begin{cases} |opchange_t| & \text{if } opchange_t < 0 \\ 0 & \text{otherwise} \end{cases} \tag{4.5}$$

We added the ISO 3166-1 alpha-3 country codes for every country to the notation of the $opchange_t$ for a better distinguishability (cf. glossary). Hence the increase and decrease of the oil price of Germany is for instance notated as $opincdeu_t$ and $opdecdeu_t$.

Using the outcome of the regression, we test the following statements by running three different tests.

Test 1: Oil price increases have no effect on real GDP growth
H_0: $opinc_j = 0 \, , \, \forall \, j = 0, 1, ... 5$
H_a: $opinc_j \neq 0 \, , \, \exists \, j = 0, 1, ... 5$

Test 2: Oil price decreases have no effect on real GDP growth
H_0: $opdec_j = 0 \, , \, \forall \, j = 0, 1, ... 5$
H_a: $opdec_j \neq 0 \, , \, \exists \, j = 0, 1, ... 5$

Test 3: The effects of oil price increases and decreases are symmetric:
H_0: $opinc_j = opdec_j \, , \, \forall \, j = 0, 1, ... 5$
H_a: $opinc_j \neq opdec_j \, , \, \forall \, j = 0, 1, ... 5$

4.2.2 Multivariate Correlations

The regression function of the multivariate correlations for every country is the following:

$$
\begin{aligned}
gdpg_t = a_0 \; &+ \sum_{j=1}^{5} a_j \; gdpg_{t-j} \; + \sum_{j=0}^{5} b_j^{+} \; opinc_{t-j} \; + \sum_{j=0}^{5} b_j^{-} \; opdec_{t-j} \; + \\
&+ \sum_{j=1}^{5} c_{infl\,j} \; infl_{t-j} \; + \sum_{j=1}^{5} c_{intr\,j} \; intr_{t-j} \; + \sum_{j=1}^{5} c_{unemp\,j} \; unemp_{t-j} \; + \\
&+ \sum_{j=1}^{5} c_{indu\,j} \; indu_{t-j} \; + \sum_{j=1}^{5} c_{oilim\,j} \; oilim_{t-j} \; + \; u_t
\end{aligned}
\tag{4.6}
$$

Following the procedure of Mork et al. (1994), we furthermore added five explanatory variables with respectively five lags. In addition to the bivariate correlation in section 4.2.1, the second process includes hence the following variables:

$infl_t$:	Overall inflation, measured by CPI
$intr_t$:	Short-term interest rate
$unemp_t$:	Unemployment rate
$indu_t$:	Growth rate of the industrial production index
$oilim_t$:	Value ratio of energy imports to GDP

After assessing the outcome of this regression, we test the the same statements as mentioned in section 4.2.1.

4.2.3 Fixed Effects

Due to the fact that we are interested in the impact of variables which are changing over time, we are running a fixed effects regression to assess the net effect of oil price changes on quarterly real GDP growth.

In a first step (**FE1**), using the same structure as in section 4.2.2, we are doing a fixed effects regression including all five independent variables. In this regression we are just using however four instead of five lags, following the procedure of (Jimenz-Rodriguez & Sanchez 2004).

After assessing the specific outcome of this regression, we are running furthermore a second fixed effects regression without adding a lag structure to the additional independent variables (**FE2**), i.e. just four lags for the dependent variable and the oil price changes.

In a third step, we have excluded Norway from our sample set, to see whether the outcomes changes in case of just having net oil importing countries in our sample (**FE3**).

To measure the significance and symmetry of the effects we are doing an unit root test for $gdpg_t$ and the same tests as in 4.2.1 and 4.2.2 to check the significance and potential symmetry of the impacts of the oil price movements.

4.3 Data Sources

Following the paper of Mork et al. (1994), the data has been taken mainly from the Main Economic Indicators (MEI) of the OECD.
The oil price changes, i.e. $opinc_t$ and $opdec_t$ are the quarterly changes of the global price of WTI Crude (POILWTIUSDM) from the IMF retrieved from FRED, the database maintained by the Federal Reserve Bank of St. Louis.

To bypass potential deviations of the results occurred due to changes in currency exchange rates not related to the oil price movements, the oil prices have first been converted into the local currencies of the respective country. The quarterly exchange rates to the USD are on the basis of the average daily rates for the specific countries and part of the MEI.

The following list shows the country specific codes of the indicator:

$France$:	CCUSMA02FRQ618N
$Germany$:	CCUSMA02DEQ618N
$Italy$:	CCUSMA02ITQ618N
$Japan$:	CCUSMA02JPQ618N
$Norway$:	CCUSMA02NOQ618N
$United\ Kingdom$:	CCUSMA02GBQ618N

The data for our investigation has been taken from:

$gdpg_t$:	Quarterly Growth Rates of real GDP, change over previous quarter, Quarterly National Accounts MEI, OECD
$infl_t$:	Consumer Prices, growth over previous quarter, MEI, OECD
$intr_t$:	Three month interbank rate, Key Short-Term Economic Indicators, OECD
$unemp_t$:	Harmonized Unemployment Rates (HURs), quarterly data, Short-Term Labor Market Statistics, MEI, OECD
$indu_t$:	Industrial Production, growth over previous quarter, MEI, OECD
$oilim_t$:	Imports of oil products in metric tons, quarterly data, Quaterly Statistics of Oil, Gas, Coal and Electricity, IEA (just data from 1997 to 2015)

4.4 Results

As mentioned in paragraph 4.2, the empirical measure contains three parts. The results of the first and the second part are differentiated by the specific countries whereas in section 4.4.3, we show the results for all countries together.

4.4.1 Bivariate Correlations

The regressions of bivariate correlations have been made just to see whether there is in general a direct connection between oil price changes and the real GDP growth.

As seen in the table 4.2 and in the appendix, the correlation is very weak in every country. The only findings worth mentioning are the negative response of Germany, Italy, Norway and the United Kingdom to oil price increases after some quarters and the significant immediate positive response of France, Japan, Norway and the United States to oil price decreases.

Having a look on the tables of the significance tests in the appendix, we can see that we can just reject the H_0 in the case of oil price decreases in Japan on a 10 percent level. The test of symmetry are just significant in a few cases, but not enough to make a reasonable conclusion.

Table 4.2: Bivariate Correlations (1980 - 2015) by Country

	DEU	FRA	ITA	JPN	NOR	GBR	USA
L0.opinc	0.004	-0.002	-0.007	-0.003	-0.003	-0.011†	-0.006
	(0.011)	(0.005)	(0.007)	(0.009)	(0.015)	(0.007)	(0.007)
L1.opinc	0.000	0.005	0.003	-0.015	-0.002	-0.002	-0.006
	(0.011)	(0.005)	(0.007)	(0.009)	(0.015)	(0.007)	(0.007)
L2.opinc	0.027*	0.001†	0.014†	0.010	0.020	-0.008	0.002
	(0.011)	(0.005)	(0.008)	(0.008)	(0.015)	(0.007)	(0.007)
L3.opinc	-0.024*	-0.002	-0.010**	0.003	-0.012	-0.011†	-0.005
	(0.011)	(0.005)	(0.008)	(0.008)	(0.015)	(0.007)	(0.007)
L4.opinc	-0.002	0.001	-0.002	-0.002	-0.026†	-0.006	-0.002
	(0.011)	(0.005)	(0.008)	(0.08)	(0.015)	(0.007)	(0.007)
L5.opinc	0.0000	-0.004	-0.002	-0.007	-0.010	-0.019	-0.005
	(0.011)	(0.005)	(0.007)	(0.08)	(0.015)	(0.007)	(0.007)
L0.opdec	0.016	0.011*	0.009	0.015	-0.016	0.009	0.021**
	(0.010)	(0.005)	(0.007)	(0.012)	(0.015)	(0.007)	(0.007)
L1.opdec	0.015	-0.009†	0.006	0.023*	0.035*	0.001	-0.003
	(0.011)	(0.005)	(0.008)	(0.012)	(0.015)	(0.007)	(0.007)
L2.opdec	-0.003	-0.004	-0.012	-0.020	-0.006	0.001	-0.003
	(0.011)	(0.005)	(0.008)	(0.012)	(0.016)	(0.007)	(0.008)
L3.opdec	-0.009	0.002	-0.007	0.003	0.012	-0.011	-0.005
	(0.011)	(0.005)	(0.008)	(0.012)	(0.016)	(0.007)	(0.007)
L4.opdec	0.008	-0.005	0.003	-0.017	0.007	0.004	-0.002
	(0.011)	(0.005)	(0.008)	(0.012)	(0.016)	(0.007)	(0.008)
L5.opdec	-0.006	-0.000	-0.005	-0.008	0.000	-0.005	0.005
	(0.011)	(0.005)	(0.008)	(0.012)	(0.015)	(0.007)	(0.008)
N	136	136	136	139	136	136	139
Log-L	-170.15	-62.20	-120.46	-198.09	-209.88	-102.52	-121.44

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

4.4.2 Multivariate Correlations

The outcome of the multivariate correlations is of much more interest. Being confronted with the poor outcome of the bivariate correlation in 4.4.1, we see the changes after adding the five explanatory variables with their five respective lags.

First of all we can see in table 4.3, that Germany, France, Japan, Norway, the United Kingdom and the United States have some significant negative responses to oil price increases. It could be of interest to highlight that these responses are not immediate but three or four quarters later. This could be a sign that in the short run existing contracts

Table 4.3: Multivariate Correlations (1997 - 2015) by Country

	DEU	FRA	ITA	JPN	NOR	GBR	USA
L0.opinc	-0.004	0.010	-0.017*	-0.062**	0.025	0.014†	-0.012
	(0.013)	(0.007)	(0.007)	(0.012)	(0.018)	(0.008)	(0.008)
L1.opinc	-0.016	0.003	0.012†	-0.047	-0.028†	0.019**	0.020†
	(0.013)	(0.006)	(0.007)	(0.025)	(0.017)	(0.008)	(0.008)
L2.opinc	-0.034**	-0.008†	0.008	-0.042	0.006	-0.011	0.004
	(0.013)	(0.007)	(0.008)	(0.030)	(0.018)	(0.007)	(0.008)
L3.opinc	-0.019	-0.008	0.020*	-0.087*	0.035*	-0.022**	-0.009
	(0.013)	(0.006)	(0.008)	(0.032)	(0.017)	(0.007)	(0.009)
L4.opinc	0.005	-0.006	0.011†	0.012	-0.009	-0.026**	0.008
	(0.013)	(0.008)	(0.006)	(0.029)	(0.014)	(0.008)	(0.008)
L5.opinc	-0.026*	-0.001	0.020**	-0.022	-0.009**	-0.030	-0.020*
	(0.010)	(0.005)	(0.005)	(0.019)	(0.013)	(0.007)	(0.009)
L0.opdec	0.019	0.010	0.004	0.048	-0.038	-0.024**	0.019*
	(0.014)	(0.007)	(0.009)	(0.012)	(0.015)	(0.009)	(0.008)
L1.opdec	0.067**	-0.0189	0.004	0.020	0.052**	0.015	0.008
	(0.019)	(0.012)	(0.010)	(0.014)	(0.017)	(0.012)	(0.011)
L2.opdec	0.030	-0.0306*	-0.026*	0.018	-0.003	0.006	-0.021*
	(0.023)	(0.012)	(0.011)	(0.017)	(0.018)	(0.011)	(0.011)
L3.opdec	0.069**	0.0090	-0.019†	0.047**	0.023	0.027*	0.015
	(0.024)	(0.011)	(0.012)	(0.015)	(0.002)	(0.011)	(0.011)
L4.opdec	0.014	0.0236†	-0.026*	-0.071**	0.024	0.025**	0.015
	(0.041)	(0.012)	(0.011)	(0.020)	(0.002)	(0.010)	(0.013)
L5.opdec	0.070**	0.0304*	-0.030**	0.042*	0.058	0.039**	0.006
	(0.021)	(0.013)	(0.009)	(0.022)	(0.020)	(0.012)	(0.015)
N	68	67	67	50	68	67	71
Log-L	-38.81	2.78	-0.28	-28.86	-54.37	-2.35	-23.89

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

between oil importing countries and oil exporting countries could give the oil importing countries (like Germany and France) the chance to import crude oil by paying a cheaper price negotiated in the contract.

If oil prices are decreasing, the economies of Germany, Japan, Norway and the United Kingdom are responding in a positive way for some lags. In contrast to the pattern of oil price increases, this responses occur much faster.
Norway, Italy, the United Kingdom and the United States seem though to gain as well from oil price increases for some lags.

An important issue in this regressions is the small sample size. As it can be seen in table 4.3, we have just 67 samples in average, due to the fact that the quarterly data for this regression (i.e. data for $oilim_t$) is just available from 1997 on.
Having a look on the F-test, we can see that oil price decreases have a strong significant impact on all economies in the sample. Besides the case of France, the H_0 can be rejected for all countries. The outcome of the test for symmetry brings us to the conclusion, that oil price increases and decreases tend to have symmetric impacts.

For a deeper understanding of the multivariate correlations, the outcomes of every single country (including the respective tests for significance and symmetry) have been listed in the appendix in section B.1 to B.7.

To increase the sample size and eliminate country specific effects, we are now looking on the fixed effect regressions.

4.4.3 Fixed Effects

The entire outcome of all three fixed effect regressions are listed in the appendix in section B.8.

Fixed Effects - Lag structure for all variables (FE1)
First we used a lag structure for all five explanatory variables. That means that all included variables have four lags. The sample size has been increased up to 468 observations.

Oil price increases do not seem to have a significant impact on GDP growth. Oil price decreases however do have a significant positive impact on GDP growth after four lags on a five percent level. Neither the H_0 for oil price increases nor the H_0 for oil price decreases can be rejected at a five percent level.
A conclusion for the question whether oil price increases and decreases have symmetric impacts can not be reasonably drawn as well.

Table 4.4: Lag Structure for All Variables (FE1)

Variable	**Coefficient**	**(Std. Err.)**
L0.opinc	-0.001	(0.004)
L1.opinc	0.002	(0.004)
L2.opinc	0.000	(0.004)
L3.opinc	0.001	(0.003)
L4.opinc	-0.005	(0.003)
L0.opdec	0.007*	(0.004)
L1.opdec	0.000	(0.004)
L2.opdec	-0.002	(0.005)
L3.opdec	0.004	(0.005)
L4.opdec	0.011*	(0.005)
N	468	
R^2	0.555	
$F_{(33,428)}$	23.55	

Significance levels : † : 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_t$ due to shortage of space.

Figure 4.1: Oil Price Increase FE1

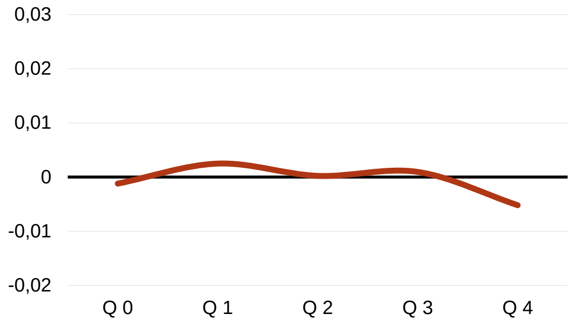
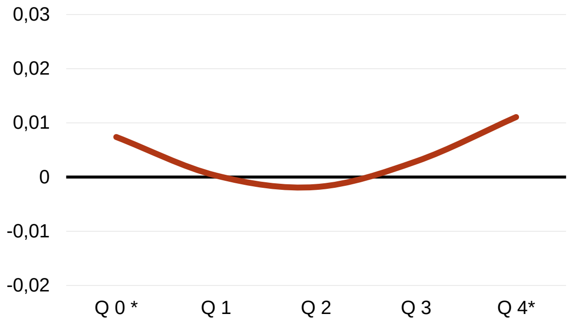


Figure 4.2: Oil Price Decrease FE1



The trend of the impact of the changes, illustrated in figure 4.1 and figure 4.2, deviates accordingly close to the zero line.

Fixed Effects - Lag Structure for gdpg, opinc and opdec (FE2)

The outcome of our second fixed effects regression is the following:

Due to the fact, that the z-values of the explanatory variables have a strongly differing value (i.e. the first lag of $indu_t$ seems to be biased), we made the regression without adding a lag structure to the independent variables.

Table 4.5: Lag Structure for gdpg, opinc and opdec (FE2)

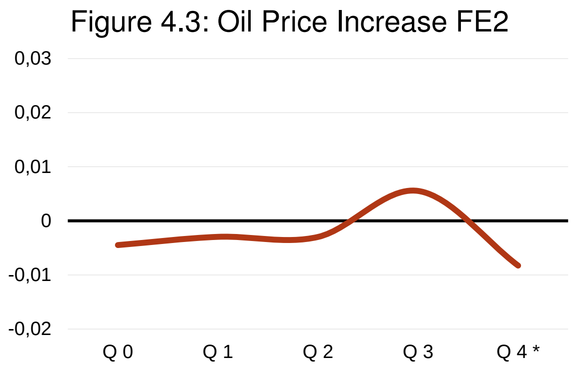
Variable	Coefficient	(Std. Err.)
L0.opinc	-0.004	(0.005)
L1.opinc	-0.003	(0.005)
L2.opinc	-0.003	(0.005)
L3.opinc	0.006	(0.005)
L4.opinc	-0.008†	(0.005)
L0.opdec	0.012*	(0.005)
L1.opdec	0.016**	(0.005)
L2.opdec	0.027**	(0.006)
L3.opdec	-0.009†	(0.006)
L4.opdec	0.003	(0.006)
infl	0.061	(0.075)
unemp	0.000	(0.026)
intr	0.042†	(0.023)
indu	0.077**	(0.018)
oilim	0.000	(0.000)
Intercept	0.673*	(0.299)
N	472	
R^2	0.27	
$F_{(24,447)}$	9.208	

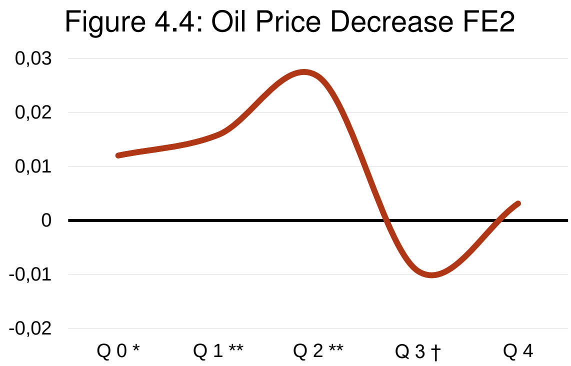
Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%
We have not listed the lags of $gdpg_{\,t}$ due to shortage of space.

In the second regression, i.e. the regression in which only $gdpg_t$, $opinc_t$ and $opdec_t$ have a lag structure, the results are similar, but much more significant.

Having a look on the test for significance (cf. Table B.50 in the appendix), we can see clearly, that oil price decreases have a very significant impact on economic growth whereas oil price increases do not seem to have any impact at all on economic growth as in the case of FE1. The H_0 of the tests for symmetry can be rejected for all lags besides the last. Therefore we conclude the impact to be symmetric.

The fluctuation in this regression (cf. Figure 4.3 and 4.4) do however seem to draw a considerable picture. Oil price decreases seem to boost economic growth in the first quar-





ters.
This could be biased by the fact, that Norway as an oil exporting country has not been excluded from the sample.

Fixed Effects - Lag Structure for gdpg, opinc and opdec withouth Norway (FE3)
In the third regression, we have therefore excluded Norway to have only net oil importing countries in the sample. The result might be the most interesting.
In fact, as seen in 4.6, oil price increases have a significant negative impact after one year and oil price decreases have a very significant positive impact on the economies almost throughout the entire sample period.
This findings correspond to the findings of Mork et al. 1994 and several other papers. As already seen in the multivariate regressions for every country, oil price decreases tend to have an immediate positive impact whereas oil price increases have an impact after some months, i.e. after four quarters.

The figures 4.5 and 4.6 demonstrate the trend of the impact and illustrate a clearer picture than the fixed regressions above. Within the first months a decrease in oil prices seems to boost real economic growth.

An oil price increase of 10 USD within one quarter leads to an economic decline of 0.11 percentage points. If oil prices decline about 10 USD, economic growth will be boosted by 0.35 percentage points within a year.

Figure 4.5: Oil Price Increase FE3

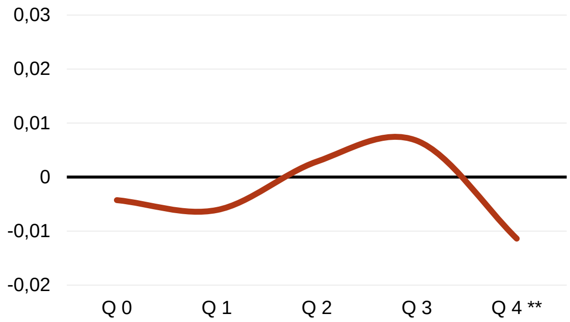


Figure 4.6: Oil Price Decrease FE3

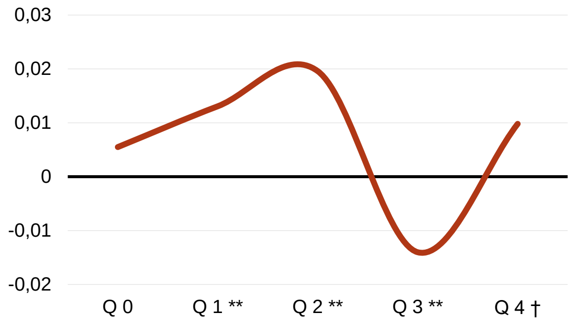


Table 4.6: Lag Structure for gdpg, opinc and opdec withouth Norway (FE3)

Variable	**Coefficient**	**(Std. Err.)**
L2.gdpg	0.217**	(0.049)
L3.gdpg	0.056	(0.050)
L4.gdpg	0.013	(0.049)
L0.opinc	-0.004	(0.004)
L1.opinc	-0.006	(0.004)
L2.opinc	0.003	(0.004)
L3.opinc	0.007	(0.004)
L4.opinc	-0.011**	(0.004)
L0.opdec	0.006	(0.005)
L1.opdec	0.013**	(0.005)
L2.opdec	0.020**	(0.005)
L3.opdec	-0.014**	(0.005)
L4.opdec	0.010†	(0.005)
infl	0.040	(0.073)
unemp	-0.002	(0.021)
intr	0.051*	(0.022)
indu	0.136**	(0.018)
oilim	0.000	(0.000)
Intercept	0.546*	(0.276)

N	403
R^2	0.458
$F_{(23,379)}$	17.817

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

To check whether our dependent variable is a non-stationary variable, we have run an unit-root-test for every fixed effect regression. In all of the three cases, we can reject the null hypothesis at least at a 5 percent level, which means that our dependent variable is stationary.

