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"Oil prices and Economic Growth"

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Abstract

In the wake of Arab world crisis that already causes oil supply disruptions and oil price increases, the present dissertation records and sheds light to the main historical oil prices shocks from the 1970s till nowadays and the main determinants of oil prices and economic growth. With the ultimate purpose being the examination of the much debated effect of oil price on the economic growth, we test and analyze the existence and the type -bidirectional or unidirectional, short-term or long-term- of this relation and the degree of influence for the main industrialized G7 countries (the USA, the UK, Italy, France, Germany, Japan and Canada) during the 1990-2007 period (quarterly basis data). The Augmented Dickey Fuller Unit Root Test is used in order to prove if the time series variables (GDP and oil prices) are stationary or non-stationary, the Johansen approach is used for tracing or not cointergration, the Error Correction Model (VEC) in case of cointegration existence while on the occasion that no cointergration is proved, we use Granger Causality test. The empirical results mainly suggest the existence of a relation- albeit different but with some common characteristics across the G7 countries. In all countries except for Canada, there is cointegration between oil prices and GDP in the long-term. In all countries except for Canada there is bidirectional relation in the long-term. In Germany, France, Italy and Japan the relation between oil prices and GDP is negative. In Germany the relation is unidirectional in the short-term where the oil prices affect the GDP. In the UK and in Japan there is unidirectional relation in the short-term where the GDP affects oil prices. In Canada, the UK and in the USA the relation is shown positive. In the case of Canada there is unidirectional relation where the GDP influences oil prices.

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CHAPTER 1

INTRODUCTION

Summary

The uncontested hegemony of oil in spurring and work horsing a whopping part of economic and human activity has started being shaken during the 1970s as a consequence of the rippling effects of the rocket high prices the crude oil reached making evident that is possible countries cannot afford to thoughtlessly consume oil. The effects of oil shocks starting from that period have been vibrating till today as they were of multiple dimensions and have shed light not only to the devastating effects of a possible depletion of oil stocks, the dependency of the industrialized and developing countries on oil and the need for switch to new, alternative and efficient sources of energy enriching the energy mixture, but also to the possible far reaching effects of oil shocks to economic growth, monetary policies and the economy as a whole.

The reciprocal relation between oil prices and economic growth is nowadays widely accepted and cannot be rejected. Nevertheless, one cannot easily gauge the degree of if and how inextricably linked are the two variables, the amount of effect of one variable to the other, and the short and long term influence of oil prices to economic growth and vice versa and if the oil prices can cause recession or development for oil importing and oil exporting countries respectively, due to the fact that other variables such as the monetary policies, the flexibility of economy including the labor and financial markets, the pre-existing inflation and the degree of energy autonomy and energy mix of each examined country determine the result etc.

In this dissertation, we examine the effect of oil price on the economic growth and vice versa of each of the main industrialized countries of G7 in the 1990-2007 period (quarterly basis). In doing so, the author seeks to: (a) highlight the need to study the bidirectional relation between oil price and economic growth and, (b) use a method for analyzing the aforementioned issue, (c) collect data based on the method used, (d) test the collected data and (e) draw conclusions. The proposed approach is significant as it: (a) adds a new dimension to existing poor literature on oil price effect on economic growth (b) facilitates the decision making process of industrialized countries (G7) for energy supplies.

1.2 Research Aim and Objectives

1.2.1 Research Aim

Hence, the aim of this dissertation is to:

Examine and test the effect of oil price on the economic growth and the existence of a bidirectional relation for the main industrialized countries of G7 in the 1990-2007 period (quarterly basis) that will support G7 countries on oil energy supplies decision making process.

1.2.2 Research Objectives

To reflect upon this aim of this project, a number of specific objectives, which will be analyzed hereunder, should be achieved:

Objective 1: To provide a spherical and comprehensive view of the oil shocks from the 1970s till nowadays as well as the major factors determining the oil prices and the economic growth in order to better understand the relation between oil prices and economic activity and grasp the whole image of the influential environment and underlying factors in this relation.

Objective 2: To examine the interactive relation between the two variables, oil prices and economic growth, since in the literature this bidirectional relation has not adequately analyzed

Objective 3: To draw conclusions that will lead to the justification or to the rejection of previous analyses

Objective 4: To enrich the insufficient literature in the specific subject for the specific period and the specific countries

1.3 Dissertation Outline

In the following paragraphs, the structure of the dissertation is displayed (Figure 2) and the content of each chapter is summarized.

Chapter 1: Introduction

Chapter 1 introduces the research presented in this dissertation and explains the research problem. As a result, the need for examining the oil price effect on economic growth and vice versa is justified. Moreover, the research aims and objectives are presented in Section 1.2 and the dissertation's outline is explained in section 1.3.

Chapter 2: Literature Review

In the second chapter, a review of the normative literature is provided. More specifically, the history of oil shocks during the period from 1970 till nowadays is presented and the determinants of economic growth and oil prices are analyzed.

Chapter 3: Econometric Methodology

Based on the aim of this research, Chapter 3 develops an argument for the selection of a suitable research methodology . The reasons for the selection of these methods, their limitations and the way these limitations are overcome, are explained. The methodology followed is based on the Augmented Dickey Fuller Unit Root Test in order to examine if the time series variables (GDP and oil prices) are stationary or non-stationary. Next, we test for cointergration using the Johansen approach and if the result shows cointergration, we use the Error Correction Model (VEC) while on the occasion that no cointergration is proved, we use Granger Causality test.

Chapter 4: Data Analysis

In Chapter 4, the author provides a detailed description of the data that are going to be used. In detail, in this dissertation data on quarterly basis for the crude oil prices and the real GDP from the G7 countries are used for the period from the first quarter of 1990 to the fourth quarter of 2007.

Chapter 5: Empirical results

In Chapter 5 the research findings are presented and further analyzed. The empirical results for the existence of interaction between oil prices and economic growth are presented for each country of the G7 separately.

Chapter 6: Conclusions

In the last Chapter, the ultimate results derived from the empirical results are presented and analyzed. Moreover, the findings are compared with those of the international literature and further conclusions are drawn and the novel contribution of this dissertation is presented. Furthermore, the chapter highlights possible limitations of this work, describes potential areas of further research, and makes some recommendations for further investigation.

CHAPTER 2

LITERATURE REVIEW

2.1 Historical review of the oil prices shocks

Before the first oil crisis, the period after the Second World War, oil exporting countries experienced increasing demand for their crude oil but 40% decline in the purchasing power of a barrel of oil. Moreover, from 1971 and on, the USA was not anymore able to put an upper limit on prices and the power to control crude oil prices shifted from the United States to OPEC.

With the first oil crisis which started in October 1973 in the aftermath of the Arab-Israeli war, OPEC acquired more power although in the end it became obvious how hypersensitive are prices to supply shortages and OPEC became almost unable to control prices. The crisis was the result of the proclamation of an oil embargo enduring till the 1974 by the OAPEC countries -the OPEC Arab countries plus Syria, Egypt and Tunisia- in retaliation to the U.S. and other Western countries decision to support Israel during the Yom Kippur war. The oil boycott meant curbs on their oil exports - a cut in production by five percent from September's output and extending cut production over time in five percent increments until their economic and political objectives were fulfilled- to various consumer countries and a total embargo on oil shipments to the United States renouncing it as a “principal hostile country”. Generally, the production of oil curtailed by 5 million barrels a day and the net loss of 4 million barrels per day extended till March 1974. The embargo was later expanded to the Netherlands and reached out variously to Western Europe and Japan.

The embargo led to an unprecedented increase of oil price with OPEC announced a decision to raise the posted price of oil by 70%, to $5.11 a barrel. On the whole, prices increased 400% in six months. The ripple effects of the OPEC forcing the oil companies to increase payments abruptly and drastically were immediate. Given the fact that the oil demand has been nearly inelastic to price increases, the prices had to be risen dramatically to reduce demand to the new lower level of supply. In anticipation of this, the market price for oil immediately peaked substantially, from 3 US dollars a barrel to 12 US dollars, in other words quadrupling by 1974. Furthermore, the total consumption of oil in the US dropped 20% in a people's effort to limit the expenditure and money.

The staggering increase of oil price had a neck breaking effect on industrialized economies since for the most part relied on crude oil and OPEC was their main supplier. The 1973 oil price shock along with the 1973-1974 stock market crash have been considered by many as the first event since the Great Depression in 1929 to have a persistent economic effect. The world financial system, which was already derailed from the breakdown of the Bretton Woods Agreement, was following a path of recessions and high inflation that persisted until the early 1980s, with oil prices continuing to rise until 1986. "*Bankers had no good options. The shock shifts the aggregate supply curve up and to the left. In response, central bankers can (a) expand demand to keep the shock from causing a recession, keeping production at potential output at the price of accelerating inflation; or (b) contract demand to keep the shock from adding to inflation, thus causing a deep recession. In practice, central banks usually split the difference. This combination is called "stagflation."(Berkeley).* A multiplier of the negative effects of the oil shock was that the Western nations' central banks decided to sharply cut interest rates in order to encourage growth *hierarching* inflation as a secondary concern. "*Somewhat paradoxically, the rational-expectations school of economics that would have given advance warning of the breakdown of the Phillips Curve, and had as a result become dominant, believed that the tripling of world oil prices was macroeconomically irrelevant: the oil price would rise, other prices would fall, and the overall price level would be unaffected because the general price level was determined by the money supply and not by decisions of producers of individual commodities to raise prices"* (DeLong, 1997). Moreover, a further accelerator of stagflation in US was the increased government spending which came with the Vietnam War. Although this was the orthodox macroeconomic response at the time, the ensuing *stagflation* flabbergasted economists and central bankers justifying current analyses which support that the followed policy have deepened and lengthened the adverse effects of the embargo. This can be partly explained by "*the oil price increase entailed large increases in the prices of goods in a few concentrated sectors. They reduce nominal demand for products in each unaffected sector by a little bit. Small administrative or information processing costs might plausibly prevent full adjustment in many of the unaffected sectors, leaving an upward bias in the overall price level"* (Delong, 1997). Furthermore, due to this persistent stagflation during this period, a popular economic theory thrived that these price increases are causing suppression of economic activity. However, the causality stated by this theory is often questioned.

All in all, over the long term, the embargo brought recession throughout the world, deteriorated unemployment and in the end altered the nature of policy in the West towards increased exploration, energy conservation, and more restrictive monetary policy to better fight inflation as the affected countries responded with a wide variety of innovative and mostly permanent initiatives to contain their further dependency.

Moreover, the oil increase shock had also an unfamiliar effect on oil exporting nations, the countries of the Middle East who had long been controlled by the industrial powers were seen to have grapple control of a vital commodity. The traditional flow of capital reversed as the oil exporting nations accumulated vast wealth. Some of the income was dispensed in the form of aid to other underdeveloped nations whose economies had been caught between higher prices of oil and lower prices for their own export commodities and raw materials amid shrinking Western demand for their goods. Nevertheless, much was absorbed in massive arms purchases that exacerbated political tensions, particularly in the Middle East. The exchange for Western moderation in Arab-Israeli affairs ultimately reshaped of the Middle-Eastern geo-political landscape that was significantly less advantageous than prior to 1973. Moreover, the end of the crisis and the decline of the oil prices at the end of the decade did not bring consumption of oil to the pre-crisis levels mainly because people and countries have adapted themselves to less energy consuming ways of life and the advances in more energy efficient commodities was irreversible.

As far as Japan is concerned, the 1973 oil crisis was a major incentive in Japan's economy departing from oil-intensive industries and heading into huge investments in industries such as electronics and car industries which, taking advantage of this embargo, innovated in energy efficient models. Lessons learned from rising fuel costs in the United States, they started producing small, more fuel efficient models, which began promoted as an alternative to gas-guzzling American vehicles of the time causing a steep decline in American auto sales that lasted into the 1980s. The American auto industry was forced to meet the new standards and re-orientate its industry to less energy consuming vehicles.

The second oil crisis spawn out of Iranian revolution in 1979 during which massive demonstrations led to the ousting of the Shah of Iran and the establishment of the religious leader Ayatollah Khomeini. Due to the political instability, Iranian oil production disrupted and exports suspended. The oil exports under the new regime were limited and thus the prices were pushed up. As a response Saudi Arabia and other OPEC nations increased production to rebalance the decline while the overall loss in production was about 4 percent. No matter the deterrence strategy and generous efforts, widespread panic prevailed in the countries and markets leading to disastrous decisions on the part of USA with striking example that of the US President Jimmy Carter decision to interrupt Iranian imports to the US and thus driving the price even higher than expected and accentuating the negative effects of the oil shock.

Moreover, in the 1970's due to high oil prices an expropriation and nationalization of oil sector industries began in Bolivia, Ecuador, Russia and in Venezuela.

The third, albeit no so longstanding, oil shock occurred in 1980 after the Iraq invaded Iran causing the halt in oil production in Iran and Iraq. The Iranian revolution in combination with the Iraq-Iran war has led to an increase of the barrel price from 14 US dollars in 1978 to 35 US dollars in 1981. Nevertheless, even today the Iran and the Iraq have not reached the levels of production before the crisis.

In the medium term to the long term, high oil prices were the incentive for investing in energy efficient and alternative resources of energy and this in turn had a dampening effect on oil demand in the 1980s.

However, after 1980, oil prices slopped down to a 60 percent till the 1990s. Saudi Arabia voluntarily shut down three quarters of its production between 1981 and 1985 although this was not enough to prevent a 26% decline in the nominal price of oil and significantly bigger decline in the real price (Hamilton, 2011). The decline of prices is partly explained by the detraction of demand and over-production since new international players in the energy arena emerged such as the USSR, which became the first oil producer in the world, Mexico, Nigeria and Venezuela while Europe and the USA started exploiting oil reserves in Alaska and the North Sea. Furthermore, new alternative forms of energy started developing and occupying their niche in the market and energy mixtures of the industrialized countries.

Nevertheless, in 1990 a new oil price shock occurred due to the Iraq invasion in Kuwait, albeit softer and not lengthy lasting only nine months but having the same macroeconomic reverberations. The two countries accounted for nearly the 9% of world production. Due to the conflict, prices rose from 21 US dollars per barrel at the end of July to 28 US dollars on August 6, reaching 46 US dollars in October. However, Saudi Arabia used its excess producing capacity to rebalance world supply and this is why the shock was so short. To this new shock is attributed the recession of the early 1990s, especially in the USA which was deteriorated by poor and delayed monetary response policies.