The H_0 of the F-tests, demonstrated in table 4.7, can be rejected in both cases at least at a significance level of 5 percent.

Table 4.7: Test for Significance of Oil Price Increases and Decreases FE3

Oil Price Increases		**Oil Price Decreases**	
L0.opinc = 0		L0.opdec = 0	
L1.opinc = 0		L1.opdec = 0	
L2.opinc = 0		L2.opdec = 0	
L3.opinc = 0		L3.opdec = 0	
L4.opinc = 0		L4.opdec = 0	
$F_{(}5, 379)$	2.69	$F_{(}5, 379)$	7.99
$Prob > F$	0.0210*	$Prob > F$	0.0000**

Significance levels : † : 10% $*$: 5% $**$: 1%

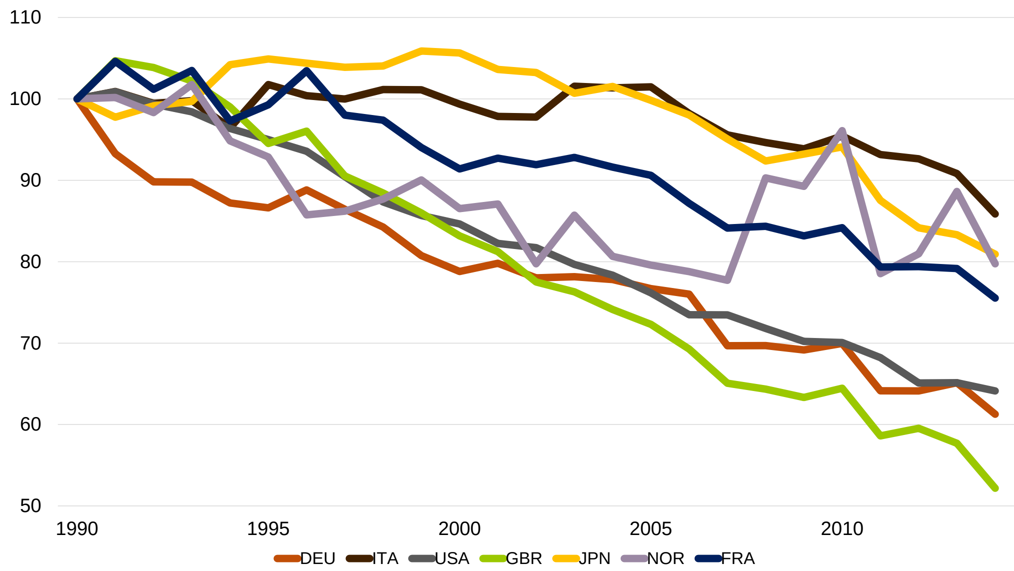
Concerning the mentioned questions whether oil price increases and decreases have a symmetric impact, we found out, that this is indeed the case. Especially in the first and third quarter after an oil price change, real GDP growth seems to have a symmetric impact. This findings however are not matching the results of Mork et al. 1994 who could not find a significant symmetry.

All in all, our findings show that oil price increases and decreases are significant. Real GDP growth is more positive affected by oil price decreases than it is negative affected if oil price are increasing. That means, that **oil price decreases are supporting economic growth to a larger extent than oil price increases hurt economic growth**.

4.5 Interpretation of the Results

The fact, that the impact of oil price changes on growth is weaker in our regressions than for instance shown by Mork et al. 1994 is not surprising, if we have a look on the general change of energy efficiency of the chosen economies in table 4.7. More energy efficient

Figure 4.7: Energy Use (koe) per 1.000 USD GDP (const. 2011 PPP)



economies make economies much less vulnerable for high increases of costs due to an increase in crude oil prices. As a consequence of a very low elasticity of demand for gasoline and diesel, households and the industry response directly to higher costs. If the dependency of the economies however is reduced as we can see it in the table, this strict correlation can be broken a bit down. After one year (i.e. four quarters), real GDP growth is negatively affected by the increase of the price of oil. Although the energy efficiency of the economies has sharply increased during the last decades, for many sectors crude oil remains the main input without any alternatives. If alternatives are available, as it is the case for instance in the production of electricity, changes can not be implemented over night, because of the fact that an oil driven power plant can not be operated by using coal, wind or solar.

On the other hand it is interesting, that oil price decreases have a high positive impact on real GDP growth. Our findings show, that a 10 percent decrease of the crude oil price leads to an increase of quarterly real GDP growth of 0.20 percent after half a year. Our interpretation of the significant response to oil price decreases is, that although the elasticity of demand for gasoline and diesel is very low, a plunge in the prices for fuels could lead to a higher demand, because of the fact, that for instance more people would be interested in traveling or using the car instead of public transports or staying home. The same could be the case for the industry. Although the long term trend highlights, that the selected economies use a constantly decreasing amount of energy per GDP, old technology (e.g. fuel power stations) could be profitable or surprisingly low oil prices could lead to immediate investments or refill of reserves to gain in situations of lower prices. This situations might be considered to not lasting very long as the economies might got used to an environment of low oil prices.

It is furthermore of interest to mention the differences between the countries in the sample. Whereas Mork et al. 1994 for instance showed evidence, that Norway is gaining from higher oil prices due to the fact, that Norway is an energy exporter, we have found a significant negative correlation both for oil price increases and decreases, i.e. if oil prices are increasing the Norwegian economy response negatively and if oil prices are decreasing real GDP growth does grow on a quarterly basis.
The industrial production needs much more energy input than the service sector for instance. Germany has the second largest industry as share of GDP in our sample after Norway and has therefore a much more sensitive economy with respect to energy prices (cf. Table 4.8). A decline in oil prices leads hence to a much more significant response in Germany and Japan as for instance in Italy, France, or the United States.

Table 4.8: Industry, Value Added (Percent of GDP) in 2013

DEU	30.3
FRA	19.7
ITA	23.6
JPN	26.2
NOR	39.8
GBR	21.3
USA	20.5

Our interpretation for the fact, that oil price decreases cause in almost every country economic growth immediately after the price movement whereas oil price increases cause an economic decline just after two or three quarters is, that oil price decreases may lead to an prompt acquisition of petroleum for companies or states at the spot market. In case of oil price increases, companies and countries (above all the United States) can make use of their huge petroleum stocks to balance the price increase and provide petroleum bought at a cheaper price or rely on long term contract negotiated at a lower price (for instance long term contracts between USA and SAU).

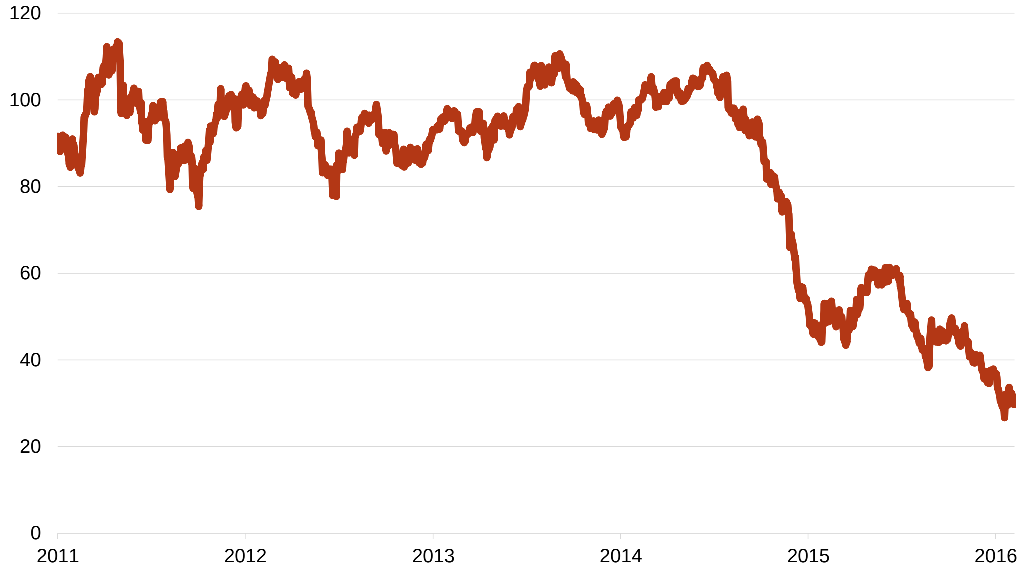
The interesting and significant behavior of real GDP growth as responses to oil price decreases is the underlining motivation of having a closer look on the plunge of crude oil prices since fall 2014 and its impacts on different countries. The reason for the recent collapse in oil prices and its different consequences are discussed in chapter 5.

5 The Oil Price Plunge Since the End of 2014

Having the empirical output of the chapter 4, we analyze the oil price plunge since 2014 to compare our findings with the actual developments in the mentioned countries and sketch an outlook for the upcoming years.

In autumn 2014, the high and stable oil prices deviating close to a level of around 100 USD per barrel came to an abrupt end. Due to various reasons, the crude oil prices collapsed to a price slightly below 30 USD per barrel in early 2016 as shown in figure 5.1.

Figure 5.1: Cushing WTI Spot Price FOB in USD/bbl (2011 - 2016)

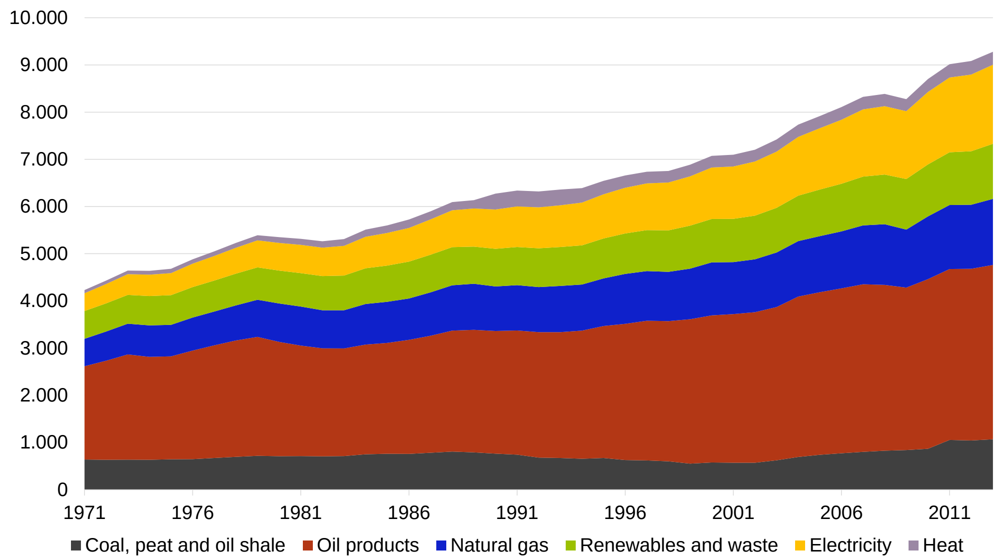


This chapter deals with the main causes of the current oil price plunge, the differences to the previous collapses mentioned in chapter 2, the macroeconomic impacts and the possible policy implications to manage the current situation in oil importing and exporting countries.

5.1 Causes of the Recent Oil Price Plunge

As we mentioned in chapter 2, oil is the most important energy source since the 1950s. Global oil demand faces however a relative decline throughout the last decades.
Although oil is yet the most important energy source with a share of 39.9 percent of the total final consumption by fuel, as an aftermath of the energy crisis of the 1970s and expected high oil prices during the last 15 years, economies experience a shift to substitutes of crude oil as for instance biofuels, waste, electricity and natural gas (IEA 2015*c*, p. 28). Substitutes of fossil fuels experienced a significant increase during the last decade and

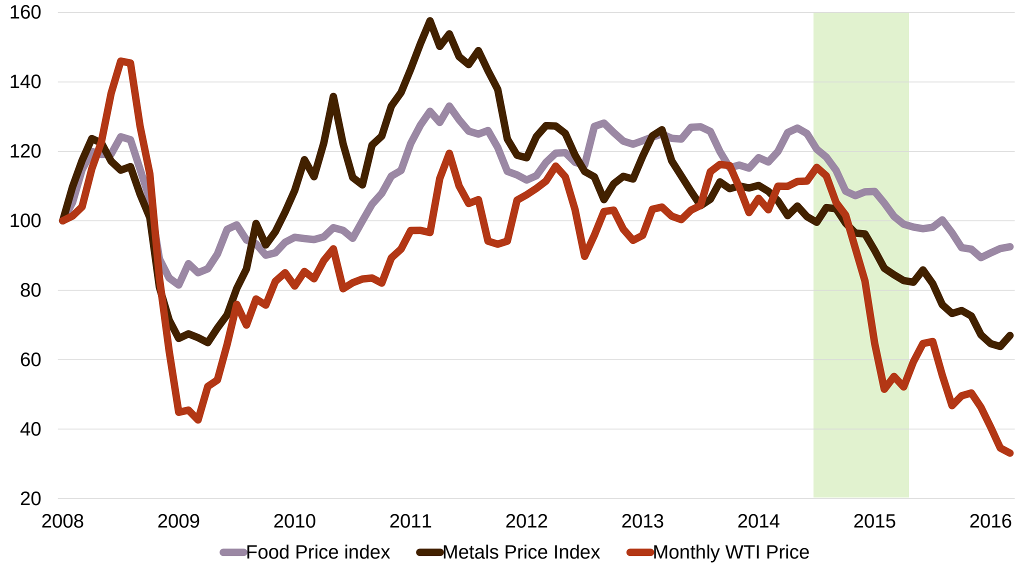
Figure 5.2: World Total Energy Consumption by Fuel in Mtoe



the oil intensity of the global economy keeps on shrinking since the peak before the first oil crisis in 1973 and reached almost half of the level of 1973 (IEA 2015*c*, p. 7).

Due to a disappointing global economic development in the last decade, energy demand had to be adjusted several times. These demand factors had however just limited effects on the current decline in oil price. Price developments of other commodities as metals (e.g. aluminum, lead, copper, nickel, zinc and tin) or food can be seen as a prove for this. Although other commodities dropped in the last years, the decline of oil prices has been

Figure 5.3: Co-movement of Metal price, Food price and Oil price



much more intense, as it can be seen in figure 5.3. In general, the oil price and selected commodity prices tend to develop in a similar way. Since late 2014, this relationship however seems to be biased.

The plunge of oil prices therefore can be explained to a much larger extent by huge changes in the global oil supply. Basically the causes of the current oil price plunge can be split in the impacts of "The Shale Revolution" and other enlargements of oil production, the unwinding of geopolitical risks, the controversy within OPEC and the appreciation of the USD.

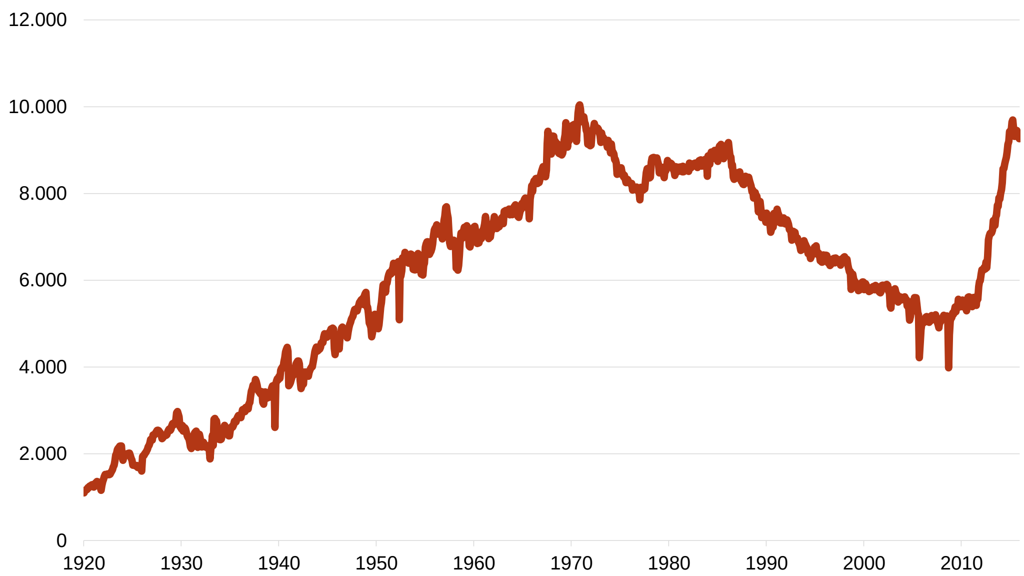
5.1.1 "The Shale Revolution" and the Glut of Global Oil Supply

Since 2013, global oil supply enlarged significantly. Besides the expansion of production of already large producers like the Russian Federation and Saudi Arabia and the resumption of countries involved in conflicts in recent years like Iraq and Libya, the change of one country is especially suspicious: The enlargement of the production of the United States.

The increase in production in the United States is mostly caused by unconventional energy sources. This large extension of energy gained from sources as shale has been called "The Shale Revolution". To gather shale oil and natural gas was considered to be inefficient and ways to expensive for a long time. Until about 20 years ago, only around 1 percent of US natural gas came from shale (Gilje et al. 2015, p. 12). In the early 2000s, several companies experimented with a technology introduced 1949 by Floyd Farris of the Stanolind Oil and Gas Corporation (Amoco). This technology is called **hydraulic fracturing** also known as fracking (Montgomery & Smith 2010, p. 27).

Hydraulic Fracturing is basically a technique that allows to exploit oil and gas sources which would not be accessible using conventional production methods. Unconventional means, that the resources are not yet available, not easily to develop and do not enable gas and oil to flow readily into boreholes (Broomfield 2012, p. 3). After drilling a vertical hole, the process of hydraulic fracturing is continued with a horizontal drill through a rock layer. In this layer a high pressurized mixture of sand, water and chemicals is injected implicating a fracturing of the layer. Due to the sand, that keeps small holes open, it is possible to gain a mass containing gas and oil that is pumped to the surface and refined. Until today, hydraulic fracturing is almost solely used in North America, in the United States and small parts of Canada (Boudet et al. 2014, p. 2). Daniel Yergin called this development

Figure 5.4: USA Crude Oil Production 1920 - 2016 in Mbbl/day



the "single most significant energy innovations so far this century" (Montgomery & Smith 2010, p. 40). Figure 5.4 demonstrates the historic increase of US crude oil production. This boost had not only impacts for the United States, but for the entire world. Although oil supply in some regions of the world have declined in the last years due to conflicts and geopolitical risks, the increase of the oil production in the United States predominated all declines and lead to a glut in the oil market. Therefore global oil supply increased disproportional in the last years and thus contributed to a decline in prices. With a disappointing development of the global economic growth and hence a decrease in demand of oil facing an enormous expansion of supply prices started to collapse.

Not only the United States have resources for hydraulic fracturing for their disposal. In some parts of the European Union oil production by using unconventional production would be possible. Due to concerns about the corrosion of the environmental and risks for public health, the European Commission launched several legal requirements for its Member states to ensure the avoidance of environmental damage and public health related effects. Some regions and countries in the EU have even banned fracking due to the mentioned reasons. Among this countries are for instance France (The Guardian 2008), Germany (Copley 2015), Bulgaria, the Czech Republic, the Netherlands and Luxembourg (The Economist 2013).

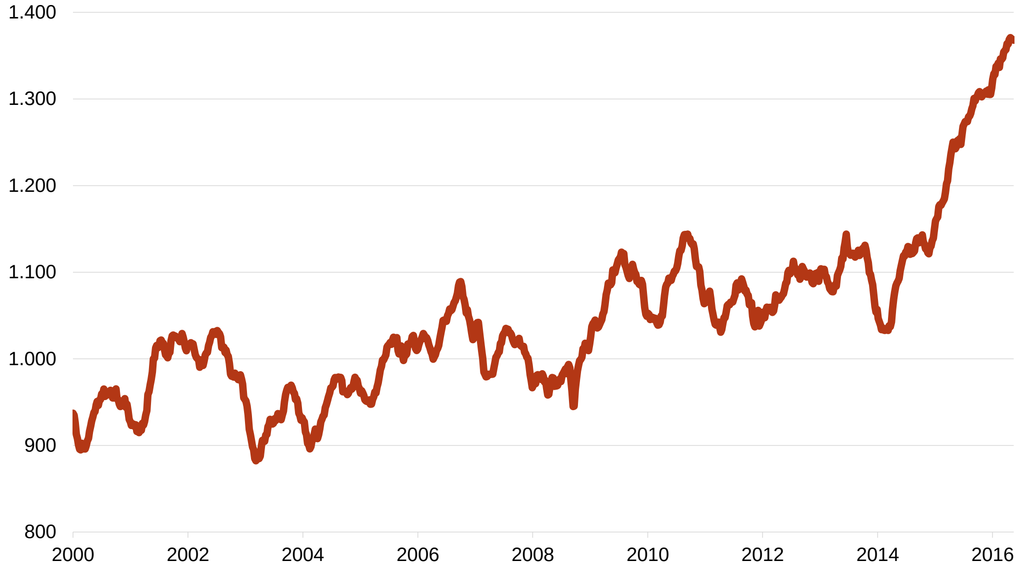
Hydraulic fracturing however is not the only unconventional production method. Two other sources have enlarged within the last decade: Oil sands and the production of bio fuels.

The extraction of products from **oil sands** are in general very expensive. Estimations indicate, that marginal costs of oil production from oil sands cost around 80 to 90 USD per bbl. The most important producer using this method is Canada. Although Canada raised their production level within 10 years just from around 3 MMbbl/day in 2004 to around 4 MMbbl/day in 2014, this increase caused another raise in global oil supply.

The other unconventional method is the production of **bio fuels**. Bio fuels are liquid fuels gained from plant material and include for instance ethanol made from sugar cane, diesel-like fuel extracted from soybean oil or dimethyl ether and Fischer-Tropsch liquids produced of lignocellulosic biomass. Bio fuels are essentially produced in the United States (44 percent), Brazil (24 percent) and the European Union (17 percent). Its production level increased sharply since the mid-2000s and reached a level of around 1.4 MMbbl/day in 2014(UNCTAD 2008, p. 1).

Other indicators for an overhang of supply are the **stocks of crude oil** hold by various countries. The most important country for this indicator are the United States. The stocks include normal inventories of fuel stored for the future use and the Strategic Petroleum Reserve (SPR), created in 1975 as a consequence of the 1973 oil crisis to face energy security issues. The following graph indicates a significant increase of crude oil stocks hold by the United States. The shown stocks ”include those domestic and Customs-cleared foreign stocks held at, or in transit to, refineries and bulk terminals, and stocks in pipelines” (EIA 2016*g*) This value has risen from February 2014 to May 2016 by around 32 percent. This can be seen as an sign, that demand in the US and abroad has declined and primarily,

Figure 5.5: US Ending Stocks of Crude Oil and Petroleum Products in MMbbl*



*: SPR excluded

that the US oil production has enlarged so much, that domestic demand has not covered supply anymore.

The glut of the oil market can, of course, not only be explained by the increase of production by the United States. The Kingdom of Saudi Arabia as the major oil producer of OPEC and the Islamic Republic of Iran have likewise played an important role that will be discussed in section 5.1.3.

5.1.2 Unwinding of Geopolitical Risks

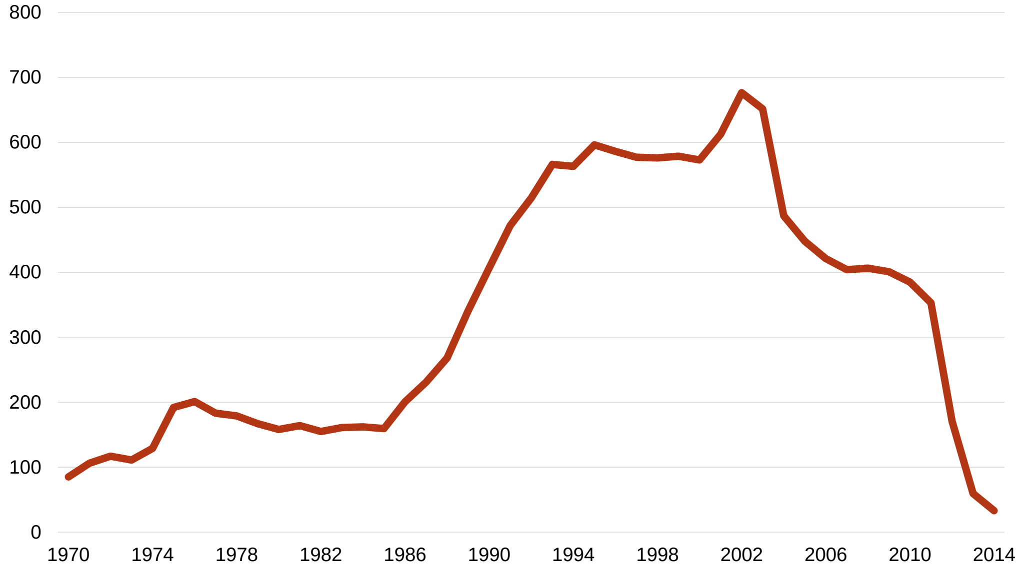
To focus not only on the United States, it is important to have a look also on other regions in the world. Various oil production fields in North Africa have been shut down during and after the Arab Spring since 2011 which led to a slight decrease in global oil supply. The internal conflict in Libya, the conflict in Ukraine, the Syrian Civil War, the insurgency of Boko Haram in Nigeria and the advance of the salafi jihadist militant group ISIS or ISIL in Northern Iraq have been the major concerns related to possible cutbacks in oil supply.

The **internal conflict in Libya** between the Libyan National Army, the Libya Shield Force, ISIL and the Tuareg forces since 2011 raised concerns due to the fact, that Libya has the ninth largest oil reserves of the world. Besides the conflict production could however be recuperated and constitutes with more or less 0.5 million barrels per day around 0.5 percent of the global production (Baffes et al. 2015*b*, p. 157).

The protests in **Ukraine**, the Crimean Crisis and the war ongoing in Donbass had also little effect on global oil supply. Ukraine as itself has with 395 millions of barrels more or less as few oil reserves as Italy, the Netherlands and Germany and has therefore no impact on the global oil market. As a major transition country between the Russian Federation and the European Union however its political stability is a major concern of European policy makers. The conflict and the resulting sanctions and counter sanctions of the Russian Federation and OECD countries had thus far little effect on oil prices (Baffes et al. 2015*b*, p. 157).

On contrary to expectations, oil prices have not been effected significantly by the **Syrian Civil War** as well. As a consequence of the ongoing conflict between the Syrian Government, the opposition, ISIL, the Al-Nusra Front and Kurdish Forces, the crude oil production in Syria collapsed since 2011 and reached a total cut off in 2014.
Figure 5.6 highlights the development of the crude oil production in Syria. Generally the amount of oil produced in Syria has been very volatile throughout the last 40 years. After the discovery of light sweet crude oil fields in Eastern Syria, oil production increased sharply in the late 1980s.
In 2002, Syria reached a historical peak of around 0.68 millions of barrels a day which

Figure 5.6: Crude Oil Production of Syria in Mbbl/day



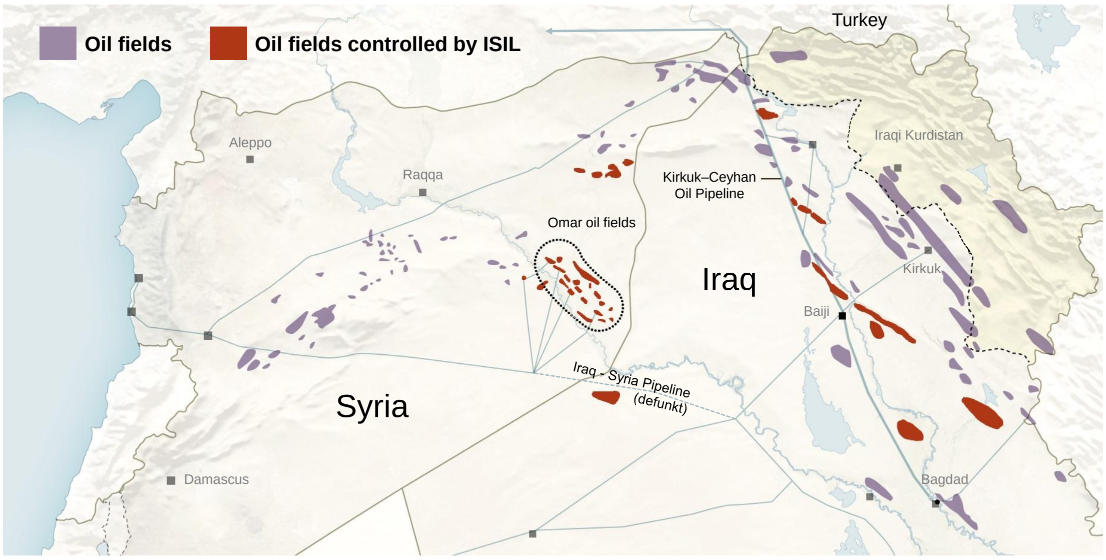
can be neglected, because at its highs it also has been just less than 1 percent of global oil supply. For comparison, the United States have currently a production of around 11 millions of barrels a day.

As an aftermath of the war in Iraq 2003, the terrorist organization **Islamic State of Iraq and the Levant (ISIL)** captured and occupied large territories in Syria and Northern Iraq. With around 140.000 millions of barrels, Iraq has the fifth biggest proven oil reserves of the world. Although the most fields are located in the southern region close to Kuwait and Iran, several pump stations and especially pipelines are going through territories occupied by the troops of ISIL.

As it can be seen on the map in figure 5.7, the terror organization ISIL occupies some oil fields the Northwest of Iraq and Eastern Syria and two major pipelines that bring oil to the Mediterranean Sea and the European Union. Although the pipeline going through Syria is defunct since several years, the Kirkuk-Ceyhan Oil Pipeline, bringing oil from the major production regions in the Kurdish region to Ceyhan, an important petroleum terminal at the Mediterranean Sea in Southern Turkey, has been operable during the last years. The 900km long pipeline though has been target of several bombing attacks since 2003 (Barker 2016).

One of the major oil fields ISIL fighters could take control of, is the important Omar oil

Figure 5.7: Oil Infrastructure of Syria and Northern Iraq



field in Eastern Syria. This field could normally produce an amount around 30 Mbbl a day. Under control of ISIL, it was possible to maintain more or less a third of it. With an oil price of 50 USD, this could equal on maximum 0.5 to 2 million USD every day being one of the most important sources of income for the terrorist organization (The New York Times 2014).

After the stall of the advance of ISIL in 2014, it became observable, that oil production in Iraq could be uphold and concerns could be slackened. This contributed to the fact, that supply has been expected to stay even stable in Iraq.

Even though major geopolitical risks have not been settled and will be ongoing issues, global oil production has not been effected significantly enough by the mentioned disputes above. This fact contributed likewise to the flood of global oil supply.

5.1.3 OPEC Objectives

The Organization of Petroleum Exporting Countries (OPEC) is an intergovernmental organization, founded in 1960 with the mission ”to coordinate and unify the petroleum policies of its Member Countries and ensure the stabilization of oil markets in order to secure an efficient, economic and regular supply of petroleum to consumers, a steady income to producers and a fair return on capital for those investing in the petroleum industry” (OPEC

2014*b*). The OPEC has currently 13 Member countries: Algeria, Angola, Ecuador, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates, and Venezuela.

The most important member of the OPEC, is the **Kingdom of Saudi Arabia**. With a daily production of around 11.6 MMbbl/day, Saudi Arabia is among the three largest producers of the world besides the Russian Federation and the United States. As experienced in various price changes in the last decades the decisions of Saudi Arabia had always huge impacts on the oil market.

In general OPEC countries follow a strategy to achieve high prices and maintain a large market share to maximize profits as shown by 5.1 and 5.2. If the world supply of crude oil is rising caused for instance by the enlargement of the oil production in the United States, OPEC countries like Saudi Arabia are even more faced with the trade-off between this objectives.

$$Profits = Production\ of\ Crude\ Oil\ in\ a\ Country \times Crude\ Oil\ Price \tag{5.1}$$

$$Market\ Share = \frac{Production\ of\ Crude\ Oil\ of\ a\ Country}{Global\ Production\ of\ Crude\ Oil} \tag{5.2}$$

A fight for market shares could lower prices even more. The achievement of high prices is either possible through the cooperation between producer countries within an organization like OPEC (cf. section 2.4) or an extraordinary cut of supply due to conflicts and the temporary shut down of parts of the global oil production as seen during the 1970s. Because of the fact, that no particular OPEC member in the last years is in charge of the large increase in supply, OPEC members and primarily Saudi Arabia are confronted with this trade-off.

If Saudi Arabia would cut production, the share of their global oil production would decrease and hence their market share. As being a heavy weight in the global oil market, production cuts of Saudi Arabia will indeed have an impact on the crude oil price. The target of maximizing profits however will not be achieved, due to the reduced market share.

After oil prices have dropped in late autumn 2014, OPEC had to weigh up whether to cut production to stabilize prices or keep production high at the level of 30.0 MMbbl/day as decided in December 2011. During the 166th meeting of the Conference of the OPEC in Vienna on November 27th, 2014, the delegations decided to keep production high. This decision lead to an immediate drop of more than 10 percent overnight and in the following month to a collapse of more than 27 percent (OPEC 2014*a*). Being confronted with sinking oil prices since late 2014, many countries had to deliberate about whether cutting production individually to higher prices or wait for an increase in prices while keeping production maintained.

Firstly, it is important to mention, that not all oil production fields in the world have the possibility to be shut down in a short period. This operation has technical constraints. Policy decisions of NOCs might therefore not have an impact on the global oil market. As a matter of the particular onshore field environment and the production capacity, Saudi Arabia is a swing producer in the global oil market. In the past, Saudi Arabia "has been willing to swing its production to balance the market" (Fattouh & Sen 2013). In the current market of low prices, Saudi Arabia has though confirmed several times, that they are not willing to give up their market share and kept on producing at their capacity limit. With official reserve assets of 592 billion USD, Saudi Arabia has the second largest reserve assets in the world (IMF 2016*c*). Although their reserves might dwindle due to the current market conditions, Saudi Arabia has still an enormous room of maneuver to persist low prices. The decisions of Saudi Arabia not to react on the global glut of oil was definitely another motor of the race to the bottom of the oil price.

Yet another member of the OPEC merits particular attention: the **Islamic Republic of Iran**. With more than 157 billion barrels proven crude oil reserves, Iran has the fourth largest reserves in the world and is with around 13 percent the third most important member of OPEC (BP plc 2016*b*). Before the Iranian Revolution in 1979, Iran produced crude oil at a level of more than 5 MMbbl/day and lowered to a level of around 3.5 MMbbl/day during the 1990s. As a consequence of the Iranian Revolution 1979 and the nuclear pro-

gram of Iran in recent years, the United States, later the EU and the UN imposed sanctions against Iran.
In mid-2015, the "P5 plus 1" countries, namely China, France, Germany, Russia, the United Kingdom and the United States reached an agreement, the so called JCPOA (Joint Comprehensive Plan of Action), that assured that the nuclear program of Iran follows exclusively peaceful purposes and declared the abolishment of Western sanctions (US Department of State 2008). As laid down in the JCPOA, January 16, 2016 has been decided to be the implementation day of the accord. This accord allows Iran to produce and export crude oil, which was hardly possible due to an embargo imposed by the EU before. During the sanctions in the last years, Iranian oil production has been on a stable and flat level of around 2.8 MMbbl/day and could rise now, according to expectations of the EIA, to a level of 3.7 MMbbl/day in the end of 2017 (EIA 2016*c*).

As Saudi Arabia and Iran being major members of the OPEC, their decisions have been significant for the recent price drop and will be relevant for the ongoing years. The strife between the regional rivals, the Shiistic Iran and the Sunni country Saudi Arabia is also present in their decision of freezing their production. Members of the governments of both countries stated frequently, that they would just cut their production if the other countries would do so as well. Saudi Arabia would be willing to reduce production and allude, that they "will not reject any opportunity that knocks on [their] door" to raise production, granted that the other OPEC members would do so as well (Micklethwait 2016). This status quo leads to a fight for market share, that has once again an enormous impact on the crude oil price.

5.1.4 Appreciation of the USD

Another important driver of the oil price collapse is the growing exchange value of the USD. Akram (2009), De Schryder & Peersman (2013) and Zhang (2013) describe the negative correlation of the exchange rate of the USD and commodity prices. The reason is that demand of commodities change due to the shift of their costs caused by a variation of the exchange rate of the USD. This is on the basis of the fact, that oil is generally priced in USD and countries for instance in the Eurozone have to exchange their money first in USD to obtain crude oil. The appreciation of the USD results hence in an increase of the costs of commodities priced in USD for countries not having the USD as their currency. Although Zhang indicates, that the relationship between the value of the USD and the price of oil is subject to structural breaks over time, the indicators have a strong negative correlation (Zhang 2013, p. 350).

Figure 5.8: Trade Weighted USD Index (2011=100)

The weighted average of the foreign exchange value of the US Dollar, calculated by the FRED and including AUD, CHF, EUR, CAD, JPY, GBP and SEK, increased about 20 percent between 2014 and 2015. The exchange rate of the USD therefore appreciated from around 1.4 EUR/USD in April 2014 to 1.05 EUR/USD in March 2015. Making crude oil more expensive in major importing countries, as Western Europe, demand decreased as a consequence of their lower purchasing power (Baffes et al. 2015*b*, p. 157).

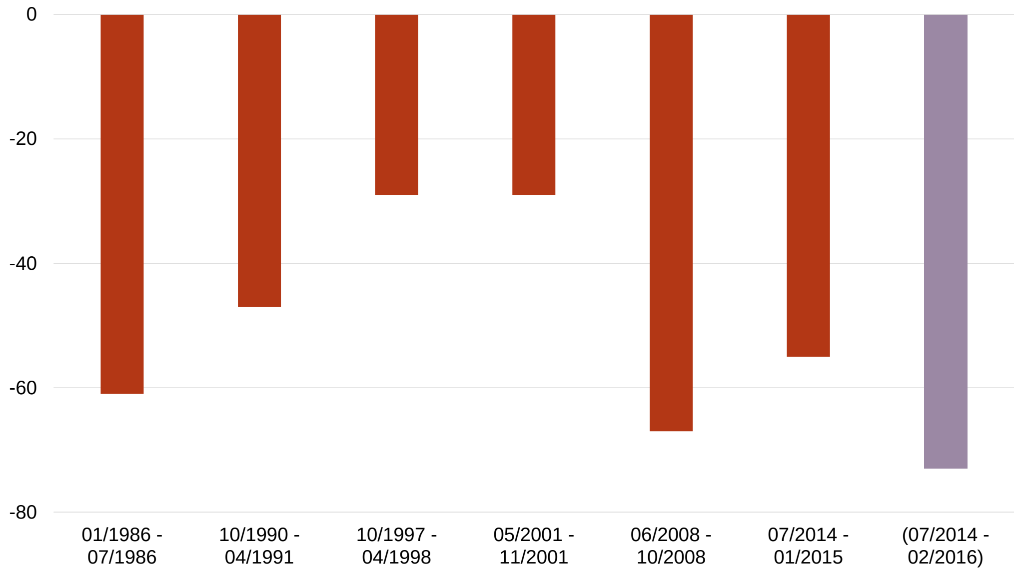
Although the contribution of the appreciation of the USD might be less significant than the glut of oil in the global markets, its impacts should not be swept under the rug.

5.2 Comparison to Previous Plunges

The plunge of crude oil since 2014 has not been the first collapse of the oil price in the last decades. As mentioned in chapter 2, the price of oil has experienced various drops since the 1980s. In this paragraph we want to compare the drops of the oil price in the past with the recent decline and highlight the parallels and differences.

Since the sharp drop of the oil price in 1986, six significant drops have taken place in the last 30 years of declines with a respectively amount of more than 30 percent within half a year.

Figure 5.9: Historical Oil Price Decline Since 1986 in Percent



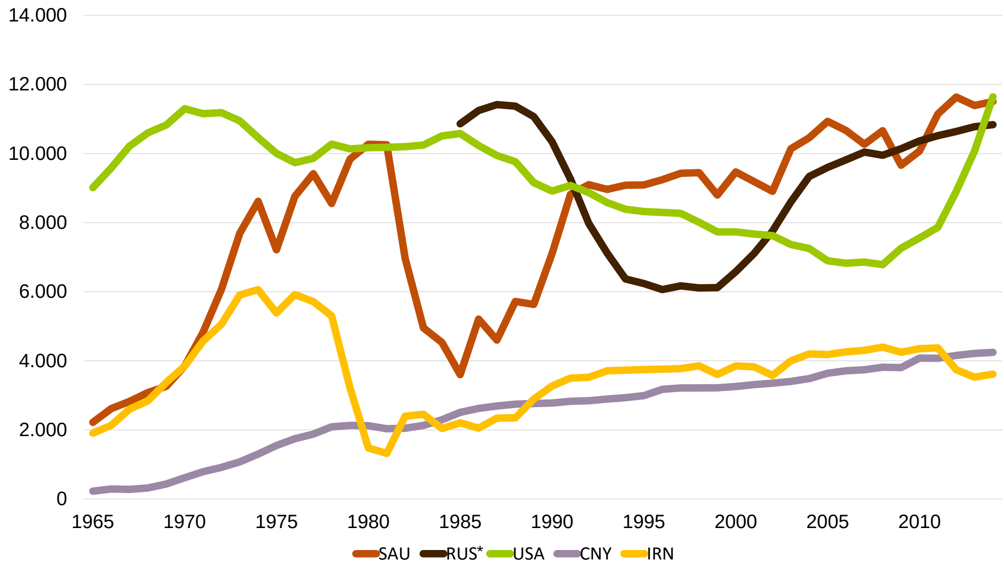
As seen on the graph 5.9, the decline between July 2014 and early 2015 with around 50 percent has not been the largest decline within half a year in the last decades. Although the drop between July 2014 and February 2016 has reached a level of more than 73 percent, it is reasonable to concentrate on the first six months to compare the decline with previous shifts.