From the mid-1980s to September 2003, the inflation-adjusted price of crude oil was generally under 25 US dollars per barrel. With the exception of the 1997 and 1998 Asian crisis which was underestimated by OPEC leading to a plummeting of oil prices because of the higher OPEC production which did not find the analogous response by the Asian economies. The rapid growth of the Asian tigers that has long before started had come to a halt, at least for that time and the previous glutton consumption of oil stopped. Although their contribution to world petroleum consumption at the time was modest, the *Hotelling Principle* suggests that a belief that their growth rate would continue could have been a factor boosting oil prices in the mid 1990s. In 1997 South Korea was under serious financial stress and Thailand followed suit. The dollar price of oil fell below 12 US dollar per barrel by the end of 1998, the lowest price since 1972. Nevertheless, the Asian crisis proved to be short-lived, as the region returned to rapid growth (Hamilton, 2011).

In 1999 world consumption of oil returned to the pre Asian crisis as well as the oil price. In mid-2002 the excess production of oil was over 6 million barrels per day and by mid-2003 the excess production was bellow 2 million. In 2003 Venezuela's political instability and the US attack in Iraq disrupted again the oil production and caused a rather modest increase in oil prices.

During 2004-2005 the spare capacity of oil production was less than 1 million barrels per day and not enough to cover an interaction of supply from most OPEC producers. This added a significant risk premium to crude oil price and was largely responsible for prices of 40-50 US dollars per barrel along with the rapid re-growth in Asia economies and increase of the oil consumption. Generally, the global economic growth was exponential and this partly explains the rise of oil prices. During 2003 the price rose above 30 US dollars, reached 60 by August 11, 2005, and peaked at 147.30 US dollars in July 2008. The hike in prices of oil in 2008 is attributed to factors including speculation about decline in petroleum reserves and peak oil and Middle East tension.

The oil shock in early 2007 was accentuated by developments in other commodity markets that are causally related to oil price increases. Inflation rose to alarming levels and followed by a dramatic economic downturn caused by the financial crisis which gave ground to theories that oil prices contribute to recessions.

In 2008 the global economy is encountered by the deepest recession in post war history that is clearly associated which oil prices. The end of 2008 witnesses a cooling down of commodity prices. The global economic recession led to fall in energy consumption in the OECD which fell faster than GDP-the sharpest decline in energy consumption on record. The OECD countries consumed less primary energy than 10 years ago, although GDP since then has risen by 18%. With consumption falling, energy prices declined in 2009 with oil prices at below 40 US dollars early in 2009 (BP Statistical Review of World Energy, 2010). The low oil price environment at the end of 2008 and in the first quarter of 2009, the global financial crisis and the low earnings of many oil companies as well as the tight credit lines led to a slowing down in the pace of investment in new upstream oil projects and in some case project cancellations and delays (World Oil Outlook 2010, OPEC).

In the latter part of 2009 and in 2010 the pace of the global economic recovery exceeded expectations with a revival in manufacturing and trade. Turning to oil, a swift recovery fro the global recession has led to increase in demand.

As a general conclusion, the oil shocks have undoubtedly affected to a less or to a greater degree the oil prices which in turn due to other multiplier factors like monetary policies have a less or great effect on economic growth of oil importing countries. The disruption of oil supplies and the ensuing high prices -along with the climate change and the greenhouse effect- has led to the development and use of energy efficient technologies and alternative forms of energy in order to differentiate their energy mixture and decrease importing countries dependency on oil and increase country-sufficient types of energy. Nevertheless, the dependency on oil is set to continue as crude oil will remain the predominant primary source for the foreseeable future. In satisfying the world's need, fossil fuels playing the prominent role, and though their share in the energy mix is expected to fall, it remains over 80% throughout the period to 2030. Generally, by 2030, world energy demand is projected to increase by more than 40% compared to today's (2011) level's and oil has the leading role in the energy mix with its share remaining above 30% albeit falling over time. (World Oil Outlook, 2010).

2.2 Determinants of oil prices

It is obvious from the previous historical review of the oil shocks that a major factor determining the oil prices is **political instability and geopolitical tensions, conflicts** and wars which end up to oil supply disruption or/and inconsistency of supply versus demand. The Arabi-Israel war in 1973, the Iranian revolution in 1979 and mainly the Gulf war in 2003 caused disruptions in the oil supply and the price of crude oil has witnessed an increase in volatility and an upward trending path. Moreover the fair factor of terrorism in the middle-East region is influencing the oil prices. Also political unrest in Nigeria and Venezuela have cost disruption of oil exports and had an impact on oil prices. Nowadays the political instability in the Arab world and the recent ousting of long-term leaders in Tunisia and Egypt and the spreading effects in other Arab nations are causing uncertainty and sometimes panic which affects the price of oil. Furthermore, unpredictable but possible destabilizing geopolitical events in unstable regions may affect the oil prices. Such events may be the flare-up of the Israeli- Palestinian conflict, a slowdown of economic growth that may trigger popular unrest and break-up of the country or the shortage of water in the

Middle East- a plausible scenario. In general, extreme market events may shift the market equilibrium between supply and demand in which prices are more sensitive to shocks than under normal circumstances.

A second factor is the **degree of economic activity** in both the industrial developed and developing countries, meaning that when growth rates of Gross Domestic Product (GDP) rise, the demand for oil from consumers and industrial users is rising too and when growth rates decrease the demand declines too. In other words oil prices are linked to the ups and downs of the business cycle. The economic growth in the United States demands high levels of oil consumption. Also the emerging economy tigers like China, India, and Brazil are depended on oil for there growth, albeit to different degrees, and thus their increasing demand may lead to oil prices rise. However there is the other way round relationship where this effect of high oil prices because of increased oil demand can lead to GDP growth rates decline. And this is because the countries may implement restrictive monetary policies afraid of inflation because of increasing oil costs and thus inhibit the economies growth. Moreover not wanting or unable to reduce oil product consumptions, may reduce expenditure on other commodities in this way may slow the GDP growth.

A third factor is the **singularity of the oil** as a commodity. The oil sector is of oligopolic character with few suppliers and many consumers. The "oil belt" which stretches form Algeria through the Middle East currently accounts for roughly 40% of crude oil production worldwide plus refinery-type liquids derived from natural gas. Very roughly speaking, the Belt possesses 63% of the world's crude oil reserves which is controlled by few global private companies and the OPEC. OPEC is a unique of its kind institution which can influence the oil price with its member nation quota system. This quota system of OPEC to control price has been debated because of the ability of OPEC members to produce beyond their assigned production levels. Nevertheless the power of OPEC in affecting the oil market is evident in the behaviour of buyers and sellers awaiting for the decisions and actions of the OPEC. This power has been clearly shown during the oil crisis in 1973 and 1996 when a huge amount of crude oil from Saudi Arabia flooded the market and led the prices down. Until the mid-1990's OPEC had been able to control, although loosely, world prices of crude oil because it controlled an important part of world production. However the Asian crisis in 1997 derailed oil prices and OPEC tried to change quota policy in order to be more reactive and better responding to better demand of oil. Again in 2004 and nowadays OPEC losses its capacity to control prices due to political instability in the middle-East.

A forth factor is the **expectations** determinant. Real or forecasting probabilities of oil market disruption as well as the estimated reserves may lead to price volatility. In some cases, it is believed that the important producers are exaggerating their estimates of reserves by a substantial amount. Moreover, OPEC, BP and the International Energy Agency have been accused of compelling the numbers of reservoirs without challenging their sources. Furthermore, due to the fact that the reservoirs for each country separately are considered a matter of “national security” there are no data by reservoir for OPEC countries published since 1982.

A fifth factor is the **reserve currency of oil** which is US dollar which influences the value of dollar in world currency markets. Exchange rate fluctuations in the US dollar can affect the world price of oil because oil is priced in dollars and generally paid for in dollars. The effect of declining dollar on oil importing countries depends on how their currency has adjusted to the changing value of the dollar. For example for the Euro area countries the effect of the increasing dollar denominated oil prices is constrained by the amount of euro appreciation.

A sixth factor is **physical calamities and disasters**, like typhoons, hurricanes, floods and in general results of climate change. Moreover consumption of oil is affected by seasonal factors and oil demand increases in the first and fourth quarters of its year. Thus, speculations and unusual weather conditions may create short-term volatility. Furthermore, accidents in oil refining or drilling procedure, like the Gulf of Mexico oil spill in 2010 may affect future supplies and prices since more stringent regulations are likely and thus, increased costs, less exploration and less favourable project economics in general.

A seventh factor is the **degree of dependency** in oil of the countries and the degree of developing and using other or alternative forms of energy as well as the degree to which there industries are depended on oil. Technological developments and resource availability play a crucial role. Moreover, the structure of industries and energy policies are one of the key drivers for future energy demand and supply of the oil.

An eighth factor is the **magnitude of oil reserves** as well as predictions of how fast or how slow these reserves can be consumed and if they can cover the demand every given period. Also concerns about future oil market conditions materialized by the shift of the futures market are regarded from many as determinants of oil prices. "*Proved reserves are the quantities that geological and engineering analysis suggest that can be recovered with high probability under existing technological and economic conditions. These reserves can be augmented through intense exploration and development of new discoveries through technological improvements as well as through the existence of more favourable economic conditions. In the past all these factors have contributed to increasing the proved reserved base. Whether the proved reserve base grows overtime or not depends in part on the level of production. As production proceeds, the level of proved reserves declines while as new oil discoveries are made, technologies improve or as the price of oil rises, the stock of proved reserves increases. This can be measured by the (R/P) indicator which is the number of years that the existing reserves base can sustain the current level of production*". According to this indicator on regional level the period between 1993-2003 is the declining reserve position of North America and the United States which mend that the US continued to depend on the world market the OPEC and Persian Gulf Nations for a large part its apply. Moreover the middle-East and Saudi Arabia still are the largest holders of reserves in the world. European reserves are including members of the formers Soviet block like Azerbaijan, Kazakhstan (International Energy Agency, World oil demand and its effect on oil prices, SRS report for Congress). Finally, increasing credibility is attributed to the *peak oil hypothesis* which provides for that the point of global maximum production has been pasted and from now on the production will decline. According to this theory the peak of production is reached when half of the known reserves have been extracted. Although we don't known yet if will reached the peak production given the fact that new technologies improve extraction capacity and costs involved in the extraction of deepwater and arctic oil. Nevertheless according to the international IEA the world faces a potential supply squeeze after 2015 as the average oil field production rate is continually increasing and production sources are becoming scarce. Moreover in 2008 during the financial crisis money for investment in new energy sources and innovating technologies was decreased substantially (fell short of the annually required total of one 1000 billion US dollar (Medium Oil and Gas Markets, 2010, IEA).

A ninth factor is the **inventories** which oil industries hold. These inventories are stocks of crude oil for emergency cases to ensure the undisrupted operation of refineries in case of potential disruptions in oil supply. From 2002 till 2004 these inventories have diminished in the USA and in other countries probably due to increased costs and thus may contributing to the high price of oil. Generally the lack of sufficient spare production capacity can be considered as a factor increasing the oil prices.

A tenth factor can be considered the **degree of refining capacity** and the lags associated with building additional extraction infrastructure. Even with modern technology, due to the fact that oil is always found underground or undersea and often at great depths and seldom reveals its presence by visible signs, the odds of finding commercial quantities of oil are against the seeker until the reservoir has been proven. Generally, changes in the refining sector and a drop in the refining utilization rate can affect oil prices. Nevertheless recent analyses indicate that there is little evidence that increasing refining capacity is able to lower crude oil prices. (Dees, S., Assessing the factors behind oil prices changes, ECB). Nonetheless, the golden age of refining capacity between 2004 and mid-2008 with demand growth and refining tightness is now followed by a collapse of demand and is estimated that around 7.3 mb/d of new crude oil distillation capacity will likely be added to the global refining system in the period towards 2015 and should the global oil demand prove to be slower than the forecasts, the capacity surplus will be high. (World Oil Outlook 2010, OPEC). Boom of the refining continues and this may lead to excess surplus by 2015 (World Energy Report, 2010 IEA).

An eleventh factor is **speculation**, meaning the behaviour of financial markets participants, which makes fundamental supply shortfalls more transparent. For example speculation about future disruptions of oil supply leads the producing countries to stockpile. Speculation for some is dangerous when large-scale transactions are a medium to achieve profits from price changes. For others speculation is useful because it allows for transparent and efficient liquidity based price discovery and helps to better allocate resources. *According to Krugman " there is no crude oil price bubble, arguing that if financial markets where in fact to generate artificial shortfalls over the long-term, this would have to be reflected by* *large stockpiles of crude oil, there a by generating additional physical demand"* (Breitenfellner, 2009). Another argument for the causal relationship between speculation and crude oil prices is the fact that the oil price increases in 2008 occurred the same time with the deregulation of futures market. Furthermore, because of time lags in processing and transportation, the oil industry makes greater use of forward and futures markets for hedging and speculative purposes than most industries and thus, oil markets are vulnerable to "players" in other markets who roil these markets by laying off bets made in other markets and vulnerable to conflicts between different groups of speculators. Thus, from 2008 to 2010, many energy meetings like the International Energy Forum in Cancun in 2010 focused upon the need to reduce excessive volatility, including through the improved regulation of oil futures and over-the-counter markets and help mitigate energy market volatility (World Oil Outlook 2010, OPEC).

A twelfth factor is the **real interest rates** as dictated by monetary policy and affect demand and supply of crude oil with a negative correlation with real oil prices. The central banks of most of the countries reacted to the oil price shocks by increasing interest rates and decreasing real money balances. Moreover, a significant part of the effects of the oil prices shock in 1990 resulted in directly from the response of monetary policy.

A thirteenth determinant is the **danger which marine transportation** of oil entails. In detail, 20% of the world's crude exports move through the Straights of Hormuz, between Iran and Oman and in the middle of this pathway is an island where Iranian Revolutionary Guards are located. Moreover, most of the Europe's crude imports enter the Red Sea between Somalia and Yemen where Somali pirates have been active. Furthermore, another bottleneck where pirates have attempted to hijack tankers transporting oil is the strait between Indonesia and Singapore.