The declines in 1990-91, 1997-98, 2001 and 2008-09 were mostly caused by a weakening global demand after two US recessions, the Asian crisis and the recession followed after the global financial crisis. The drop of the crude oil price in spring 1986 however has much more similarities to the recent collapse of 2014. The main parallels are the massive increase of crude oil production in Non-OPEC countries and the objectives of OPEC countries.

As discussed above, mainly unconventional sources enlarged the global oil supply in the previous years. In the 1970s and early 1980s has occurred a similar expansion of unconventional oil sources. As a consequence of the increase of the oil price after the first and second oil crisis, several other oil production methods have become profitable as oil from Alaska, the North Sea and the Gulf of Mexico. Together this oil sources made it possible to add around 6 MMbbl/day to the global markets what resulted in a glut of the oil market. The expansion of unconventional oil sources from Non-OPEC countries in the recent years added almost the same amount to the global oil market.

The other remarkable parallel to the 1986 drop is the policy followed by OPEC. In the early 1980s, Saudi Arabia tried to reach high oil prices by adjusting their production. In June 1985, OPEC lost more than half of their market share of 1979 and Saudi Arabia produced only about 13.7 MMbbl/day as seen in figure 5.10. Despite this large cut of production by Saudi Arabia, oil prices have not increased but declined by some 20 percent. The already mentioned trade-off between gaining market share and maintaining high prices brought OPEC members to the decision to fight for their individual market share instead of waiting for the prices to rise. As the production level of OPEC countries wide up to 18 MMbbl/day in December 1985, oil prices started to collapse. Following the graph 5.10, we can see,

Figure 5.10: Crude Oil Production of Selected Countries in Mbbl/day



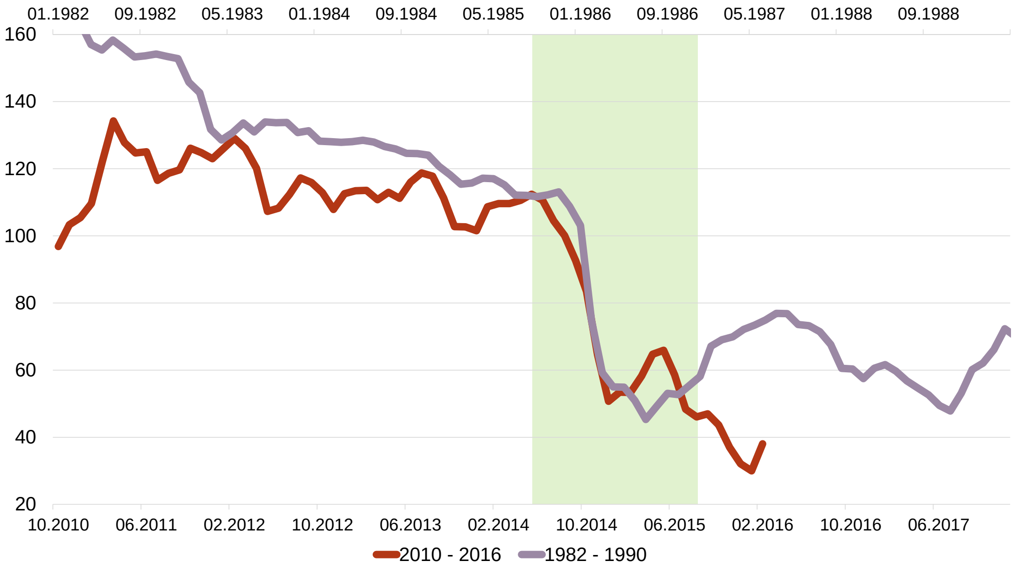
*: No data available before 1985

that the largest positive changes in the last 40 years have been occurred by the increase of Saudi Arabia after 1986, the increase of the US production since 2011 and a fight for market share of the Russian Federation after the collapse of the Soviet Union.

The long term series highlights furthermore, that China and since some months also Iran are gaining market share again and increasing their production constantly. World oil markets are therefore flooded with crude oil.

On the figure 5.11, we draw a comparison between the developments of the oil price in 1986 and 2014. Both price collapses are occurring after some years of stable prices.

Figure 5.11: Real Oil Price Changes in USD/bbl 1979=100



If the comparison of 1986 and 2014 holds true and prices stay at a lower level, it is possible that we are facing a ”New Oil Order” as stated by Goldman Sachs (Goldman Sachs 2016). With ”New Oil Order” it is meant, that we have lower oil prices due to a faster and more competitive market. Hydraulic Fracturing allows it to have a profit within just a view weeks after the investments, whereas classic drilling may require years of investment and uncertainty before the breakeven point. In section 5.5, we will have a closer look on possible oil market developments in future years.

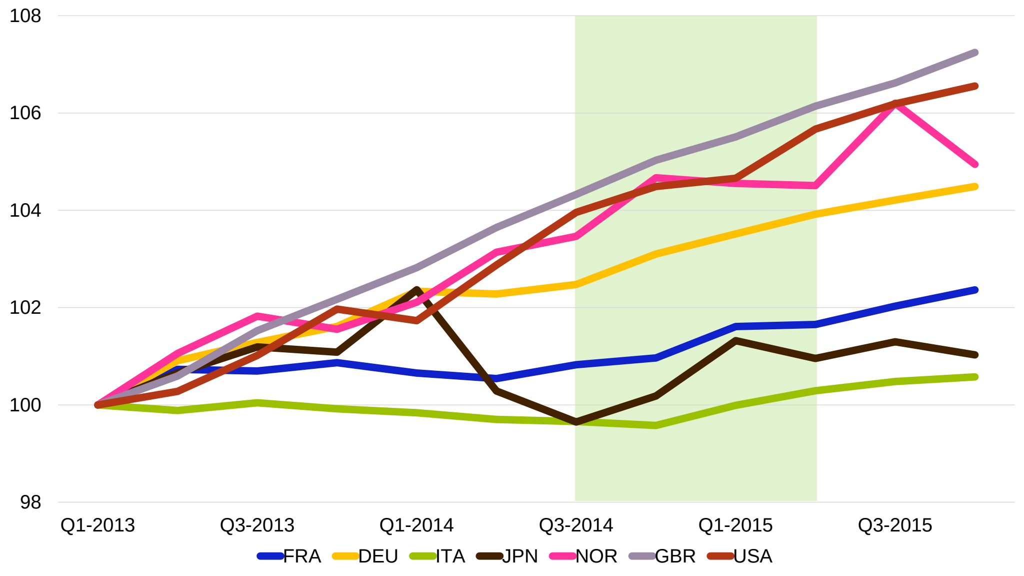
The most important parallel between the oil price plunge in 2014 and 1986 is hence the fast increase of the oil production of one specific country within just a few months or years and the incapability or the reluctance of OPEC to find a combined policy.

5.3 Economic Effects of the Current Oil Price Plunge

In this section we focus on the economic effects caused by the large collapse of the crude oil price since the end of 2014. The effects vary between oil importing and oil exporting countries and depend on various factors as energy dependency (cf. chapter 4).

By having a look on the economic development of the seven selected countries of chapter 4, it is visible, that the **real GDP** of the seven countries increased during the last three years. This movement is however different between the countries of our sample. Figure 5.12 shows the real GDP of the specific countries indexed to January 2013. The period in which the oil price collapsed is highlighted in green, i.e. Q4 2014 and Q1 2015. According to our findings the economies should respond within the first three months to the oil price collapse.

Figure 5.12: GDP of Selected Economies (01/2013=100)

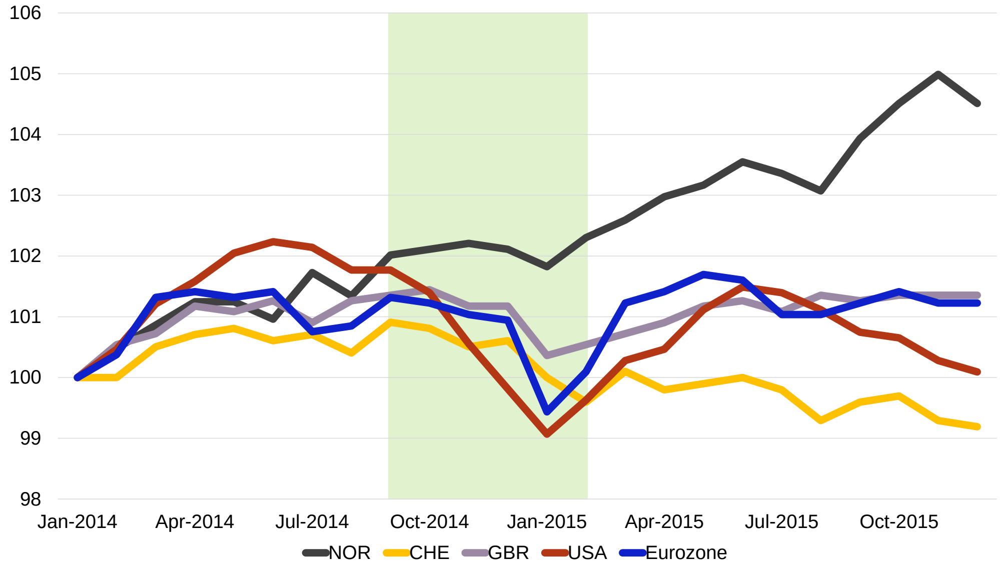


In fact, six of seven OECD countries experienced an increase of real GDP of 0.46 percent in average.
Norway is an exception in this case as well as discussed in chapter 4. The Norwegian economy shrunk by around 0.11 percent between Q4 2014 and Q1 2015 as an immediate response to a drop of the revenue in the oil producing sector.

Surprisingly however the recent plunge in oil prices has had less impacts on global growth than expected. According to Kenneth S. Rogoff, Professor of Economics at Harvard University, this is mainly due to the fact, that much more emerging markets have a larger economic footprint and do respond much less on oil price changes. Countries like China or India are much more interventionist, i.e. governments intervened and by paying a lot of subsidies if prices are high and could stable the markets by cutting them off (Rogoff 2016).

Another important impact of oil price movements is a change in **inflation**. Because inflation has already been worryingly low in the last years, the collapse of the oil price denotes another significant downward pressure. As the group ”housing, water, electricity, gas and other fuels” with 16.0 percent and ”transport” with 14.8 percent are besides ”food and non-alcoholic beverages” the largest groups within the Harmonized index of consumer price (HICP) of the European Central Bank, a movement of the price of oil is expected to have a strong effect on the HICP and therefore on inflation. Indeed, the inflation rates of various countries came under pressure. This development can be observed in almost all OECD

Figure 5.13: Harmonised Comsumer Price Index (01/2014 = 100)



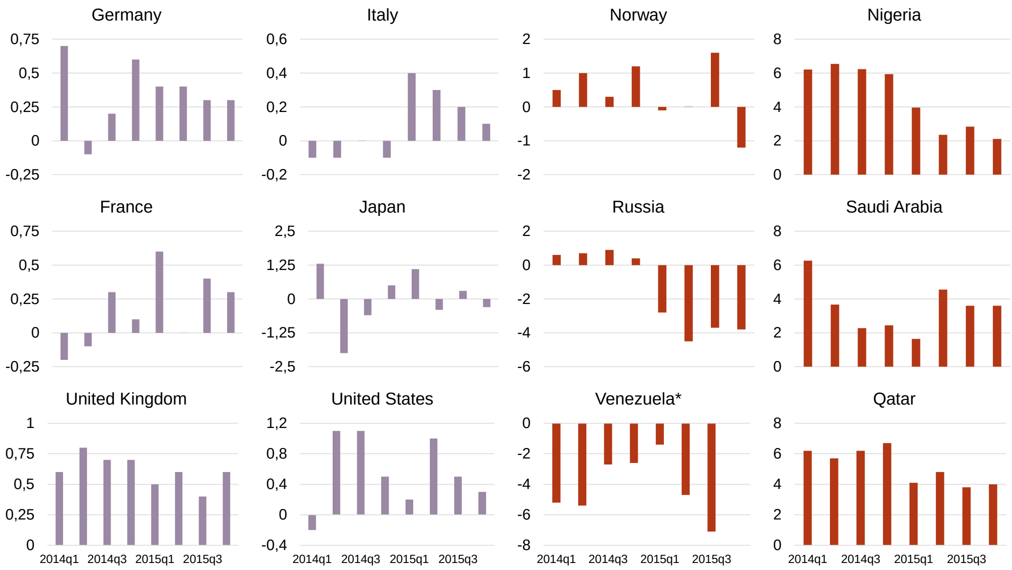
countries shown in figure 5.13.

The oil producing countries of the North Sea, Norway and slightly even the United Kingdom, faced a different movement.

The most important determinants for the impact of oil price changes on the inflation are the energy efficiency of industries, exchange rate developments, stance of monetary policy and the extent of fuel subsidies and other price regulations (Baffes et al. 2015*b*).

To explain the different developments of the specific countries in detail, we have to distinguish between different characteristics of the economies and their policy responses to the current situation.

Figure 5.14: Quarterly Real GDP Growth by Country



*: No data for 2015Q4 available

Figure 5.14 shows the quarterly growth rates of real GDP of twelve selected countries. We marked net energy importers in violet and net energy exporters in red.

The countries in our sample which are all net energy importers apart from Norway, experienced different economic responses to the recent collapse of oil prices.

Germany generates a quarterly economic growth since Q3 2014, i.e. since the months in which the oil price stated to collapse. According to the Deutsche Bundesbank, one of the main drivers of economic growth throughout the last two years has been the stable domestic demand. Domestic demand has been supported by a larger available income due to the decline of energy costs that lead to an increase in purchasing power as prices, e.g. for traveling reduced (Deutsche Bundesbank 2016). Germany being the third largest exporter of goods and services in the world, after China and the United States, with exports of 1,76 trillion USD in 2014 (cf. World Bank WDI), has to endeavor with demand drops in China and major oil exporting countries. This decline in demand for cars, machinery and chemical goods could be reflected in the real GDP growth following months.

The third largest European economy, **France**, could also gain from a cheaper energy bill. In contrast to Germany, France is debilitated by a weaker labor market situation. As a result of a higher unemployment rate, declining energy prices have a lower real effect on disposable income. Following the macroeconomic assumption, that households are trying to smooth their consumption, the Banque de France expects an increase of the savings rate of around 0.2 percent. Economic growth has been positive in every quarter since the beginning of the oil price decline in the third quarter of 2014. The future development of oil prices are seen to be one of the major economic risks for France (Banque de France 2015).

The economic situation in **Italy** has been more critical in the last years. As seen in table 5.14, the quarterly economic growth could though recover since the beginning of 2015. In pursuant of the economic outlook of the Banca d'Italia, political reforms, low interest rates and the decline of the oil price have contributed to the recovery. The Banca d'Italia expects falling oil prices to add around 0.8 percentage points to the economic output of Italy in 2016-17 (Banca d'Italia 2016). This expectation do not match with our findings.

Japan, being a large exporting country, faces similar challenges as Germany. Lower oil prices contribute, like in all oil importing countries, to a higher disposable income which have positive impacts on domestic demand. The low oil prices and a low yen rate had therefore a strong positive influence on economic growth as exports have risen in Japan during the last quarters. Due to a relative flat industrial production, low inflation and a yet low level of domestic demand, economic growth in Japan has however just fluctuated around the zero line (Bank of Japan 2016).

A much more positive conclusion can be drawn for the economic situation of the second largest economy of the European Union, the **United Kingdom**. The Bank of England quantifies the rise of real income caused by the collapse in oil prices at around 0.25 percent. In contrast to continental Europe, the United Kingdom has an oil extraction sector.

As a matter of course, falling oil prices harmed this sector. The Bank of England accounts a decline of investments of around 20 percent in this sector, which will be perceptible in the near future (Bank of England 2016). PricewaterhouseCoopers states in a paper, that the major sectors gaining from the oil price collapse will be agriculture, air transport, land transport and construction as a consequence of their high share of energy costs. The collapse could lead to a total increase of the level of employment of around 1.6 to 2.9 percent in difference to 2013 (PWC 2015).

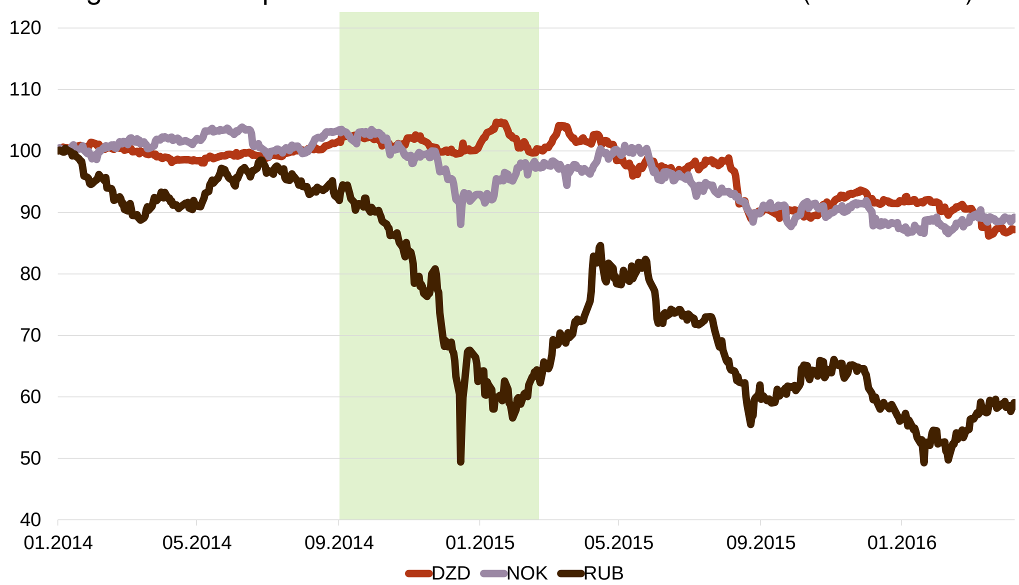
The biggest economy in our sample are the **United States**. Although the USA have always been one of the major oil producing country in the world, their domestic production is not enough to satisfy the domestic needs. Falling oil prices reduce therefore import costs and likewise boost consumer disposable income. According to Mine Yücel, director of research at the Federal Reserve Bank of Dallas, the decline in gasoline prices added up to 550 USD to household budgets in 2015. The US industry gains naturally due to lower energy costs. As the United Kingdom, the United States on the other hand have a large oil producing sector. Companies in the energy producing sector are confronted with reduction of their profitability. All in all the US economy experienced a decent economic growth since the decline in oil prices in 2014 (Yücel 2015).

The Norges Bank, the central bank of **Norway**, alludes in their yearly report to the particular situation of the Norwegian economy. In contrast to the countries mentioned above, Norway is relying to a large extent on the revenues gained by exporting petroleum products. The share of offshore production to GDP is in Norway around 20 percent, making the country rely to a large extent of the oil price. As demonstrated in chapter 4, Norway is gaining from oil price increases. Oil price decreases however tend to have a faint negative impact after some quarters. The oil price plunge constitutes a decrease of income (mainly for the government) and a decrease in demand for the oil sector. The current economic environment demands therefore a proper policy response. The Norges Bank refers to the depreciation of the NOK as one positive fact to avoid harmful developments. A weak NOK will help to stabilize the mainland employment and production but leads however to a much higher price for imports (cf. figure 5.15). As in the United Kingdom, Norway's investments in oil have fallen in 2015 on the level of 2012 again. The lack of investment can cause output gaps in the future when prices will stabilize. This could have another negative indirect impact that should be avoided (Bruce et al. 2016).

In general it is visible in table 5.14, that all **net oil exporting countries** faced a negative response to the oil price plunge. Although Saudi Arabia, Qatar and Nigeria had still an economic growth of around 2 to 4 percent in the fourth quarter 2015, all three countries faced cutbacks with respect to the level of economic growth before the decline in oil prices. This development is even more crucial for Venezuela and Russia, due to different reasons as the general composition of the Venezuelan economy and the sanctions against the Russian Federation.

The decrease in oil prices that had indeed slightly positive impacts on oil importing countries have fatal impacts on major oil exporting countries. The reevaluation of growth expectations of oil exporting countries led to significant capital outflows, reserve losses and an increase in the sovereign credit default swaps spreads (Baffes et al. 2015*b*, p. 162). Several oil producing and exporting countries like Norway, the Russian Federation and Algeria experienced additionally a significant depreciation of their currencies against the Euro.
As pointed in figure 5.15, with the start of the collapse of crude oil prices in November 2014, the currencies depreciated. The Norwegian krone and the Algerian dinar lost around 10

Figure 5.15: Depreciation of Selected Currencies to EUR (1/2014=100)

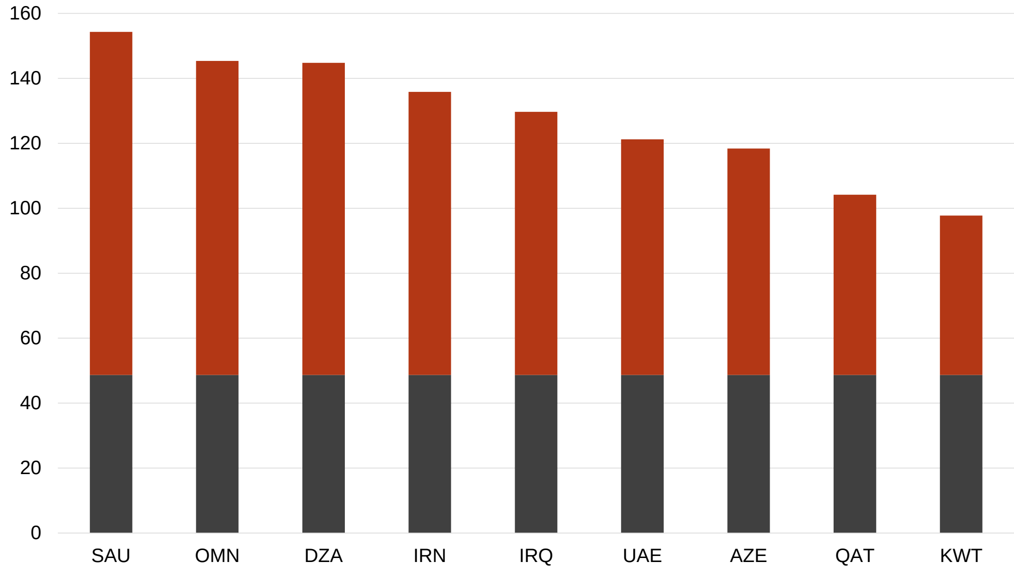


percent in cash value between January 2014 and April 2016 against the Euro.