The determinants of oils are summarised in the following diagram.

Figure 2. Determinats of Oil Price

2.3 Current developments in oil prices

During 2010 we witnessed a recovering global economy with higher oil prices while both demand and supply baselines raised and a better market balance, although some serious problems persist such as Eurozone uncertainty, entrenched price subsidies and ongoing supply risks. Oil prices fluctuated within the range of 65 US to 85 US dollars and OPEC spare capacity was countered by strong non-OECD demand growth (Medium –Term Oil and Gas market, 2010, IEA). Nevertheless, in January 2011 crude prices were propelled higher due to political unrest in Tunisia, Egypt and elsewhere in the Arab world reaching 100 US dollars per barrel due to fears that the turmoil might disrupt Suez Canal and SUMED pipeline flows or spread in the region. In February 2011, Brent Futures remain around 100, 50 per barrel and WTI at 87.20 US dollar per barrel. Global oil product demand for 2010 and for 2011 is up by 120 kb/d on average and world oil supply rose0.5 mb/b in January 2011, to 88,5 mb/d. Global refinery crude throughputs for 4Q10 are adjusted up by 150 kb/d, to 74.7 mb/d and December 2010 OECD industry stocks declined by 55.6 mb to 2668 mb. (Oil market Report, 2011, IEA). Except from the turmoil in the Arab world other factors seem to lead to an increase in oil price such as the supply problems, interest form investors and rising demand, especially from fuel-thirsty China to fuel its factories and power thousand of new cars.

2.4 Determinants of economic growth

In this section the major factors influencing economic growth are presented and analyzed in order to show the wide range of co-determinants affecting economic growth except for the oil prices that constitutes the main focus of this dissertation. The ultimate purpose is a spherical view of the economic growth process that will facilitate the analysis of our main subject, the relation between oil prices and economic growth, leading us to safe and reliable results.

A major determinant of economic growth is **investment**. In particular, **Foreign Direct Investment (FDI)** is positively correlated to economic development. (Arvanitidis, Pavleas, Petrakos, 2009). FDI has recently played a crucial role of internationalizing economic activity and it is a primary source of technology transfer and economic growth. FDI generates positive knowledge externalities through labour training and skill acquisition, transfers technology and organizational know-how, introduces new production processes, creates backward and forward linkages across sectors, and provides domestic firms with access to foreign markets (Doucouliagos, Iamsiraroj and Ulubasoglou, 2010). This major role is stressed in several models of endogenous growth theory. The empirical literature examining the impact of FDI on growth has provided more-or-less consistent findings affirming a significant positive link between the two. As of June 2009, there were 108 empirical studies using cross-country data and reporting 880 regression estimates of the effects of FDI on growth. Less than half of the studies have found a positive and statistically significant effect and nearly one third report a negative effect. However, using meta-regression analysis

(MRA) lead to four robust conclusions emerged regarding the FDI-growth relationship. First, FDI has, on average, a positive total effect on economic growth that is of statistical significance. Second, there are important regional differences in FDI's effect. Third, when FDI interacts with capacity variables, such as education, trade, and especially financial markets, its marginal contribution to growth is even greater. Fourth, higher levels of FDI are associated with larger governments, more developed financial markets, lower inflation, higher levels of schooling, and higher levels of foreign aid. Finally, there are indications that developing countries benefit more from the direct effects, such as productivity increases (Doucouliagos, Iamsiraroj and Ulubasoglou, 2010). Furthermore, the **price of investment goods** influences economic development. A growth promoting policy should target the decrease of taxes and distortions that raise the price of investment goods (Moral-Benito, 2010) as well as enhancing effectiveness of law enforcement, sanctity of contracts and the security of property rights.

Governance and the institutions influence economic growth. More specifically, institution quality and political freedoms and civil rights are significant determinants. The conduction of free and fair elections as well as the freedom of property, freedom of speech and expressing and pluralism is of crucial importance. On the contrary, insecure formal institutions or high level of bureaucracy can be an impediment to economic growth. Also, high degree of state intervention can be prohibiting of growth as opposed to a free market economy. The other way round, secure and strong institutions, maintenance of the rule of law, low level of political corruption and of bureaucracy and enhanced political rights are able to trigger growth. In general, democratic institutions provide a check on governmental power and in this way they limit the potential of public officials to amass personal wealth and to carry out unpopular policies. However, since at least some policies that stimulate growth will also be politically popular, more political rights tend to be growth enhancing on this count. A proper policy should have as a purpose structural reforms of the administrative and political system for a smooth functioning of economic activity.

As far as **democracy** is concerned, it does not emerge as a critical determinant of growth but there is soma evidence of a nonlinear relationship. At low levels of political rights, an expansion of these rights stimulates economic growth. However, once a moderate amount of democracy has been attained, a further expansion reduces growth. A possible interpretation for this is that in extreme dictatorships an increase in political rights tends to raise growth because the limitation on governmental authority is critical. However, in places that have already achieved some political rights, further democratization may retard growth because of the heightening concern with social programs and income redistribution. On the contrary, there is a strong positive linkage from prosperity to the propensity to experience democracy. (Barro, 1996).

Moreover, the **size of the government** indicated by the ratio of government consumption to GDP can influence economic growth. Government consumption may have indirect effects on private productivity through taxation to fund government expenditure. Empirical findings have shown that lower government consumption can enhance growth in terms of private economic activity. Moreover, the greater the volume of nonproductive government spending is and the ensuing taxation, the greater the reduction of growth rate for a given starting value of GDP. (Barro, 1996).

Economic policies and macroeconomic conditions boost or inhibit economic growth. Poor macroeconomic policies can constitute an obstacle to economic growth and robust and flexible macroeconomic management can enhance economic growth through mitigating the adverse effects of economic cycle (Arvanitidis, Pavleas, Petrakos, 2009). In general, higher inflation goes along with a lower rate of economic growth. Clear evidence for adverse effects of inflation comes from the experiences of high inflation which was an impediment to growth and development. Other public policies that seem to influence growth include public pension and transfer programs, tax distortions and regulations that affect labor and financial markets (Barro, 1996). More specifically, regarding the relation between the cyclicality of fiscal policy, output volatility, and economic growth, firstly both pro- and countercyclical fiscal policy amplify output volatility, much in a way like pure fiscal shocks that are unrelated to the cycle. Second, output volatility, due to variations in cyclical and discretionary fiscal policy, is negatively associated with economic growth. Third, there is no direct effect of cyclicality of economic growth other than through output volatility. These findings advocate the introduction of fiscal rules that limit the use of (discretionary and) cyclical fiscal policy to improve growth performance by reducing volatility (Badinger, 2008).

Other factors include active participation of countries in **conflicts, political instability and timing of independence** as far as countries of former colonial rule or other are concerned. To these factors are added determinants of inequality and religious affiliation (Barro, 1996).

Other parameters can include **demographic indicators**, **projections for population growth** and **life expectancy.** These factors can be subdivided to population density, health and fertility (Ciccone and Jarocinski, 2008), population growth and composition and migration (Kelley and Schmidt, 1995, 2000, Barro 1997).