The massive depreciation of the Ruble against the Euro needs to be interpreted in a different way. The drop of the cash value is mailny caused by other impacts like the Western sanctions against the Russian Federation. The sharp lost in November and December 2014 however is probably due to the collapse in oil prices.

Furthermore the NOCs mentioned in table 2.3 in section 2.4, had a lost in average of around 30 percent of their revenues in 2015.
The decline in income leads to another important issue, the financial situation of the balances of net oil exporting countries. The International Monetary Fund (IMF) calculates on an annual basis the fiscal breakeven crude oil price of selected economies. This price indicates the crude oil price that is approximately required to balance the national budget of the respective major oil exporting countries. If the current oil price go below the fiscal breakeven price, countries are not able to balance their budget anymore and have either to cut their public spending or go into debt. The black part of the columns in 5.16 is with 48.66 USD per bbl the average annual WTI oil price of 2015.

Figure 5.16: Breakeven Fiscal Oil Prices for 2015 in USD

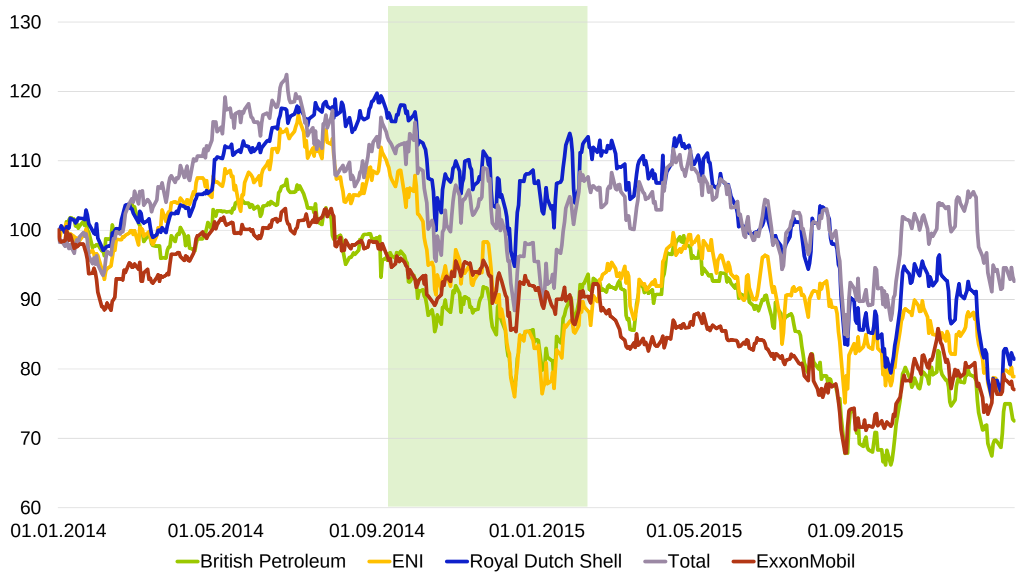


Following table 5.16, no OPEC country was able to balance its national budget without either cutting expenditures or raising taxes in 2015.
If the crude oil price remains for a long period on a low level, oil exporting countries that merely rely on the petroleum sector, could get into troubles because of the fact that the

repatriation of foreign assets lead to further capital outflows and financial strains (Baffes et al. 2015*b*, p. 163).

The current market is not only a challenge for governments of oil exporting countries, but likewise for **International Oil Companies**.
The figure 5.17 demonstrates the development of the stocks of leading IOCs since the beginning of 2014. In late 2014, all IOCs have lost around 10 to 20 percent of their value.

Figure 5.17: Stock Price Development of IOCs (01/2014=100)



The decrease of the oil price and general developments in global oil markets as the "Shale Revolution" in North America, limits on carbon emissions and an enormous growth of renewable energy are challenges which have to be managed. The decline in stock prices of IOCs lead on the other hand to mergers and acquisitions. The most prominent acquisition has been made by Warren Buffet. In January 2016, the American investor bought stocks a billion USD worth of Phillips 66 (Stempel 2016).

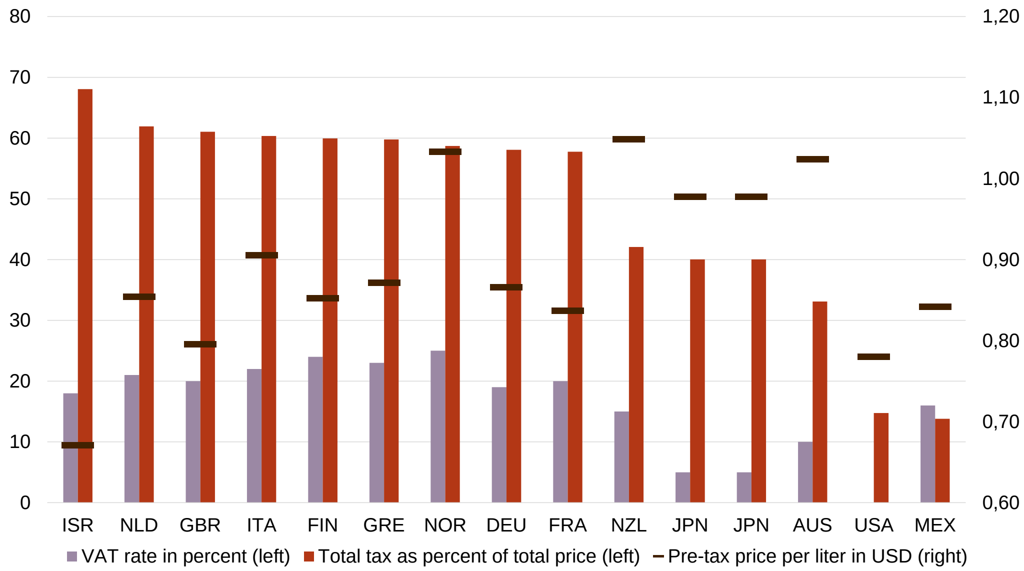
5.4 Policy Interventions

The current situation of low oil prices is harmful for oil exporting countries as well as an opportunity for oil importing countries which are not able to generate economic growth since years. In this paragraph we highlight the options of fiscal and monetary policy interventions. Oil exporting and oil importing countries are facing different situation though.

5.4.1 Fiscal Policy

Low consumer prices put always one topic on the agenda: The rise of consumption taxes.

Figure 5.18: Unleaded Gasoline Taxes in Selected OECD Countries



By comparing for instance the gasoline taxes as a percent share of the final price we can see a huge difference between selected OECD countries in figure 5.18. Whereas North American countries have low taxes on gasoline, European countries like the United Kingdom and the Netherlands face a very high tax on gasoline. Although the amount of taxes for diesel varies slightly in some countries and are in almost every OECD member state smaller than the tax on gasoline, the picture is in general very similar to gasoline. In an environment of low oil prices could every country discuss the option of raising energy taxes (e.g. on gasoline and diesel) "while reducing other distortionary taxes or raising priority spending" (Husain et al. 2015, p. 36). The gained tax revenue could be used to rebuild fiscal space wich have been lost after the global financial crisis, reallocate taxes to poor households or invest in infrastructure and human capital (Baffes et al. 2015*b*, p. 163).

Major oil importing countries that rely to a certain extent on oil as an input for their industry and households, should fill up their strategic petroleum reserves. Low oil prices make this step economically speaking reasonable and give the governments the option to be prepared for probable rising energy prices in the future.

For oil exporting countries and especially in developing countries, the current situation provide an opportunity to lower fuel subsidies. As agreed at the 2009 G20 summit in Pittsburgh in the United States, this topic should be on the agenda for every country. The G20 countries stated, that energy subsidies ”encourage wasteful consumption, reduce our energy security, impede investment in clean energy sources and undermine efforts to deal with the threat of climate change” (G20 2015). The low energy costs that are effectuated due to the energy subsidies move economies towards production and industry that is against environmental and climate goals of various governments (Baffes et al. 2015*a*, p. 40)

In 2014, the global total fossil fuel subsidies for all products sum up to 493 billion USD. The main product with 267 billion USD has been oil that equals 54 percent of the total subsidies. The other products are electricity (117 billion USD), natural gas (107 billion USD) and coal (2 billion USD). Especially Qatar (2754 USD per capita, 2014), Kuwait (2528 USD per capita, 2014) and Saudi Arabia (2428 USD per capita, 2014) have possible savings that would provide the opportunity to invest in the diversification of the economies. It has though to be mentioned, that without the energy subsidy reforms which have already been implemented since the G20 summit in 2009, total energy subsidies however would even sum up to 24 percent or 610 billion USD in 2014 (IEA 2016).

Furthermore Del Granado et al. (2012) found out, that energy subsidies privilege high income households due to the fact that high income households have much more possibilities to consume subsidized products with respect to low income households.

5.4.2 Monetary Policy

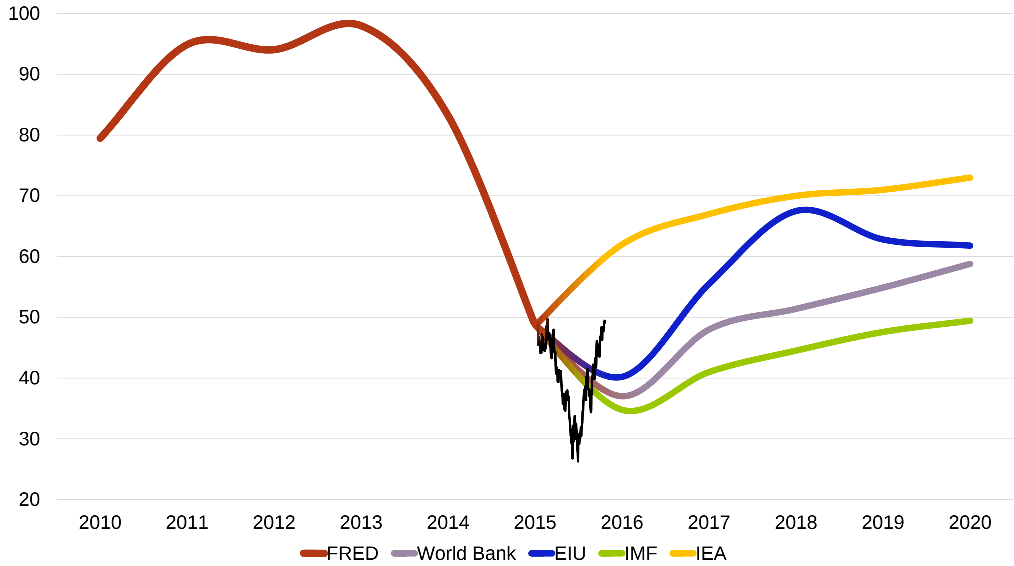
Low oil price on the other hand poses a challenge for monetary policymakers. The impact of oil price changes on inflation tends to be temporary and if price become stable within the next months, central bank might not have to do anything. For oil importing countries and especially European countries which face already the issue of low inflation, actions of the central bank could though become necessary. If inflation expectations become deanchored central banks should think about loosening monetary policy decisions (Baffes et al.

2015*b*). The ECB therefore decided on March 10, 2016 to lower the interest rate on the main refinancing operations of the Eurosystem by five basis points to 0.00 percent.
Oil exporting countries on the other side weight up the target of generate growth and the maintaining stable inflation and investors' confidence in the specific currency (Baffes et al. 2015*b*, p. 163).

5.5 Outlook and Expected Price Development

As already mentioned in the previous paragraphs, the forecast of oil prices and commodity prices in general appears to be a quite difficult undertaking.
Currently, the oil price increased up to around 50 USD per barrel after the creation of a bottom at around 35 to 40 USD per barrel this spring.

Figure 5.19: Oil Price Forecasts of the World Bank, IMF and EIU in USD/bbl



The actual oil price development is highlighted in black.

As seen in graph 5.19, the World Bank Group, the International Monetary Fund, the Intelligence Unit of The Economist (EIU) and the International Energy Agency expect a rising oil price over last years of this decade. The forecasts have a range from 49,4 USD per barrel by the IMF up to 73 USD per barrel expected by the IEA. This pattern demonstrates, that the current market situation is interpreted in different ways. The black underlining trend is the actual daily price development of WTI in USD per barrel throughout the last months (updated: 31/05/2016).

The Economist Intelligence Unit expects the demand for oil price to exceed global oil supply in 2017 the first time in four years. This could lead to a peak at around 70 USD per barrel. The demand is underlined by a faster growth in global economic growth in the next months. The missing investments in China as the largest oil consumer and knock-on effects on other economies could lead to a decrease in 2017-18 again. In the years 2019-20 the EIU expects that the growing oil production in Iraq, Iran and Libya will lead to an exceedance of oil demand again. According to their forecast, this movements could result in a stabilization of the oil price at around 60 USD per barrel at the end of this decade (The Economist Intelligence Unit 2016).

The IEA and IMF expect prices to raise again to re-balance the missing investments made in the upstream infrastructure in several countries during the last two years.

It is important to underline again the fact, that energy markets will change much faster in the next years than in the last decades. An increasing amount of small players in the oil market and the decrease of market power of single companies or countries will make it more difficult to change the prices individually.

New technologies as hydraulic fracturing let supply be much more flexible due to shorter payback periods. Hence production can be adjusted easier than in the past. An offshore oil rig for instance has to be planned, financed and constructed. After such a process has been finished, the production of an oil rig stays stable for decades and cannot be widen or reduced as a consequence of less demand.
On the demand side, other consumers will come into focus. The most important consumer markets in the past have been the United States and the European Union. The following years, India, China and other emerging markets will demand more energy and therefore global policies and contract mechanisms will change.

As a matter of costs and environmental issues, not only the amount of production and demand of crude oil will shift, but especially new energy sources will become profitable.

Natural Gas as an energy source is increasing in almost every country in the world. New pipelines between Russia and the European Union but mainly between Russia and China will have an impact on the energy mix of the countries. Coal as the major primary energy source of the past is expected to decline even more and will be replaced by new energy sources as renewable energy. Renewable energy sources, i.e. mainly energy gained by biofuels, waste, hydro, wind, solar and geothermal account already around 14 percent of the world total primary energy supply (IEA 2015*c*, p. 6).

No matter to which extent different energy sources will be developed in the future. Crude oil will still play a major role in global energy markets throughout the next decades.

6 Conclusion

Although the relationship between oil price movements and changes in real GDP growth has diminished over the last decades, due to more energy efficient economies, the correlation is still remarkable. Our regressions have underlined, that oil price increases and decreases have a significant impact on economic growth. This movements tends furthermore to move symmetric.

The countries in our sample are net oil importing countries, aside from Norway. For practical reasons, i.e. due to the availability of data, we concentrated on the OECD countries Germany, France, Italy, Japan, Norway, the United Kingdom and the United States. To get a more diversified picture of the effects, it could be interesting to do the same regression with net oil exporting countries like Russia, Saudi Arabia, Venezuela and other countries of the Persian Gulf. In addition it could be of interest, to have a closer look on emerging markets like China, India and Brazil.

Another interesting initial point of further research is the abrupt change of the futures trading in early 2005 highlighted in figure 2.3 in section 2.2. It could be of interest to investigate whether the rise of the amount of futures traded during the last decade had an impact on the correlation of the oil price and economic growth.

More energy efficient technologies, a general reduction of the industrial sector in the advanced economies and the development of substitutes for fossil fuels make oil less important than it used to be in the last decades.

The current environment of cheap oil is already about to change somewhat. Although it can be assumes that we are facing a ”New Oil Order” as Goldman Sachs mentioned, prices have already risen up to around 50 USD per barrel in June 2016. Changes and

dislocation of the mentioned geopolitical risk as for instance the military advance of ISIL in Iraq, Syria and Libya or the diplomatic tensions between Saudi Arabia and Iran could change the global oil markets abruptly. Furthermore new technologies in the oil market as hydraulic fracturing could lead to much more uncertainty in the markets and will lead to an increase in oil price volatility.
The development of alternative energy resources should not be removed from the agenda as well. Disasters like the explosion on the oil rig "Deep Water Horizon" in 2010 or the frequent emerge of economic issues in the Niger Delta could maybe be avoided by switching to renewable energy resources.

All in all an outlook for the development of global oil markets is very complicated. Oil will experience a reduction of its importance as primary energy resource of the world throughout the next decades. As a consequence of its relatively easy production, its particular characteristics and the absence of alternatives (i.e. for transportation), oil will remain nevertheless the **black blood of our economies**.

A Appendix: Summary of the Variables

A.1 Germany

Table A.1: Summary of the Variables of Germany

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.41875	.9326231	-4.5	2.9
opincdeu	141	5.291104	7.970802	0	44.68637
opdecdeu	141	-4.214749	8.050219	-47.35954	0
infl	144	.525	.5366954	-.6	2.6
intr	144	4.454861	3.016501	-.1	13.2
indu	144	.3590278	2.015514	-13.4	5.6
unemp	100	7.805	1.77749	4.4	11.2
oilim	76	25329.54	2017.657	21409	28906

A.2 France

Table A.2: Summary of the Variables of France

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.4361111	.4976323	-1.6	1.6
opincfra	141	5.619628	7.904171	0	44.68637
opdecfra	141	-4.006188	8.03421	-47.05641	0
infl	144	.7590278	.8784453	-.5	3.9
intr	144	5.822222	4.359901	-.1	17.4
indu	144	.0534722	1.384071	-7.7	5
unemp	132	9.989394	1.328849	7.2	12.5
oilim	76	18902.04	3203.558	12290	23778

A.3 Italy

Table A.3: Summary of the Variables of Italy

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.2805556	.7118653	-2.9	2.2
opincita	141	5.619628	7.904171	0	44.68637
opdecita	141	-4.006188	8.03421	-47.05641	0
infl	144	1.195833	1.193682	-.4	6.5
intr	144	7.811111	6.201208	-.1	20.5
indu	144	.0444444	1.833556	-10.5	3.7
unemp	132	9.304545	1.67231	5.9	12.8
oilim	76	21262.21	2732.691	14435	25607

A.4 Japan

Table A.4: Summary of the Variables of Japan

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.4833333	1.110157	-4	3.2
opincjpn	144	5.290535	8.342995	0	44.09787
opdecjpn	144	-4.630953	8.808766	-55.77052	0
infl	144	.2402778	.6890065	-1.2	3.2
intr	55	.3236364	.2395703	.1	.9
indu	144	.2861111	2.658792	-19.6	7.1
unemp	144	3.524306	1.062866	1.9	5.4
oilim	76	49508.68	5550.974	37664	61431

A.5 Norway

Table A.5: Summary of the Variables of Norway

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.6138889	1.340108	-2.6	4
opincnor	141	5.086559	7.544372	0	41.11225
opdecnor	141	-3.798839	7.424491	-45.4338	0
infl	144	.9381945	.9812221	-1.7	4.9
indu	144	.4430556	3.070857	-11	17.3
intr	144	7.36875	4.576796	1.1	16.5
unemp	108	4.190741	1.218206	2.4	6.7
oilim	76	256.7895	171.5259	15	795

A.6 United Kingdom

Table A.6: Summary of the Variables of the United Kingdom

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.5375	.7040219	-2.3	2.5
opincgbr	141	5.385597	7.629885	0	38.48088
opdecgbr	141	-4.076954	7.715194	-42.20466	0
infl	144	.8888889	1.015276	-.7	5.8
indu	144	.1	1.252634	-4.5	4
intr	144	6.922222	4.503044	.5	17.7
unemp	131	7.49313	2.089873	4.6	11.3
oilim	76	13581.18	1589.523	9786	17493

A.7 United States

Table A.7: Summary of the Variables of the United States

Variable	Obs	Mean	Std. Dev.	Min	Max
gdpg	144	.6520833	.7402484	-2.1	2.3
opincusa	144	5.353909	8.40131	0	48.86641
opdecusa	144	-4.305675	8.230987	-50.46333	0
infl	144	.7930556	.7691293	-2.8	4
indu	144	.4909722	1.359654	-5.5	3.8
intr	144	5.153472	3.964315	.1	17.5
unemp	144	6.418056	1.622984	3.9	10.7
oilim	76	127231.4	14077.45	99834	154284