Human capital investments and initial income can also constitute factors of economic growth. Economies that have less capital per worker tend to have higher rates of return and higher growth rates. However, this depends on other factors such as the propensity to save, the growth rate of population and the position of the production function, government policies for the level of consumption spending, protection of property rights that may vary across countries. Furthermore, they are influenced by distortions of domestic and international markets (Barro, 1996). Human capital which is measured as the share of educated workers to population is associated with regional economic growth and can function as an engine of economic activity. This factor is clearly associated with the quality of education systems of each country. Specialization in high level knowledge as well as development of capital intensive sectors is able to boost a country's competitiveness and competitive advantages. The estimated European countries imply that an increase of 10% in the share of high educated in working age population increase GDP per capita growth on average by 0.6% (Cuaresma, Doppelhofer, Feldkircher, 2009). In detail, schooling at the secondary and higher level has a significantly positive effect on growth and in particular, female schooling is important for other indicators of economic development such as infant mortality, fertility and political freedom. As far as fertility is concerned, a higher rate of population growth has negative effects on growth since the economy’s investment is used to provide capital for new workers rather than raising capital per worker and the higher the fertility rate the more resources devoted to childrearing than production of goods (Barro, 1996). Furthermore, Education seems likely to encourage economic growth not only by increasing and improving human capital but also physical capital and social capital – that is, by reducing inequality. If so, the inverse association between inequality on economic growth since the mid-1960s that has been reported in the literature may in part reflect the favourable effects of more and better education on both economic growth and social equality (Gylfason, and Zoega, 2003)

Income convergence in the European countries along with spillovers which lead to growth clusters can play a major role in the EU regions. Conditional income convergence appears as the most robust driving force of income growth across European regions. The convergence process between regions is dominated by the catching up process of regions in Central and Eastern European (CEE), whereas convergence within countries is mostly characteristic of regions in old EU member states (Cuaresma, Doppelhofer, Feldkircher, 2009).

Innovation and R&D is positively associated with productivity and growth. In the global economy, the productive sector can survive only by competing through quality, novelty and a diversity of products and services that are generated through innovation and continuous technological change. It is worth noting that most of the world commerce is based on manufactured products with a high technological content. In order to improve competitiveness of the productive sectors internationally, focus must be given to science, technology and innovation. Furthermore, the Information and Communication Technology (ICT) revolution, especially the internet, has substantially enhanced the productivity and use of human capital across nations the last decades. ICT exerts positive effect on economic growth through two channels. Firstly, it fosters innovation and technology diffusion which promote in turn economic growth and secondly, ICT improves the quality of decision-making at the firm-level , which enhances the performance of business sector as a whole and hence, the economy. Furthermore, ICT penetration together with the initial level of income, institutional quality, population size, the agricultural sector's share in the economy and the investment per GDP level is a strong determinant of the variation of GDP growth across countries over the period 1995-2005 (Vu, 200-).

Geography plays an important role in the economic growth of countries. Land area and privileged geographical and geostrategical position can enhance or determine the economic development of a country. In detail, the fraction of land area near navigable water and the degree of remoteness determine to a degree the economic development of a country. Other factors can include latitude, average temperatures and rainfall, soil quality and disease ecology (Hall and Jones 1999, Easterly and Levine 2003, Rodrik et al, 2004). Moreover, natural resources, country size and urbanization have their play in the economic growth. Thus, regions with capital cities present a systematic better performance than other regions. In addition, the **distance to major world cities** like New York, Rotterdam and Tokyo is correlated to the geographical determinant (Moral-Benito, 2010). Furthermore, infrastructure plays an important role in economic growth and in particular infrastructure related to air transport (Cuaresma, Doppelhofer, Feldkircher, 2009). Generally, favorable geography is an asset for countries hence, a proper growth policy should aim to improve access to major cities and international markets, improve infrastructure and exploit the maximum of comparative advantages of the geomorphology of a country as well as natural resources and geo dynamics.

Trade openness can be considered as a determinant of economic growth. Trade openness is measured by the share of imports and exports in the GDP. Movements in real GDP occur only if the shift in terms of trade stimulates a change in domestic employment and output. For example, an oil-importing country might react to an increase in the relative price of oil by cutting back on its employment and production (Barro, 1996). Generally, openness affects economic growth through several channels such as exploitation of comparative advantage, technology transfer and diffusion of knowledge, increasing scale economies and exposure to competition.

A newly emerged factor influencing economic growth that has being examined in very recent literature is **the relationship between capital endowment and industrial structure and the impact structural coherence has on growth**. For the overall capital, the data shows that the capital-intensive industries output and employment sizes are larger when capital endowment is higher, and growth in capital endowment also leads industrial structure to shift towards capital-intensive industries. In terms of the relationship between structural coherence and growth, the results show that a country's aggregate growth performance is significantly and positively associated with the coherence level between industrial structure and capital endowment (Xingyuan Che, N., 2010).

Furthermore, according to other researchers **climate change may affect economic growth and induce competition among groups inside a state**. Estimating the consequences of climate change for economic growth, the relationship is very tricky for various reasons. Climate and weather impact on almost all human activities from leisure to agriculture to industrial production. But even when considering only a few activities, for example agriculture or industrial output, the estimation task remains quite daunting. The main reason is that the impact of climate change will vary with levels of economic development and political capacity of a country, with levels and types of climate change. In other words, although economic and political actors will of course respond to climatic conditions by developing and implementing adaptation strategies, their ability to do so depends critically on institutional, economic, and technological capabilities. The researchers conclude that countries with greater economic capacity and democratic institutions are likely to have a superior capacity to avoid or escape the climate change–poverty–conflict trap (Bernauer, Kalbhenn, Koubi and Ruoff, 2010).

In general, a combination of the above determinants is the recipe for robust economic growth. Nevertheless, different combination of factors is important to developed countries as compared to those important for developing countries. For example, for countries that have reached a high degree of development, innovation and R&D, high technology, human capital intensive sectors and specialization in high knowledge are deemed important for further development while for developing countries natural resources, favorable geography and investment strategies and mainly Foreign Direct Investment play a crucial role in jumpstarting their economies. Nevertheless, some factors are indispensable for both developed and developing countries such as high quality human capital, good infrastructure, high degree of openness, stable political environment, secure formal institutions, capacity for adjustment and robust macroeconomic management (Arvanitidis, Pavleas, Petrakos 2009).

The determinants of oils are summarised in the following diagram.

Figure 3. Determinats of Economic Growth

2.5 Oil prices and economic growth

Oil prices are considered as another determinant of economic growth. Their relation is believed to be reciprocal and bidirectional due to the fact that not only oil prices affect economic growth but also economic growth influences the price of oil, even though we do not have enough evidence to prove the degree and extend of influence. The literature dealing with the issue of the relation between oil prices and economic growth is not sufficient not to say inadequate and sometimes problematic. In general, the majority of the studies conducted after the middle of the 1980s agree that the relationship is asymmetric and non linear. As follows, example studies from the international literature which deal with the relation of oil prices and economic growth or with oil prices and other relative to economic growth variables, are presented.