B Appendix: Empirical Results

B.1 Germany

Table B.1: Bivariate Correlation (1980 - 2015) Germany

Variable	Coefficient	(Std. Err.)
L1.gdpg	0.107	(0.084)
L2.gdpg	0.100	(0.084)
L3.gdpg	0.094	(0.082)
L4.gdpg	0.182*	(0.081)
L5.gdpg	-0.155†	(0.081)
L0.opincdeu	0.004	(0.011)
L1.opincdeu	0.000	(0.011)
L2.opincdeu	0.027*	(0.011)
L3.opincdeu	-0.024*	(0.011)
L4.opincdeu	-0.002	(0.011)
L5.opincdeu	0.000	(0.011)
L0.opdecdeu	0.016	(0.010)
L1.opdecdeu	0.015	(0.011)
L2.opdecdeu	-0.003	(0.011)
L3.opdecdeu	-0.009	(0.011)
L4.opdecdeu	0.008	(0.011)
L5.opdecdeu	-0.006	(0.011)
Intercept	0.345†	(0.181)

N	136
Log-likelihood	-170.148

Significance levels : † : 10% * : 5% ** : 1%

Table B.2: Test for Significance of Oil Price Increases and Decreases DEU1

Oil Price Increases		**Oil Price Decreases**	
L0.opincdeu = 0		L0.opdecdeu = 0	
L1.opincdeu = 0		L1.opdecdeu = 0	
L2.opincdeu = 0		L2.opdecdeu = 0	
L3.opincdeu = 0		L3.opdecdeu = 0	
L4.opincdeu = 0		L4.opdecdeu = 0	
L5.opincdeu = 0		L5.opdecdeu = 0	
χ^2 (5)	10.07	χ^2 (5)	6.84
$Prob > \chi^2$	0.1216	$Prob > \chi^2$	0.3359

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.3: Test for Symmetry of Oil Price Increases and Decreases DEU1

L0.opincdeu = L0.opdecdeu	
χ^2 (1)	0.44
$Prob > \chi^2$	0.5079

L1.opincdeu = L1.opdecdeu	
χ^2 (1)	0.69
$Prob > \chi^2$	0.4056

L2.opincdeu = L2.opdecdeu	
χ^2 (1)	2.93
$Prob > \chi^2$	0.0871†

L3.opincdeu = L3.opdecdeu	
χ^2 (1)	0.72
$Prob > \chi^2$	0.3977

L4.opincdeu = L4.opdecdeu	
χ^2 (1)	0.33
$Prob > \chi^2$	0.5651

L5.opincdeu = L5.opdecdeu	
χ^2 (1)	0.13
$Prob > \chi^2$	0.7171

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.4: Multivariate Correlation (1997 - 2015) Germany

Variable	Coefficient	(Std. Err.)
L0.opincdeu	-0.004	(0.013)
L1.opincdeu	-0.016	(0.013)
L2.opincdeu	-0.034**	(0.013)
L3.opincdeu	-0.019	(0.013)
L4.opincdeu	0.005	(0.013)
L5.opincdeu	-0.026*	(0.010)
L0.opdecdeu	0.019	(0.014)
L1.opdecdeu	0.067**	(0.019)
L2.opdecdeu	0.030	(0.024)
L3.opdecdeu	0.069**	(0.024)
L4.opdecdeu	0.014	(0.024)
L5.opdecdeu	0.070**	(0.021)
L1.infl	-0.355	(0.316)
L2.infl	0.247	(0.324)
L3.infl	-0.696†	(0.375)
L4.infl	-1.056**	(0.386)
L5.infl	-1.346**	(0.346)
L1.intr	-0.256	(0.376)
L2.intr	0.143	(0.537)
L3.intr	0.325	(0.594)
L4.intr	0.496	(0.538)
L5.intr	-0.590†	(0.350)
L1.indu	0.097	(0.088)
L2.indu	-0.234*	(0.100)
L3.indu	-0.226*	(0.094)
L4.indu	-0.246**	(0.081)
L5.indu	-0.267**	(0.079)
L1.unemp	0.374	(0.724)
L2.unemp	-1.256	(1.635)
L3.unemp	1.933	(1.772)
L4.unemp	-1.815	(1.480)
L5.unemp	1.440*	(0.727)
L1.oilim	0.000**	(0.000)
L2.oilim	0.000	(0.000)
L3.oilim	0.000	(0.000)
L4.oilim	0.000**	(0.000)
L5.oilim	0.000	(0.000)
Intercept	12.703**	(4.557)

N	68
Log-likelihood	-38.808

Significance levels : † : 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_t$ due to shortage of space.

Table B.5: Test for Significance of Oil Price Increases and Decreases DEU2

Oil Price Increases		**Oil Price Decreases**	
L0.opincdeu = 0		L0.opdecdeu = 0	
L1.opincdeu = 0		L1.opdecdeu = 0	
L2.opincdeu = 0		L2.opdecdeu = 0	
L3.opincdeu = 0		L3.opdecdeu = 0	
L4.opincdeu = 0		L4.opdecdeu = 0	
L5.opincdeu = 0		L5.opdecdeu = 0	
χ^2 (5)	14.12	χ^2 (5)	28.69
$Prob > \chi^2$	0.0283*	$Prob > \chi^2$	0.0001**

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.6: Test for Symmetry of Oil Price Increases and Decreases DEU2

L0.opincdeu = L0.opdecdeu	
χ^2 (1)	0.97
$Prob > \chi^2$	0.3256

L1.opincdeu = L1.opdecdeu	
χ^2 (1)	8.81
$Prob > \chi^2$	0.0030**

L2.opincdeu = L2.opdecdeu	
χ^2 (1)	4.23
$Prob > \chi^2$	0.0398*

L3.opincdeu = L3.opdecdeu	
χ^2 (1)	7.47
$Prob > \chi^2$	0.0063**

L4.opincdeu = L4.opdecdeu	
χ^2 (1)	0.08
$Prob > \chi^2$	0.7829

L5.opincdeu = L5.opdecdeu	
χ^2 (1)	12.83
$Prob > \chi^2$	0.0003**

Significance levels : † : 10% $*$: 5% $**$: 1%

B.2 France

Table B.7: Bivariate Correlation (1980 - 2015) France

Variable	Coefficient	(Std. Err.)
L0.gdpg	0.455**	(0.087)
L2.gdpg	0.219*	(0.094)
L3.gdpg	0.051	(0.097)
L4.gdpg	-0.118	(0.090)
L5.gdpg	-0.001	(0.084)
L0.opincfra	-0.002	(0.005)
L1.opincfra	0.005	(0.005)
L2.opincfra	0.001	(0.005)
L3.opincfra	-0.002	(0.005)
L4.opincfra	0.001	(0.005)
L5.opincfra	-0.003	(0.005)
L0.opdecfra	0.011*	(0.005)
L1.opdecfra	-0.009†	(0.005)
L2.opdecfra	-0.003	(0.005)
L3.opdecfra	0.002	(0.005)
L4.opdecfra	-0.005	(0.005)
L5.opdecfra	0.000	(0.005)
Intercept	0.172†	(0.092)

N	136
Log-likelihood	-62.197

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.8: Test for Significance of Oil Price Increases and Decreases FRA1

Oil Price Increases		**Oil Price Decreases**	
L0.opincfra = 0		L0.opdecfra = 0	
L1.opincfra = 0		L1.opdecfra = 0	
L2.opincfra = 0		L2.opdecfra = 0	
L3.opincfra = 0		L3.opdecfra = 0	
L4.opincfra = 0		L4.opdecfra = 0	
L5.opincfra = 0		L5.opdecfra = 0	
χ^2 (5)	1.87	χ^2 (5)	9.27
$Prob > \chi^2$	0.9312	$Prob > \chi^2$	0.1590

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.9: Test for Symmetry of Oil Price Increases and Decreases FRA1

L0.opincfra = L0.opdecfra	
χ^2 (1)	2.94
$Prob > \chi^2$	0.0862†

L1.opincfra = L1.opdecfra	
χ^2 (1)	2.78
$Prob > \chi^2$	0.0952†

L2.opincfra = L2.opdecfra	
χ^2 (1)	0.32
$Prob > \chi^2$	0.5741

L3.opincfra = L3.opdecfra	
χ^2 (1)	0.30
$Prob > \chi^2$	0.5852

L4.opincfra = L4.opdecfra	
χ^2 (1)	0.48
$Prob > \chi^2$	0.4871

L5.opincfra = L5.opdecfra	
χ^2 (1)	0.13
$Prob > \chi^2$	0.7146

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.10: Multivariate Correlation (1997 - 2015) France

Variable	Coefficient	(Std. Err.)
L0.opincfra	0.010	(0.006)
L1.opincfra	0.003	(0.006)
L2.opincfra	-0.008	(0.007)
L3.opincfra	-0.008	(0.006)
L4.opincfra	-0.006	(0.008)
L5.opincfra	-0.001	(0.005)
L0.opdecfra	0.010	(0.007)
L1.opdecfra	-0.019	(0.012)
L2.opdecfra	-0.031*	(0.012)
L3.opdecfra	0.009	(0.011)
L4.opdecfra	0.024†	(0.012)
L5.opdecfra	0.030*	(0.013)
L1.infl	0.246	(0.318)
L2.infl	0.102	(0.222)
L3.infl	-0.028	(0.218)
L4.infl	-0.350	(0.218)
L5.infl	-0.443*	(0.204)
L1.intr	-0.028	(0.174)
L2.intr	-0.157	(0.333)
L3.intr	-0.119	(0.311)
L4.intr	0.036	(0.316)
L5.intr	0.057	(0.207)
L1.indu	0.107	(0.087)
L2.indu	0.005	(0.093)
L3.indu	-0.150†	(0.089)
L4.indu	-0.175*	(0.080)
L5.indu	-0.159**	(0.061)
L1.unemp	0.109	(0.271)
L2.unemp	0.104	(0.331)
L3.unemp	-0.701*	(0.351)
L4.unemp	0.466	(0.425)
L5.unemp	0.026	(0.287)
L1.oilim	0.000	(0.000)
L2.oilim	0.000	(0.000)
L3.oilim	0.000	(0.000)
L4.oilim	0.000	(0.000)
L5.oilim	0.000	(0.000)
Intercept	-0.615	(1.387)

N	67
Log-likelihood	2.775

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_t$ due to shortage of space.

Table B.11: Test for Significance of Oil Price Increases and Decreases FRA2

Oil Price Increases		**Oil Price Decreases**	
L0.opincfra = 0		L0.opdecfra = 0	
L1.opincfra = 0		L1.opdecfra = 0	
L2.opincfra = 0		L2.opdecfra = 0	
L3.opincfra = 0		L3.opdecfra = 0	
L4.opincfra = 0		L4.opdecfra = 0	
L5.opincfra = 0		L5.opdecfra = 0	
χ^2 (5)	6.47	χ^2 (5)	21.34
$Prob > \chi^2$	0.3726	$Prob > \chi^2$	0.0016**

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.12: Test for Symmetry of Oil Price Increases and Decreases FRA2

L0.opincfra = L0.opdecfra	
χ^2 (1)	0.00
$Prob > \chi^2$	0.9463

L1.opincfra = L1.opdecfra	
χ^2 (1)	2.77
$Prob > \chi^2$	0.0960†

L2.opincfra = L2.opdecfra	
χ^2 (1)	2.14
$Prob > \chi^2$	0.1440

L3.opincfra = L3.opdecfra	
χ^2 (1)	1.52
$Prob > \chi^2$	0.2183

L4.opincfra = L4.opdecfra	
χ^2 (1)	3.14
$Prob > \chi^2$	0.0763†

L5.opincfra = L5.opdecfra	
χ^2 (1)	4.76
$Prob > \chi^2$	0.0291*

Significance levels : † : 10% $*$: 5% $**$: 1%

B.3 Italy

Table B.13: Bivariate Correlation (1980 - 2015) Italy

Variable	Coefficient	(Std. Err.)
L1.gdpg	0.409**	(0.086)
L2.gdpg	0.069	(0.092)
L3.gdpg	0.196*	(0.089)
L4.gdpg	-0.104	(0.090)
L5.gdpg	0.022	(0.083)
L0.opincita	-0.007	(0.007)
L1.opincita	0.003	(0.007)
L2.opincita	0.014†	(0.007)
L3.opincita	-0.010	(0.008)
L4.opincita	-0.002	(0.008)
L5.opincita	-0.002	(0.007)
L0.opdecita	0.009	(0.007)
L1.opdecita	0.006	(0.008)
L2.opdecita	-0.012	(0.008)
L3.opdecita	-0.007	(0.008)
L4.opdecita	0.002	(0.008)
L5.opdecita	-0.005	(0.008)
Intercept	0.122	(0.129)

N	136
Log-likelihood	-120.455

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.14: Test for Significance of Oil Price Increases and Decreases ITA1

Oil Price Increases		**Oil Price Decreases**	
L0.opincita = 0		L0.opdecita = 0	
L1.opincita = 0		L1.opdecita = 0	
L2.opincita = 0		L2.opdecita = 0	
L3.opincita = 0		L3.opdecita = 0	
L4.opincita = 0		L4.opdecita = 0	
L5.opincita = 0		L5.opdecita = 0	
χ^2 (5)	6.11	χ^2 (5)	6.66
$Prob > \chi^2$	0.4113	$Prob > \chi^2$	0.3532

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.15: Test for Symmetry of Oil Price Increases and Decreases ITA1

L0.opincita = L0.opdecita	
χ^2 (1)	1.78
$Prob > \chi^2$	0.1821

L1.opincita = L1.opdecita	
χ^2 (1)	0.06
$Prob > \chi^2$	0.8053

L2.opincita = L2.opdecita	
χ^2 (1)	4.52
$Prob > \chi^2$	0.0335*

L3.opincita = L3.opdecita	
χ^2 (1)	0.04
$Prob > \chi^2$	0.8425

L4.opincita = L4.opdecita	
χ^2 (1)	0.16
$Prob > \chi^2$	0.6915

L5.opincita = L5.opdecita	
χ^2 (1)	0.04
$Prob > \chi^2$	0.8372

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.16: Multivariate Correlation (1997 - 2015) Italy

Variable	Coefficient	(Std. Err.)
L0.opincita	-0.017*	(0.007)
L1.opincita	0.012†	(0.007)
L2.opincita	0.008	(0.007)
L3.opincita	0.020**	(0.008)
L4.opincita	0.011†	(0.006)
L5.opincita	0.020**	(0.005)
L0.opdecita	0.004	(0.009)
L1.opdecita	0.004	(0.010)
L2.opdecita	-0.026*	(0.011)
L3.opdecita	-0.019†	(0.012)
L4.opdecita	-0.026*	(0.011)
L5.opdecita	-0.029**	(0.009)
L1.infl	-0.577†	(0.303)
L2.infl	-0.453*	(0.223)
L3.infl	-0.187	(0.236)
L4.infl	0.002	(0.243)
L5.infl	-0.056	(0.287)
L1.intr	-0.636**	(0.233)
L2.intr	0.593†	(0.345)
L3.intr	-0.507	(0.328)
L4.intr	1.012**	(0.309)
L5.intr	-0.888**	(0.225)
L1.indu	0.190**	(0.065)
L2.indu	0.236**	(0.059)
L3.indu	0.096	(0.066)
L4.indu	0.047	(0.050)
L5.indu	0.050	(0.060)
L1.unemp	-0.215	(0.200)
L2.unemp	0.616*	(0.292)
L3.unemp	-0.741*	(0.342)
L4.unemp	0.233	(0.318)
L5.unemp	0.473	(0.337)
L1.oilim	0.000	(0.000)
L2.oilim	0.000	(0.000)
L3.oilim	0.000**	(0.000)
L4.oilim	0.000	(0.000)
L5.oilim	0.000	(0.000)
Intercept	-12.385**	(3.110)

N	67
Log-likelihood	-.278

Significance levels : † : 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_{\ t}$ due to shortage of space.

Table B.17: Test for Significance of Oil Price Increases and Decreases ITA2

Oil Price Increases		**Oil Price Decreases**	
L0.opincita = 0		L0.opdecita = 0	
L1.opincita = 0		L1.opdecita = 0	
L2.opincita = 0		L2.opdecita = 0	
L3.opincita = 0		L3.opdecita = 0	
L4.opincita = 0		L4.opdecita = 0	
L5.opincita = 0		L5.opdecita = 0	
χ^2 (5)	32.98	χ^2 (5)	21.80
$Prob > \chi^2$	0.0000**	$Prob > \chi^2$	0.0013**

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.18: Test for Symmetry of Oil Price Increases and Decreases ITA2

L0.opincita = L0.opdecita	
χ^2 (1)	3.47
$Prob > \chi^2$	0.0626†

L1.opincita = L1.opdecita	
χ^2 (1)	0.53
$Prob > \chi^2$	0.4648

L2.opincita = L2.opdecita	
χ^2 (1)	5.27
$Prob > \chi^2$	0.0217*

L3.opincita = L3.opdecita	
χ^2 (1)	6.11
$Prob > \chi^2$	0.0134*

L4.opincita = L4.opdecita	
χ^2 (1)	7.24
$Prob > \chi^2$	0.0071**

L5.opincita = L5.opdecita	
χ^2 (1)	19.68
$Prob > \chi^2$	0.0000**

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

B.4 Japan

Table B.19: Bivariate Correlation (1980 - 2015) Japan

Variable	Coefficient	(Std. Err.)
L1.gdpg	0.121	(0.086)
L2.gdpg	0.049	(0.085)
L3.gdpg	0.178*	(0.083)
L4.gdpg	-0.021	(0.085)
L5.gdpg	0.051	(0.082)
L0.opincjpn	-0.003	(0.012)
L1.opincjpn	-0.015	(0.012)
L2.opincjpn	0.010	(0.012)
L3.opincjpn	0.003	(0.012)
L4.opincjpn	-0.002	(0.012)
L5.opincjpn	-0.007	(0.011)
L0.opdecjpn	0.015	(0.011)
L1.opdecjpn	0.023*	(0.012)
L2.opdecjpn	-0.020	(0.012)
L3.opdecjpn	0.003	(0.012)
L4.opdecjpn	-0.017	(0.013)
L5.opdecjpn	-0.008	(0.012)
Intercept	0.350	(0.241)

N	139
Log-likelihood	-198.092

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.20: Test for Significance of Oil Price Increases and Decreases JPN1

Oil Price Increases		**Oil Price Decreases**	
L0.opincjpn = 0		L0.opdecjpn = 0	
L1.opincjpn = 0		L1.opdecjpn = 0	
L2.opincjpn = 0		L2.opdecjpn = 0	
L3.opincjpn = 0		L3.opdecjpn = 0	
L4.opincjpn = 0		L4.opdecjpn = 0	
L5.opincjpn = 0		L5.opdecjpn = 0	
χ^2 (5)	2.84	χ^2 (5)	12.02
$Prob > \chi^2$	0.8286	$Prob > \chi^2$	0.0616†

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.21: Test for Symmetry of Oil price Increases and Decreases JPN1

L0.opincjpn = L0.opdecjpn	
χ^2 (1)	0.97
$Prob > \chi^2$	0.3235

L1.opincjpn = L1.opdecjpn	
χ^2 (1)	3.98
$Prob > \chi^2$	0.0459*

L2.opincjpn = L2.opdecjpn	
χ^2 (1)	2.31
$Prob > \chi^2$	0.1285

L3.opincjpn = L3.opdecjpn	
χ^2 (1)	0.00
$Prob > \chi^2$	0.9988

L4.opincjpn = L4.opdecjpn	
χ^2 (1)	0.59
$Prob > \chi^2$	0.4421

L5.opincjpn = L5.opdecjpn	
χ^2 (1)	0.00
$Prob > \chi^2$	0.9730

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.22: Multivariate Correlation (1997 - 2015) Japan

Variable	Coefficient	(Std. Err.)
L0.opincjpn	-0.062**	(0.023)
L1.opincjpn	-0.047	(0.031)
L2.opincjpn	-0.042	(0.031)
L3.opincjpn	-0.087*	(0.034)
L4.opincjpn	-0.012	(0.030)
L5.opincjpn	-0.022	(0.018)
L0.opdecjpn	0.005	(0.017)
L1.opdecjpn	0.020	(0.015)
L2.opdecjpn	-0.057**	(0.018)
L3.opdecjpn	0.047**	(0.015)
L4.opdecjpn	-0.071**	(0.021)
L5.opdecjpn	0.042*	(0.020)
L1.infl	-1.338**	(0.294)
L2.infl	-1.464**	(0.444)
L3.infl	-1.078*	(0.420)
L4.infl	-1.418**	(0.388)
L5.infl	-1.399**	(0.423)
L1.intr	-10.044**	(3.580)
L2.intr	5.225	(3.752)
L3.intr	4.851	(3.335)
L4.intr	10.335*	(4.434)
L5.intr	-12.229**	(3.417)
L1.indu	0.485**	(0.106)
L2.indu	0.351**	(0.116)
L3.indu	0.351**	(0.101)
L4.indu	0.163†	(0.088)
L5.indu	0.023	(0.069)
L1.unemp	0.025	(0.944)
L2.unemp	-2.462*	(1.062)
L3.unemp	-2.171†	(1.134)
L4.unemp	3.865**	(1.005)
L5.unemp	-0.750	(1.010)
L1.oilim	0.000	(0.000)
L2.oilim	0.000†	(0.000)
L3.oilim	0.000	(0.000)
L4.oilim	0.000*	(0.000)
L5.oilim	0.000†	(0.000)
Intercept	8.403**	(1.984)

N	50
Log-likelihood	-28.854

Significance levels : † : 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_{\ t}$ due to shortage of space.

Table B.23: Test for Significance of Oil Price Increases and Decreases JPN2

Oil Price Increases		**Oil Price Decreases**	
L0.opincjpn = 0		L0.opdecjpn = 0	
L1.opincjpn = 0		L1.opdecjpn = 0	
L2.opincjpn = 0		L2.opdecjpn = 0	
L3.opincjpn = 0		L3.opdecjpn = 0	
L4.opincjpn = 0		L4.opdecjpn = 0	
L5.opincjpn = 0		L5.opdecjpn = 0	
χ^2 (5)	16.17	χ^2 (5)	37.23
$Prob > \chi^2$	0.0128*	$Prob > \chi^2$	0.000**

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.24: Test for Symmetry of Oil Price Increases and Decreases JPN2

L0.opincjpn = L0.opdecjpn	
χ^2 (1)	4.34
$Prob > \chi^2$	0.0373*

L1.opincjpn = L1.opdecjpn	
χ^2 (1)	3.35
$Prob > \chi^2$	0.0670†

L2.opincjpn = L2.opdecjpn	
χ^2 (1)	0.19
$Prob > \chi^2$	0.6643

L3.opincjpn = L3.opdecjpn	
χ^2 (1)	11.97
$Prob > \chi^2$	0.0005**

L4.opincjpn = L4.opdecjpn	
χ^2 (1)	2.28
$Prob > \chi^2$	0.1308

L5.opincjpn = L5.opdecjpn	
χ^2 (1)	4.55
$Prob > \chi^2$	0.0330*

Significance levels : † : 10% $*$: 5% $**$: 1%

B.5 Norway

Table B.25: Bivariate Correlation (1980 - 2015) Norway

Variable	Coefficient	(Std. Err.)
L1.gdpg	-0.309**	(0.083)
L2.gdpg	0.037	(0.084)
L3.gdpg	0.061	(0.084)
L4.gdpg	0.124	(0.083)
L5.gdpg	0.215**	(0.077)
L0.opincnor	-0.003	(0.015)
L1.opincnor	-0.002	(0.015)
L2.opincnor	0.019	(0.015)
L3.opincnor	-0.012	(0.015)
L4.opincnor	-0.025†	(0.015)
L5.opincnor	-0.010	(0.015)
L0.opdecnor	-0.016	(0.015)
L1.opdecnor	0.035*	(0.016)
L2.opdecnor	-0.006	(0.016)
L3.opdecnor	0.013	(0.016)
L4.opdecnor	0.007	(0.016)
L5.opdecnor	0.000	(0.016)
Intercept	0.840**	(0.301)

N	136
Log-likelihood	-209.881

Significance levels : † : 10% * : 5% ** : 1%

Table B.26: Test for Significance of Oil Price Increases and Decreases NOR1

Oil Price Increases		**Oil Price Decreases**	
L0.opincnor = 0		L0.opdecnor = 0	
L1.opincnor = 0		L1.opdecnor = 0	
L2.opincnor = 0		L2.opdecnor = 0	
L3.opincnor = 0		L3.opdecnor = 0	
L4.opincnor = 0		L4.opdecnor = 0	
L5.opincnor = 0		L5.opdecnor = 0	
χ^2 (5)	6.82	χ^2 (5)	6.42
$Prob > \chi^2$	0.3375	$Prob > \chi^2$	0.3775

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.27: Test for Symmetry of Oil Price Increases and Decreases NOR1

L0.opincnor = L0.opdecnor	
χ^2 (1)	2.33
$Prob > \chi^2$	0.1266

L1.opincnor = L1.opdecnor	
χ^2 (1)	0.28
$Prob > \chi^2$	0.5994

L2.opincnor = L2.opdecnor	
χ^2 (1)	2.09
$Prob > \chi^2$	0.1480

L3.opincnor = L3.opdecnor	
χ^2 (1)	1.04
$Prob > \chi^2$	0.3077

L4.opincnor = L4.opdecnor	
χ^2 (1)	1.70
$Prob > \chi^2$	0.1923

L5.opincnor = L5.opdecnor	
χ^2 (1)	0.17
$Prob > \chi^2$	0.6795

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.28: Multivariate Correlation (1997 - 2015) Norway

Variable	Coefficient	(Std. Err.)
L0.opincnor	0.025	(0.018)
L1.opincnor	-0.028†	(0.017)
L2.opincnor	0.006	(0.018)
L3.opincnor	0.035*	(0.017)
L4.opincnor	-0.009	(0.014)
L5.opincnor	-0.009	(0.013)
L0.opdecnor	-0.038**	(0.015)
L1.opdecnor	0.052**	(0.017)
L2.opdecnor	0.018	(0.018)
L3.opdecnor	0.033	(0.020)
L4.opdecnor	-0.011	(0.020)
L5.opdecnor	0.006	(0.020)
L1.infl	-0.373*	(0.179)
L2.infl	-0.312	(0.208)
L3.infl	-0.671**	(0.232)
L4.infl	0.102	(0.222)
L5.infl	0.204	(0.182)
L1.intr	0.210	(0.239)
L2.intr	-1.148*	(0.460)
L3.intr	1.272*	(0.554)
L4.intr	-0.065	(0.548)
L5.intr	-0.171	(0.331)
L1.indu	0.034	(0.048)
L2.indu	0.019	(0.059)
L3.indu	-0.131†	(0.075)
L4.indu	-0.174*	(0.068)
L5.indu	0.111*	(0.056)
L1.unemp	-0.482	(0.599)
L2.unemp	0.953	(0.926)
L3.unemp	-0.309	(0.991)
L4.unemp	-1.384	(1.029)
L5.unemp	1.959**	(0.658)
L1.oilim	0.000	(0.001)
L2.oilim	-0.001	(0.001)
L3.oilim	0.000	(0.001)
L4.oilim	0.001*	(0.001)
L5.oilim	0.001	(0.001)
Intercept	-2.080*	(0.947)
N	68	
Log-likelihood	-54.370	

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_{\ t}$ due to shortage of space.

Table B.29: Test for Significance of Oil Price Increases and Decreases NOR2

Oil Price Increases		Oil Price Decreases	
L0.opincnor = 0		L0.opdecnor = 0	
L1.opincnor = 0		L1.opdecnor = 0	
L2.opincnor = 0		L2.opdecnor = 0	
L3.opincnor = 0		L3.opdecnor = 0	
L4.opincnor = 0		L4.opdecnor = 0	
L5.opincnor = 0		L5.opdecnor = 0	
χ^2 (5)	13.35	χ^2 (5)	18.24
$Prob > \chi^2$	0.0378*	$Prob > \chi^2$	0.0057**

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.30: Test for Symmetry of Oil Price Increases and Decreases NOR2

L0.opincnor = L0.opdecnor	
χ^2 (1)	6.32
$Prob > \chi^2$	0.0119*

L1.opincnor = L1.opdecnor	
χ^2 (1)	9.99
$Prob > \chi^2$	0.0016**

L2.opincnor = L2.opdecnor	
χ^2 (1)	0.14
$Prob > \chi^2$	0.7065

L3.opincnor = L3.opdecnor	
χ^2 (1)	0.01
$Prob > \chi^2$	0.9399

L4.opincnor = L4.opdecnor	
χ^2 (1)	0.01
$Prob > \chi^2$	0.9259

L5.opincnor = L5.opdecnor	
χ^2 (1)	0.26
$Prob > \chi^2$	0.6072

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

B.6 United Kingdom

Table B.31: Bivariate Correlation (1980 - 2015) United Kingdom

Variable	Coefficient	(Std. Err.)
L1.gdpg	0.358**	(0.087)
L2.gdpg	0.142	(0.093)
L3.gdpg	0.014	(0.094)
L4.gdpg	-0.057	(0.089)
L5.gdpg	0.033	(0.081)
L0.opincgbr	-0.011†	(0.007)
L1.opincgbr	-0.002	(0.007)
L2.opincgbr	-0.008	(0.007)
L3.opincgbr	-0.012†	(0.007)
L4.opincgbr	-0.006	(0.007)
L5.opincgbr	-0.002	(0.007)
L0.opdecgbr	0.009	(0.007)
L1.opdecgbr	0.010	(0.007)
L2.opdecgbr	0.001	(0.007)
L3.opdecgbr	-0.011	(0.007)
L4.opdecgbr	0.004	(0.007)
L5.opdecgbr	-0.005	(0.007)
Intercept	0.565**	(0.154)

N	136
Log-likelihood	-102.527

Significance levels : † : 10% * : 5% ** : 1%

Table B.32: Test for Significance of Oil Price Increases and Decreases GBR1

Oil Price Increases		**Oil Price Decreases**	
L0.opincgbr = 0		L0.opdecgbr = 0	
L1.opincgbr = 0		L1.opdecgbr = 0	
L2.opincgbr = 0		L2.opdecgbr = 0	
L3.opincgbr = 0		L3.opdecgbr = 0	
L4.opincgbr = 0		L4.opdecgbr = 0	
L5.opincgbr = 0		L5.opdecgbr = 0	
χ^2 (5)	10.52	χ^2 (5)	7.47
$Prob > \chi^2$	0.1044	$Prob > \chi^2$	0.2793

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.33: Test for Symmetry of Oil Price Increases and Decreases GBR1

L0.opincgbr = L0.opdecgbr	
χ^2 (1)	3.33
$Prob > \chi^2$	0.0682†

L1.opincgbr = L1.opdecgbr	
χ^2 (1)	1.13
$Prob > \chi^2$	0.2877

L2.opincgbr = L2.opdecgbr	
χ^2 (1)	0.72
$Prob > \chi^2$	0.3965

L3.opincgbr = L3.opdecgbr	
χ^2 (1)	0.00
$Prob > \chi^2$	0.9504

L4.opincgbr = L4.opdecgbr	
χ^2 (1)	0.75
$Prob > \chi^2$	0.3862

L5.opincgbr = L5.opdecgbr	
χ^2 (1)	0.10
$Prob > \chi^2$	0.7531

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.34: Multivariate Correlation (1997 - 2015) United Kingdom

Variable	Coefficient	(Std. Err.)
L0.opincgbr	0.014†	(0.008)
L1.opincgbr	0.019*	(0.008)
L2.opincgbr	-0.011	(0.007)
L3.opincgbr	-0.022**	(0.007)
L4.opincgbr	-0.026**	(0.008)
L5.opincgbr	-0.029**	(0.007)
L0.opdecgbr	-0.024**	(0.009)
L1.opdecgbr	0.015	(0.012)
L2.opdecgbr	-0.003	(0.011)
L3.opdecgbr	0.023*	(0.011)
L4.opdecgbr	0.024*	(0.009)
L5.opdecgbr	0.058**	(0.012)
L1.infl	-0.302*	(0.140)
L2.infl	-0.520**	(0.159)
L3.infl	-0.414**	(0.153)
L4.infl	-0.982**	(0.175)
L5.infl	-0.605**	(0.204)
L1.intr	0.100	(0.148)
L2.intr	-0.052	(0.250)
L3.intr	0.661*	(0.283)
L4.intr	-0.757*	(0.297)
L5.intr	-0.006	(0.196)
L1.indu	-0.142*	(0.063)
L2.indu	0.045	(0.059)
L3.indu	0.054	(0.059)
L4.indu	-0.015	(0.058)
L5.indu	-0.137*	(0.059)
L1.unemp	0.306	(0.323)
L2.unemp	1.124*	(0.462)
L3.unemp	-0.786†	(0.461)
L4.unemp	1.106*	(0.446)
L5.unemp	-1.421**	(0.276)
L1.oilim	0.000**	(0.000)
L2.oilim	0.000	(0.000)
L3.oilim	0.000	(0.000)
L4.oilim	0.000	(0.000)
L5.oilim	0.000	(0.000)
Intercept	2.832*	(1.276)

N	67
Log-likelihood	-2.353

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_{\ t}$ due to shortage of space.

Table B.35: Test for Significance of Oil Price Increases and Decreases GBR2

Oil Price Increases		**Oil Price Decreases**	
L0.opincgbr = 0		L0.opdecgbr = 0	
L1.opincgbr = 0		L1.opdecgbr = 0	
L2.opincgbr = 0		L2.opdecgbr = 0	
L3.opincgbr = 0		L3.opdecgbr = 0	
L4.opincgbr = 0		L4.opdecgbr = 0	
L5.opincgbr = 0		L5.opdecgbr = 0	
χ^2 (5)	54.82	χ^2 (5)	29.05
$Prob > \chi^2$	0.0000**	$Prob > \chi^2$	0.0001**

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.36: Test for Symmetry of Oil Price Increases and Decreases GBR2

L0.opincgbr = L0.opdecgbr	
χ^2 (1)	6.29
$Prob > \chi^2$	0.0121*

L1.opincgbr = L1.opdecgbr	
χ^2 (1)	0.06
$Prob > \chi^2$	0.8009

L2.opincgbr = L2.opdecgbr	
χ^2 (1)	0.31
$Prob > \chi^2$	0.5788

L3.opincgbr = L3.opdecgbr	
χ^2 (1)	8.06
$Prob > \chi^2$	0.0045**

L4.opincgbr = L4.opdecgbr	
χ^2 (1)	11.52
$Prob > \chi^2$	0.0007**

L5.opincgbr = L5.opdecgbr	
χ^2 (1)	25.96
$Prob > \chi^2$	0.0000**

Significance levels : † : 10% $*$: 5% $**$: 1%

B.7 United States

Table B.37: Bivariate Correlation (1980 - 2015) United States

Variable	Coefficient	(Std. Err.)
L1.gdpg	0.248**	(0.085)
L2.gdpg	0.209*	(0.086)
L3.gdpg	0.089	(0.087)
L4.gdpg	-0.001	(0.081)
L5.gdpg	-0.116	(0.077)
L0.opincusa	-0.006	(0.007)
L1.opincusa	-0.006	(0.007)
L2.opincusa	0.002	(0.007)
L3.opincusa	-0.005	(0.007)
L4.opincusa	-0.002	(0.007)
L5.opincusa	-0.005	(0.007)
L0.opdecusa	0.020**	(0.007)
L1.opdecusa	-0.003	(0.007)
L2.opdecusa	-0.003	(0.008)
L3.opdecusa	-0.005	(0.007)
L4.opdecusa	-0.002	(0.008)
L5.opdecusa	0.005	(0.008)
Intercept	0.545**	(0.163)

N	139
Log-likelihood	-121.44

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.38: Test for Significance of Oil Price Increases and Decreases USA1

Oil Price Increases		**Oil Price Decreases**	
L0.opincusa = 0		L0.opdecusa = 0	
L1.opincusa = 0		L1.opdecusa = 0	
L2.opincusa = 0		L2.opdecusa = 0	
L3.opincusa = 0		L3.opdecusa = 0	
L4.opincusa = 0		L4.opdecusa = 0	
L5.opincusa = 0		L5.opdecusa = 0	
χ^2 (5)	3.70	χ^2 (5)	10.30
$Prob > \chi^2$	0.7172	$Prob > \chi^2$	0.1127

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.39: Test for Symmetry of Oil Price Increases and Decreases USA1

L0.opincusa = L0.opdecusa	
χ^2 (1)	5.47
$Prob > \chi^2$	0.0194*

L1.opincusa = L1.opdecusa	
χ^2 (1)	0.08
$Prob > \chi^2$	0.7815

L2.opincusa = L2.opdecusa	
χ^2 (1)	0.14
$Prob > \chi^2$	0.7061

L3.opincusa = L3.opdecusa	
χ^2 (1)	0.00
$Prob > \chi^2$	0.9656

L4.opincusa = L4.opdecusa	
χ^2 (1)	0.00
$Prob > \chi^2$	0.9853

L5.opincusa = L5.opdecusa	
χ^2 (1)	0.74
$Prob > \chi^2$	0.3891

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.40: Multivariate Correlation (1997 - 2015) United States

Variable	Coefficient	(Std. Err.)
L0.opincusa	-0.013	(0.008)
L1.opincusa	0.020**	(0.008)
L2.opincusa	0.000	(0.008)
L3.opincusa	-0.009	(0.009)
L4.opincusa	0.008	(0.008)
L5.opincusa	-0.020*	(0.009)
L0.opdecusa	0.019*	(0.008)
L1.opdecusa	0.008	(0.011)
L2.opdecusa	-0.021†	(0.011)
L3.opdecusa	0.015	(0.011)
L4.opdecusa	0.015	(0.013)
L5.opdecusa	0.006	(0.015)
L1.infl	-0.399*	(0.180)
L2.infl	0.228	(0.189)
L3.infl	-0.249	(0.187)
L4.infl	0.044	(0.168)
L5.infl	-0.192	(0.156)
L1.intr	-0.159	(0.212)
L2.intr	0.477	(0.344)
L3.intr	-0.549	(0.363)
L4.intr	0.726*	(0.363)
L5.intr	-0.521*	(0.218)
L1.indu	0.541**	(0.112)
L2.indu	-0.100	(0.125)
L3.indu	-0.111	(0.120)
L4.indu	-0.057	(0.113)
L5.indu	0.063	(0.088)
L1.unemp	1.315**	(0.453)
L2.unemp	-1.615**	(0.559)
L3.unemp	0.268	(0.579)
L4.unemp	0.013	(0.619)
L5.unemp	0.001	(0.457)
L1.oilim	0.000**	(0.000)
L2.oilim	0.000*	(0.000)
L3.oilim	0.000	(0.000)
L4.oilim	0.000	(0.000)
L5.oilim	0.000**	(0.000)
Intercept	3.059**	(1.115)

N	71
Log-likelihood	-23.892

Significance levels : † : 10% $*$: 5% $**$: 1%

We have not listed the lags of $gdpg_{\ t}$ due to shortage of space.

Table B.41: Test for Significance of Oil Price Increases and Decreases USA2

Oil Price Increases		**Oil Price Decreases**	
L0.opincusa = 0		L0.opdecusa = 0	
L1.opincusa = 0		L1.opdecusa = 0	
L2.opincusa = 0		L2.opdecusa = 0	
L3.opincusa = 0		L3.opdecusa = 0	
L4.opincusa = 0		L4.opdecusa = 0	
L5.opincusa = 0		L5.opdecusa = 0	
χ^2 (5)	16.81	χ^2 (5)	15.19
$Prob > \chi^2$	0.0061**	$Prob > \chi^2$	0.0188*

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.42: Test for Symmetry of Oil Price Increases and Decreases USA2

L0.opincusa = L0.opdecusa	
χ^2 (1)	6.94
$Prob > \chi^2$	0.0084**

L1.opincusa = L1.opdecusa	
χ^2 (1)	0.73
$Prob > \chi^2$	0.3920

L2.opincusa = L2.opdecusa	
χ^2 (1)	2.12
$Prob > \chi^2$	0.1457

L3.opincusa = L3.opdecusa	
χ^2 (1)	2.73
$Prob > \chi^2$	0.0987†

L4.opincusa = L4.opdecusa	
χ^2 (1)	0.14
$Prob > \chi^2$	0.7064

L5.opincusa = L5.opdecusa	
χ^2 (1)	1.77
$Prob > \chi^2$	0.1836*

Significance levels : † : 10% $*$: 5% $**$: 1%

B.8 Fixed Effects

B.8.1 Lag Structure for All Variables FE1

Table B.43: FE1

Variable	Coefficient	(Std. Err.)
L2.gdpg	-0.151**	(0.049)
L3.gdpg	-0.114*	(0.049)
L4.gdpg	-0.047	(0.049)
L0.opinc	-0.001	(0.004)
L1.opinc	0.002	(0.004)
L2.opinc	0.000	(0.004)
L3.opinc	0.001	(0.003)
L4.opinc	-0.005	(0.003)
L0.opdec	0.007*	(0.003)
L1.opdec	0.000	(0.004)
L2.opdec	-0.002	(0.005)
L3.opdec	0.004	(0.005)
L4.opdec	0.011*	(0.005)
L1.infl	-0.059	(0.057)
L2.infl	-0.147*	(0.059)
L3.infl	-0.183**	(0.058)
L4.infl	-0.138*	(0.058)
L1.unemp	-0.231†	(0.139)
L2.unemp	-0.115	(0.224)
L3.unemp	0.098	(0.224)
L4.unemp	0.253†	(0.139)
L1.intr	0.015	(0.084)
L2.intr	0.188	(0.146)
L3.intr	-0.415**	(0.145)
L4.intr	0.253**	(0.082)
L1.indu	0.261**	(0.014)
L2.indu	0.045*	(0.019)
L3.indu	0.032†	(0.019)
L4.indu	0.007	(0.019)
L1.oilim	0.000†	(0.000)
L2.oilim	0.000	(0.000)
L3.oilim	0.000	(0.000)
L4.oilim	0.000	(0.000)
Intercept	0.448†	(0.235)

N	468
R^2	0.645
$F_{(39,428)}$	23.555

Significance levels : † : 10% * : 5% ** : 1%

Table B.44: Levin-Lin-Chu Unit-Root Test FE1

H0: Panels contain unit roots
H1: Panels are stationary

	Statistic	**p-value**
Unadjusted t	-8.5590	
Adjusted t*	-2.3133	0.0104*

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.45: Test for Symmetry of Oil Price Increases and Decreases FE1

L0.opinc = L0.opdec	
$F_(1, 428)$	2.25
$Prob > F$	0.1348

L1.opinc = L1.opdec	
$F_(1, 428)$	0.13
$Prob > F$	0.7178

L2.opinc = L2.opdec	
$F_(1, 428)$	0.10
$Prob > F$	0.7539

L3.opinc = L3.opdec	
$F_(1, 428)$	0.25
$Prob > F$	0.6162

L4.opinc = L4.opdec	
$F_(1, 428)$	5.91
$Prob > F$	0.0154*

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.46: Test for Significance of Oil Price Increases and Decreases FE1