An analysis conducted by **Al-Salman., A., Ghali, K. and Al-Shammari, N. (2008),** intend to find the relation between crude oil prices fluctuation and the real business cycle in the G7 economies. It uses three types of variables of business cycles, macroeconomic variables such as the employment rate, inflation rate, and gross fixed capital formation, monetary variables such as money supply and interest rate, variables of balance of payments and exchange rate policy such as net exports and the exchange rate volatility and finally the variable of energy prices in G7 economies. The econometric methodology it uses firstly unit roots tests and specifically Augmented Dickey-Fuller (ADF) and the Cointegration Method using the Johansen Procedure in order to examine the relationship the real business cycle and its determinants and finally it uses the Granger – causality test procedure with different lag structures in order to fined the short-run effect of the fluctuation of oil prices on the business cycle. The paper concludes that the changes of oil prices have an impact on the real GDP on all G7 economies. However, there is a short-term neutrality of the oil effect in Italy, Japan and the UK while the oil effect is significant of the rest of the G7 economies especially for Germany and France. Different governmental policies have helped to mitigate the effect of oil prices in the business cycle while in other countries the individual characteristics of their economies have defined the degree of the effect. For example, Germany depends heavily on imports to meet its energy needs due to a lack of domestic fossil-fuel resources and that is why the impact of oil prices on the business cycle is more significant in Germany. Japan has increased its diversification of energy sources thus the effect of oil prices in the business cycle is less significant.

Lee, C. and Chiu, Y. (2010) attempt to investigate the impacts from oil price and oil consumption changes on nuclear energy development due to international crude oil price hikes and oil supply shortages. In order to find whether there is the substitute or complementary relationship between nuclear energy and oil. This study is the first one utilizing a model with nuclear energy consumption as independent variable to examine the income elasticity of a nuclear energy consumption and to analyze the impact of the policy for stimulating economic growth on nuclear energy development. It uses the generalized impulse response function (GIRF) and the generalized forecast error variance decompositions (GVDC) with purpose to explore the dynamic relationship among nuclear energy consumption, real oil price, oil consumption and real income. The study examines six highly industrialized countries, Canada, France, Germany, Japan, the UK and the USA, and covers the period from 1965 to 2008. More specifically, it uses five different unit root tests and also the Johansen's approach for five vector autocorrelation models, proving that there is a stable long-run equilibrium relationship between the five variables. Then it uses the Granger causality test of Toda and Yamamoto. The study concludes that in the US and Canada there is the substitute relationship between nuclear energy and oil. In France, Japan and the UK there is a complementary relationship between oil and nuclear energy. Furthermore, there is a bi-directional relationship between nuclear energy consumption and real income in Canada, Germany and the UK whereas there is no causality between nuclear consumption and real income in France and the US. Except for the US, in all the other five countries oil price increases affect the nuclear energy development.

Rodriguez, R. and Sanchez, M. (2004) examines the G7 countries, Norway and the Euro-area as a whole. It uses the linear and three non-linear approaches, in order to assess the impact of oil price shocks on the level of real activity. It uses the Granger-causality type analysis and then the asymmetric, the scaled and net specifications models. The paper concludes that according to linear specification an oil price shock has a negative accumulative effect on GDP growth in oil importing countries except for Japan and the largest negative accumulative effect of an oil price shock is on the US economy. Also, Euro-area countries Germany, France and Italy exhibit large accumulated real impacts of a positive oil price shock due to oil dependency. According to non-linear specifications in Canada and in the US in oil price hike induces an exchange rate appreciation in effective terms. Moreover the non-linear specifications show larger negative accumulative impact on GDP growth than in the linear case with the only exception is Canada where the losses of GDP growth rate during the first year and a half after the shock are smaller than in the linear case. For Japan both linear and non-linear models show positive reaction of GDP growth to an oil price increase. In sum the output growth of all countries except from Japan responds negatively to an increase in oil prices. Finally oil price increases generally have a larger impact on GDP growth than that of oil price declines with the latter being statistically in significant in all countries apart from Canada. For the two oil exporting countries using the scaled specification the paper finds that in Norway the output growth responds positively to an increase in the oil price variable and in Britain the output growth is unexpectedly negatively affected due to sharper real exchange rate appreciation.

Kilian, L. (2007), examines exogenous oil supply shocks rather than oil prices. The analysis is based on a recently proposed approach to quantifying the dynamic effects of exogenous oil supply shocks that avoids some of the conceptual and econometric difficulties with earlier analyses. The analysis also distinguishes between consumer prices and the implicit GDP deflator. It uses counterfactual simulations and a linear regression model of the relationship between exogenous oil supply fluctuations and macroeconomic aggregates. It is based on quarterly data for the period from 1971 to 2004. The paper finds a fair degree of similarity in the qualitative features of the estimated real GDP growth responses showing that an exogenous oil supply disruption causes a temporary reduction in real GDP growth. In most countries exogenous oil supply disruptions cause at least a temporary decline in real wages, a depreciation of the local currency against the dollar and a rise in short-term interest rates. Despite qualitative similarities, there is strong statistical evidence that the responses to exogenous oil supply disruptions differ across G7 countries.

Cologni and Manera (2005, 2008) aim to measure the direct impact of oil prices on macroeconomic indicators and to verify in the central banks of the G7 have reacted to exogenous oil price shocks. It uses a cointegrated structural vector autoregression (SVAR) technique to vector error correction models (VECM) with cointegrated variables, meaning the SVECM analysis. Some of the findings result show with regard to the response of monetary policy, the central banks of most of the countries reacted to the oil price shock by increasing interest rates and decreasing real money balances. However if this is true for Japan and Italy for the other countries an increase in oil prices lead to a decrease in a short-term interest rates rejecting the hypothesis of a monetary policy directed to fight inflation. As far as the impact of a contractionary monetary policy response is concerned in Japan the inflation rate tends to decrease in response to the contractionary monetary shock. In Italy, the UK and the US the tightening of monetary conditions do not succeed in reducing price growth. Furthermore for Canada, the UK and Italy an increase in interest rate is consistent with significant but transitory real effects on the value of their currencies. Moreover the impact effect of the monetary policy shock on the output growth is significant in

Canada and the US. Finally, a significant part of the effects of the oil prices shock in 1990 resulted in directly from the response of monetary policy.

In a later paper, **Cologni, Manera (2009)** examine the relationship between the conditions in the oil market and a business cycle for G7 countries using different Markov-Switching Models in order to measure business cycle asymmetries and to assess the effect of oil prices changes on the level of output by analyzing the business cycle features in the real GDP series for each country. The novelty of this paper is that it assesses explicitly the dynamic impact of exogenous oil shocks on the movements of real output by examining alternative specification of MS models that differ in the parameters that switch across regimes (mean, intercept autoregressive component). Furthermore it compares the most common definitions of oil shocks to detect asymmetries in the oil-output relationship. The data concern the period from 1970 to 2005. The paper concludes that models with exogenous oil variables generally outperform the corresponding univariate specification which excludes oil from the analysis. Oil shocks effects tend to be asymmetric and depend on the degree of whether or not the price increases are simple corrections of past decreases. Moreover the role of oil shocks in recessions has decreased over time and improvements in energy efficiency and the policy by monetary authorities are the once that determined the effects of oil shocks. Vice versa the economies of the G7 countries can not affect oil market conditions.