Oil Price Increases		**Oil Price Decreases**	
L0.opdec = 0		L0.opdec = 0	
L1.opinc = 0		L1.opdec = 0	
L2.opinc = 0		L2.opdec = 0	
L3.opinc = 0		L3.opdec = 0	
L4.opinc = 0		L4.opdec = 0	
$F_(5, 428)$	0.61	$F_(5, 428)$	2.01
$Prob > F$	0.6918	$Prob > F$	0.0759†

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

B.8.2 Lag Structure for gdpg, opinc and opdec FE2

Table B.47: FE2

Variable	**Coefficient**	**(Std. Err.)**
L2.gdpg	0.100*	(0.048)
L3.gdpg	0.002	(0.048)
L4.gdpg	0.073	(0.048)
L0.opinc	-0.004	(0.005)
L1.opinc	-0.003	(0.005)
L2.opinc	-0.003	(0.005)
L3.opinc	0.006	(0.005)
L4.opinc	-0.008†	(0.005)
L0.opdec	0.012*	(0.005)
L1.opdec	0.016**	(0.005)
L2.opdec	0.027**	(0.006)
L3.opdec	-0.009†	(0.006)
L4.opdec	0.003	(0.006)
infl	0.061	(0.075)
unemp	0.000	(0.026)
intr	0.042†	(0.023)
indu	0.077**	(0.018)
oilim	0.000	(0.000)
Intercept	0.673*	(0.299)
N	472	
R^2	0.27	
$F_{(24,447)}$	9.208	

Significance levels : $\dagger$: 10% $*$: 5% $**$: 1%

Table B.48: Levin-Lin-Chu Unit-Root Test FE2

H0: Panels contain unit roots
H1: Panels are stationary

	Statistic	**p-value**
Unadjusted t	-8.5590	
Adjusted t*	-2.3133	0.0104*

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.49: Test for Symmetry of Oil Price Increases and Decreases FE2

	L0.opinc = L0.opdec
$F_{(1,447)}$	4.28
$Prob > F$	0.0392*

	L1.opinc = L1.opdec
$F_{(1,447)}$	5.41
$Prob > F$	0.0205*

	L2.opinc = L2.opdec
$F_{(1,447)}$	11.98
$Prob > F$	0.0006**

	L3.opinc = L3.opdec
$F_{(1,447)}$	3.08
$Prob > F$	0.0801†

	L4.opinc = L4.opdec
$F_{(1,447)}$	1.82
$Prob > F$	0.1779

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.50: Test for Significance of Oil Price Increases and Decreases FE2

Oil Price Increases		**Oil Price Decreases**	
L0.opdec = 0		L0.opdec = 0	
L1.opinc = 0		L1.opdec = 0	
L2.opinc = 0		L2.opdec = 0	
L3.opinc = 0		L3.opdec = 0	
L4.opinc = 0		L4.opdec = 0	
$F_(5,447)$	1.34	$F_(5,447)$	9.01
$Prob > F$	0.2451	$Prob > F$	0.0000**

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

B.8.3 Lag Structure for gdpg, opinc and opdec (Norway Excluded) FE3

Table B.51: FE3

Variable	**Coefficient**	**(Std. Err.)**
L2.gdpg	0.217**	(0.049)
L3.gdpg	0.056	(0.050)
L4.gdpg	0.013	(0.049)
L0.opinc	-0.004	(0.004)
L1.opinc	-0.006	(0.004)
L2.opinc	0.003	(0.004)
L3.opinc	0.007	(0.004)
L4.opinc	-0.011**	(0.004)
L0.opdec	0.006	(0.005)
L1.opdec	0.013**	(0.005)
L2.opdec	0.020**	(0.005)
L3.opdec	-0.014**	(0.005)
L4.opdec	0.010†	(0.005)
infl	0.040	(0.073)
unemp	-0.002	(0.021)
intr	0.051*	(0.022)
indu	0.136**	(0.018)
oilim	0.000	(0.000)
Intercept	0.546*	(0.276)
N	403	
R^2	0.458	
$F_{(23,379)}$	17.817	

Significance levels : † : 10% ∗ : 5% ∗∗ : 1%

Table B.52: Levin-Lin-Chu Unit-Root Test FE3

H0: Panels contain unit roots
H1: Panels are stationary

	Statistic	**p-value**
Unadjusted t	-8.0399	
Adjusted t*	-2.7760	0.0028**

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.53: Test for Symmetry of Oil Price Increases and Decreases FE3

L0.opinc = L0.opdec	
$F_{(1,379)}$	1.89
$Prob > F$	0.1695

L1.opinc = L1.opdec	
$F_{(1,379)}$	7.34
$Prob > F$	0.0071**

L2.opinc = L2.opdec	
$F_{(1,379)}$	4.88
$Prob > F$	0.0278*

L3.opinc = L3.opdec	
$F_{(1,379)}$	7.76
$Prob > F$	0.0056**

L4.opinc = L4.opdec	
$F_{(1,379)}$	8.11
$Prob > F$	0.0046**

Significance levels : † : 10% $*$: 5% $**$: 1%

Table B.54: Test for Significance of Oil Price Increases and Decreases FE3

Oil Price Increases		**Oil Price Decreases**	
L0.opdec = 0		L0.opdec = 0	
L1.opinc = 0		L1.opdec = 0	
L2.opinc = 0		L2.opdec = 0	
L3.opinc = 0		L3.opdec = 0	
L4.opinc = 0		L4.opdec = 0	
$F_(5,379)$	2.69	$F_(5,379)$	7.99
$Prob > F$	0.0210*	$Prob > F$	0.0000**

Significance levels : † : 10% $*$: 5% $**$: 1%

C Appendix: Glossary

C.1 General Abbreviations

API	American Petroleum Institute
Bbl	Barrel, equals around 160 liters
Bpd	Barrels per day
ECB	European Central Bank
EIA	US Energy Information Administration
EIU	The Economist Intelligence Unit
EMU	Economic and Monetary Union of the European Union
FED	Federal Reserve System, Central Bank of the US
FRE	Federal Reserve Economic Data, the database of the FED
GDP	Gross domestic product
HKex	Hong Kong Stock Exchange
ICE	Intercontinental Exchange, Inc.
IEA	International Energy Agency
ISIL	Islamic State of Iraq and the Levant, jihadist terror organization
JCPOA	Joint Comprehensive Plan of Action, agreement on the nuclear program of Iran
Koe	Kilogram of Oil Equivalent
Mbbl	Thousand Barrels
MMbbl	Million Barrels
MMMbbl	Billion Barrels

MEI	Main Economic Indicators of the OECD
Mtoe	Million Tonnes of Oil Equivalent
NYMEX	New York Mercantile Exchange
OECD	Organization for Economic Co-operation and Development
OAPEC	Organization of Arab Petroleum Exporting Countries
OPEC	Organization of Petroleum Exporting Countries
SICOM	Singapore Commodity Exchange
SPR	Strategic Petroleum Reserve of the United States of America
TOCOM	Tokyo Commodity Exchange
WTI	West Texas Intermediate

C.2 ISO 3166-1 Alpha-3 Country Codes Used in the Thesis

ARE	United Arab Emirates
AUT	Republic of Austria
AZE	Republic of Azerbaijan
BHR	Kingdom of Bahrain
BOL	Plurinational State of Bolivia
CAN	Canada
CHE	Swiss confederation
CHN	People's Republic of China
DEU	Federal Republic of Germany
DZA	People's Democratic Republic of Algeria
ECU	Republic of Ecuador
EGY	Arab Republic of Egypt
FRA	French Republic

GBR United Kingdom of Great Britain and Northern Ireland

IRN Islamic Republic of Iran

IRQ Republic of Iraq

ISR State of Israel

ITA Italian Republic

JPN Japan

KWT State of Kuwait

LBY Libya

MEX United Mexican States

NLD Kingdom of the Netherlands

NOR Kingdom of Norway

OMN Sultanate of Oman

QAT State of Qatar

RUS Russian Federation

SAU Kingdom of Saudi Arabia

SYR Syrian Arab Republic

TKM Turkmenistan

TUR Republic of Turkey

USA United States of America

UZB Republic of Uzbekistan

VEN Bolivarian Republic of Venezuela

YEM Republic of Yemen

C.3 ISO 4217 Currency Names Used in the Thesis

AUD Australian dollar, currency of the Commonwealth of Australia

CAD Canadian dollar, currency of Canada

CHF Swiss franc, currency of the Swiss Confederation

DZD Algerian dinar, currency of the People's Dem. Rep. of Algeria

EUR Euro, currency of the Eurozone

GBP Pound sterling, currency of the United Kingdom

JPY Japanese yen, currency of Japan

NOK Norwegian krone, currency of Kingdom of Norway

RUB Russian ruble, currency of the Russian Federation

SEK Swedish krona, currency of the Kingdom of Sweden

USD United States Dollar, currency of the United States of America

D Appendix: Stata Code

Code Example D.1: Germany

```
*Germany
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\DEU1.dta", clear
sum

*Bivariate correlation (1980 - 2015) DEU
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincdeu L(0/5).opdecdeu)

*Test for significance DEU
test L0.opincdeu L1.opincdeu L2.opincdeu L3.opincdeu L4.opincdeu L5.opincdeu
test L0.opdecdeu L1.opdecdeu L2.opdecdeu L3.opdecdeu L4.opdecdeu L5.opdecdeu

*Test for symmetry DEU
test L0.opincdeu = L0.opdecdeu
test L1.opincdeu = L1.opdecdeu
test L2.opincdeu = L2.opdecdeu
test L3.opincdeu = L3.opdecdeu
test L4.opincdeu = L4.opdecdeu
test L5.opincdeu = L5.opdecdeu

*Multivariate correlation (1997 - 2015) DEU
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincdeu L(0/5).opdecdeu L(1/5).infl L(1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)

*Test for significance DEU
test L0.opincdeu L1.opincdeu L2.opincdeu L3.opincdeu L4.opincdeu L5.opincdeu
```

```
test L0.opdecdeu L1.opdecdeu L2.opdecdeu L3.opdecdeu L4.opdecdeu L5.
    opdecdeu

*Test for symmetry DEU
test L0.opincdeu = L0.opdecdeu
test L1.opincdeu = L1.opdecdeu
test L2.opincdeu = L2.opdecdeu
test L3.opincdeu = L3.opdecdeu
test L4.opincdeu = L4.opdecdeu
test L5.opincdeu = L5.opdecdeu
```

Code Example D.2: France

```
*France
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\FRA1.dta", clear
sum

*Bivariate correlation (1980 - 2015) FRA
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincfra L(0/5).opdecfra)

*Test for significance FRA
test L0.opincfra L1.opincfra L2.opincfra L3.opincfra L4.opincfra L5.
    opincfra
test L0.opdecfra L1.opdecfra L2.opdecfra L3.opdecfra L4.opdecfra L5.
    opdecfra

*Test for symmetry FRA
test L0.opincfra = L0.opdecfra
test L1.opincfra = L1.opdecfra
test L2.opincfra = L2.opdecfra
test L3.opincfra = L3.opdecfra
test L4.opincfra = L4.opdecfra
test L5.opincfra = L5.opdecfra

*Multivariate correlation (1997 - 2015) FRA
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincfra L(0/5).opdecfra L(1/5).infl L
    (1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)

*Test for significance FRA
```

```
test L0.opincfra L1.opincfra L2.opincfra L3.opincfra L4.opincfra L5.
    opincfra
test L0.opdecfra L1.opdecfra L2.opdecfra L3.opdecfra L4.opdecfra L5.
    opdecfra

*Test for symmetry FRA
test L0.opincfra = L0.opdecfra
test L1.opincfra = L1.opdecfra
test L2.opincfra = L2.opdecfra
test L3.opincfra = L3.opdecfra
test L4.opincfra = L4.opdecfra
test L5.opincfra = L5.opdecfra
```

Code Example D.3: Italy

```
*Italy
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\ITA1.dta", clear
sum

*Bivariate correlation (1980 - 2015) ITA
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincita L(0/5).opdecita)

*Test for significance ITA
test L0.opincita L1.opincita L2.opincita L3.opincita L4.opincita L5.
    opincita
test L0.opdecita L1.opdecita L2.opdecita L3.opdecita L4.opdecita L5.
    opdecita

*Test for symmetry ITA
test L0.opincita = L0.opdecita
test L1.opincita = L1.opdecita
test L2.opincita = L2.opdecita
test L3.opincita = L3.opdecita
test L4.opincita = L4.opdecita
test L5.opincita = L5.opdecita

*Multivariate correlation (1997 - 2015) ITA
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincita L(0/5).opdecita L(1/5).infl L
    (1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)
```

```
*Test for significance ITA
test L0.opincita L1.opincita L2.opincita L3.opincita L4.opincita L5.
    opincita
test L0.opdecita L1.opdecita L2.opdecita L3.opdecita L4.opdecita L5.
    opdecita

*Test for symmetry ITA
test L0.opincita = L0.opdecita
test L1.opincita = L1.opdecita
test L2.opincita = L2.opdecita
test L3.opincita = L3.opdecita
test L4.opincita = L4.opdecita
test L5.opincita = L5.opdecita
```

Code Example D.4: Japan

```
*Japan
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\JPN1.dta", clear
sum

*Bivariate correlation (1980 - 2015) JPN
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincjpn L(0/5).opdecjpn)

*Test for significance JPN
test L0.opincjpn L1.opincjpn L2.opincjpn L3.opincjpn L4.opincjpn L5.
    opincjpn
test L0.opdecjpn L1.opdecjpn L2.opdecjpn L3.opdecjpn L4.opdecjpn L5.
    opdecjpn

*Test for symmetry JPN
test L0.opincjpn = L0.opdecjpn
test L1.opincjpn = L1.opdecjpn
test L2.opincjpn = L2.opdecjpn
test L3.opincjpn = L3.opdecjpn
test L4.opincjpn = L4.opdecjpn
test L5.opincjpn = L5.opdecjpn

*Multivariate correlation (1997 - 2015) JPN
tsset time, quarterly
```

```
var gdpg, lags(1/5) exog(L(0/5).opincjpn L(0/5).opdecjpn L(1/5).infl L(1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)

*Test for significance JPN
test L0.opincjpn L1.opincjpn L2.opincjpn L3.opincjpn L4.opincjpn L5.opincjpn
test L0.opdecjpn L1.opdecjpn L2.opdecjpn L3.opdecjpn L4.opdecjpn L5.opdecjpn

*Test for symmetry JPN
test L0.opincjpn = L0.opdecjpn
test L1.opincjpn = L1.opdecjpn
test L2.opincjpn = L2.opdecjpn
test L3.opincjpn = L3.opdecjpn
test L4.opincjpn = L4.opdecjpn
test L5.opincjpn = L5.opdecjpn
```

Code Example D.5: Norway

```
*Norway
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\NOR1.dta", clear
sum

*Bivariate correlation (1980 - 2015) NOR
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincnor L(0/5).opdecnor)

*Test for significance NOR
test L0.opincnor L1.opincnor L2.opincnor L3.opincnor L4.opincnor L5.opincnor
test L0.opdecnor L1.opdecnor L2.opdecnor L3.opdecnor L4.opdecnor L5.opdecnor

*Test for symmetry NOR
test L0.opincnor = L0.opdecnor
test L1.opincnor = L1.opdecnor
test L2.opincnor = L2.opdecnor
test L3.opincnor = L3.opdecnor
test L4.opincnor = L4.opdecnor
test L5.opincnor = L5.opdecnor

```

```
*Multivariate correlation (1997 - 2015) NOR
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincnor L(0/5).opdecnor L(1/5).infl L
    (1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)

*Test for significance NOR
test L0.opincnor L1.opincnor L2.opincnor L3.opincnor L4.opincnor L5.
    opincnor
test L0.opdecnor L1.opdecnor L2.opdecnor L3.opdecnor L4.opdecnor L5.
    opdecnor

*Test for symmetry NOR
test L0.opincnor = L0.opdecnor
test L1.opincnor = L1.opdecnor
test L2.opincnor = L2.opdecnor
test L3.opincnor = L3.opdecnor
test L4.opincnor = L4.opdecnor
test L5.opincnor = L5.opdecnor
```

Code Example D.6: United Kingdom

```
*United Kingdom
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\GBR1.dta", clear
sum

*Bivariate correlation (1980 - 2015) GBR
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincgbr L(0/5).opdecgbr)

*Test for significance GBR
test L0.opincgbr L1.opincgbr L2.opincgbr L3.opincgbr L4.opincgbr L5.
    opincgbr
test L0.opdecgbr L1.opdecgbr L2.opdecgbr L3.opdecgbr L4.opdecgbr L5.
    opdecgbr

*Test for symmetry GBR
test L0.opincgbr = L0.opdecgbr
test L1.opincgbr = L1.opdecgbr
test L2.opincgbr = L2.opdecgbr
test L3.opincgbr = L3.opdecgbr
test L4.opincgbr = L4.opdecgbr
```

```
test L5.opincgbr = L5.opdecgbr

*Multivariate correlation (1997 - 2015) GBR
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincgbr L(0/5).opdecgbr L(1/5).infl L(1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)

*Test for significance GBR
test L0.opincgbr L1.opincgbr L2.opincgbr L3.opincgbr L4.opincgbr L5.opincgbr
test L0.opdecgbr L1.opdecgbr L2.opdecgbr L3.opdecgbr L4.opdecgbr L5.opdecgbr

*Test for symmetry GBR
test L0.opincgbr = L0.opdecgbr
test L1.opincgbr = L1.opdecgbr
test L2.opincgbr = L2.opdecgbr
test L3.opincgbr = L3.opdecgbr
test L4.opincgbr = L4.opdecgbr
test L5.opincgbr = L5.opdecgbr
```

Code Example D.7: United States

```
*United States
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\USA1.dta", clear
sum

*Bivariate correlation (1980 - 2015) USA
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincusa L(0/5).opdecusa)

*Test for significance USA
test L0.opincusa L1.opincusa L2.opincusa L3.opincusa L4.opincusa L5.opincusa
test L0.opdecusa L1.opdecusa L2.opdecusa L3.opdecusa L4.opdecusa L5.opdecusa

*Test for symmetry USA
test L0.opincusa = L0.opdecusa
test L1.opincusa = L1.opdecusa
test L2.opincusa = L2.opdecusa
```

```
test L3.opincusa = L3.opdecusa
test L4.opincusa = L4.opdecusa
test L5.opincusa = L5.opdecusa

*Multivariate correlation (1997 - 2015) USA
tsset time, quarterly
var gdpg, lags(1/5) exog(L(0/5).opincusa L(0/5).opdecusa L(1/5).infl L(1/5).intr L(1/5).indu L(1/5).unemp L(1/5).oilim)

*Test for significance USA
test L0.opincusa L1.opincusa L2.opincusa L3.opincusa L4.opincusa L5.opincusa
test L0.opdecusa L1.opdecusa L2.opdecusa L3.opdecusa L4.opdecusa L5.opdecusa

*Test for symmetry USA
test L0.opincusa = L0.opdecusa
test L1.opincusa = L1.opdecusa
test L2.opincusa = L2.opdecusa
test L3.opincusa = L3.opdecusa
test L4.opincusa = L4.opdecusa
test L5.opincusa = L5.opdecusa
```

Code Example D.8: Fixed Effects

```
*FIXED EFFECTS REGRESSION
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\DATA2.dta", clear

*Lag structure for all variables
xtset state time, quarterly
xtreg L(1/4).gdpg L(0/4).opinc L(0/4).opdec L(1/4).infl L(1/4).unemp L(1/4).intr L(1/4).indu L(1/4).oilim, fe

*Unit Root Test FE
xtunitroot llc gdpg, lags(4)

*Test for significance FE
test L0.opinc L1.opinc L2.opinc L3.opinc L4.opinc
test L0.opdec L1.opdec L2.opdec L3.opdec L4.opdec

*Test for symmetry FE
```

```
test L0.opinc = L0.opdec
test L1.opinc = L1.opdec
test L2.opinc = L2.opdec
test L3.opinc = L3.opdec
test L4.opinc = L4.opdec

*Lag structure just for gdpg and oilprice changes
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\DATA2.dta", clear
xtset state time, quarterly
xtreg L(1/4).gdpg L(0/4).opinc L(0/4).opdec infl unemp intr indu oilim, fe

*Unit Root Test FE2
xtunitroot llc gdpg, lags(4)

*Test for significance FE2
test L0.opinc L1.opinc L2.opinc L3.opinc L4.opinc
test L0.opdec L1.opdec L2.opdec L3.opdec L4.opdec

*Test for symmetry FE2
test L0.opinc = L0.opdec
test L1.opinc = L1.opdec
test L2.opinc = L2.opdec
test L3.opinc = L3.opdec
test L4.opinc = L4.opdec

*Lag structure just for gdpg and oilprice changes (excluding Norway)
use "C:\Users\Raphael\OneDrive\Thesis\Data\STATA\DATA3.dta", clear
xtset state time, quarterly
xtreg L(1/4).gdpg L(0/4).opinc L(0/4).opdec infl unemp intr indu oilim, fe

*Unit Root Test FE3
xtunitroot llc gdpg, lags(4)

*Test for significance FE3
test L0.opinc L1.opinc L2.opinc L3.opinc L4.opinc
test L0.opdec L1.opdec L2.opdec L3.opdec L4.opdec

*Test for symmetry FE3
```

```
test L0.opinc = L0.opdec
test L1.opinc = L1.opdec
test L2.opinc = L2.opdec
test L3.opinc = L3.opdec
test L4.opinc = L4.opdec
```

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