Lardic and Mignon (2005, 2006) examine the impact of oil prices in various European countries using data from 1970 to 2003. It uses the asymmetric cointegration framework and results to the finding that economic activity reacts asymmetrically to oil price shocks probably because of monetary policy, adjustment costs, adverse effects of uncertainty of the investment environment and asymmetry in petroleum product prices. Indeed rising oil prices seem to retard aggregate economic activity by more than falling oil prices stimulated.

Kilian, Rebucci and Spatafora (2009) are analysing the link between oil prices and external balances, particularly the effects of oil demand and oil supply shocks on external balances of oil exporting and oil importing countries during the period from 1975 to 2006. It uses variance decompositions to measure the average importance of these shocks for external balances. Moreover the analysis distinguishes between oil price changes driven by crude oil supply shocks, by oil market specific demand shocks and by innovations to the demand for oil industrial commodities driven by the global business cycle. It follows closely the identification strategy of Kilian and uses the structural VAR model (SVAR). The analysis concerns oil exporters and major oil importers countries (US, Japan and Euro area) and excludes the Canada and the UK because these countries behave differently from both oil importing and oil exporters. The analysis recognises that oil price changes reflect at least in part the state of the global economy. More specifically the main findings are: a) global business cycle demand shocks and oil specific demand and supply shocks are important for the determination of external balances, b) the nature of the transmission of oil price shocks depends on the cause of the oil price increase, c) the overall effect of oil demand and supply shocks on the trade balance of oil importers and oil exporters depends critically on the response of the non oil trade balance, d) in addition to the adjustment of the trade balance and current account, a second channel of adjustment is provided by valuation effects in the form of capital gains or capital losses on foreign assets and liabilities, e) shocks to the demand for industrial commodities driven by the global business cycle have played a significant role in recent years in the emergence of the external imbalances but valuation effects have helped cushion the impact of these shocks on net foreign asset positions.

Yoon, J. (2004), attempt to investigate the relationship between oil price and common recessions in the G7 and to find out whether oil price shocks have been a principal determinant of common recessions in the G7 over the past forty years from 1960 to 2002. It uses the Friedman's plucking Markov Switching Model and adds to this the exogenous oil price variable. It uses augmented Dickey-Fuller test and the Johansen's test for cointergration. According to the findings the exogenous oil price increases have impacts on the GDP of the G7, although oil prices shocks have not been a principal determinant of common recessions in the G7 except two major OPEC oil price shocks in 1973-74 and in 1979-80.

Rodriguez (2008) analyzes the disaggregated effects of oil price shocks on the industrial output for four Euro area countries (France, Germany, Italy and Spain), the UK and the US with a purpose to find the degree of differences in the reaction of the manufacturing industries of these economies to oil price shocks. A bivariate VAR model is used with real oil price in domestic currency and specific industrial output as variables. The data for all countries are from 1975 to 1998 except from France and

Spain where it uses data starting from 1980. The response of industrial output to oil price shocks differs across the four EMU countries because of differences in the industrial structure of its country but is highly similar in the UK and the US. Therefore economic policy should respond to this heterogeneity because the adoption of a common of a monetary policy in the EMU area to counter act oil shocks may create asymmetric effects as long as the effects of oil price shocks are different in the industries of the EMU countries and the only solution is fiscal policy -although sometimes not enough- which is country specific and can smooth final pricing by adjusting energy taxes.

Korhonen and Ledyaeva (2009) examine the degree to which oil price shocks influence growth in different countries through the medium of foreign trade. It tries to find out how the short-term effect of highly oil prices to energy exporters can be negative on the long-run when trade linkages are taken into account. Adversely it is interested in the situation which an oil exporter experiences an economic boom because of highly oil prices another countries are able to export more towards it. It uses the methodology formulated by Abeysinghe (1998, 2001) that includes the oil price as an exogenous variable. Secondly it uses the Augmented Dickey-Fuller and the KPSS tests for unit roots. The estimations are based on an asymmetric specification with separate metrics for positive and negative oil price shocks. It uses data from the large oil exporter Russia and its most important trading partners from 1995 to 2006 and also for Canada. The analysis proves that oil price increases have a clear and positive effect on the oil exporters GDP growth although this positive direct effect is temperate by a negative albeit small indirect effect because Russia is less able to export to countries that have been negatively affected by the oil price shock, since for most oil important countries the net effect of higher oil prices is negative. The largest negative direct effects of an increase of oil price are found for Japan, China, Finland, Switzerland and the USA. However many European countries aren't affected negatively by the recent increase of oil price. A crucial point of this study is the effort to distinguish between the direct and indirect effects of an oil price shock for the sample countries

Yanan He and Wang, Lai (2009) analyse the cointegrating relationship between global economic activity and crude oil real prices using the Kilian (2008) economic index which proposes a structural decomposition of the real price of crude oil into three components: supply shocks, shocks to the global demand for all industrial commodities and demand shocks that are specific to the crude oil market. The utter purpose is to find the dynamic responses of crude oil prices to global economic activity over different time horizons that have been ignored to a great extent. It proves the cointergration relations between Kilian economic index and crude oil prices and it uses Granger causality to see whether the Kilian economic index causes crude oil prices in the long-run. It also develops an empirically stable, data-coherent and single-equation error-correction model (ECM) which has sensible economic properties. The data used are concerning the period from 1988 to 2007. The paper proves that oil prices are affected significantly by fluctuations in the Kilian economic index through long-run equilibrium conditions and short-run impacts. The adjustment process of crude oil pries due to a permanent change in the Kilian economic index takes a longer time than that caused by a permanent change in the US dollar index.

Apergis, N. and Miller, S. (2009), examine how the oil price changes of endogenous character influence stock prices across eight countries (Australia, Canada, France, Germany, Italy, Japan, the UK and the US), using the Kilian procedure to decompose, with a VEC or a VAR model, oil price changes into free components: oil supply shocks, global aggregate demand shocks and global oil demand shocks. The data span from 1981 to 2007. The paper shows that different oil market structural shocks play the significant role in explaining the adjustments in stock market returns. The oil supply and global aggregate demand shocks do not significantly explain stock returns in Australia while the idiosygratic demand shocks affect stock returns in Canada at a weaker level. The Granger temporal causative tests show a strong role of idiosygratic demand shocks leading the stock market returns while the oil supply an global aggregate demand shocks do not temporally lead stock market returns. The magnitude of the effects of the structural shocks is small leading to a presumption that other (control) variables, such as exchange rates, interest rates and consumer durable spending seem to be explanatory determinants of stock market returns.

CHAPTER 3

ECONOMETRIC METHODOLOGY

3.1 Unit Root Test

In order to proceed to the implementation of the methodology and examine the spillover effects our series must be stationary. If a time series is stationary its mean variance and autocovariance (at various lags) remain the same no matter at what point we measure them. In this way we can conclude that the series are not depending on time. A process Y_t is the stationary in the following conditions hold:

1. $E(Y_t) = \mu < \infty$ (constant mean)

2. $Cov(Y_t, Y_{t-k}) = \gamma_k < \infty$

If k=0 we obtain γ_0 which is simply the variance of $Y = (\sigma^2)$ .The second condition implies that a stationary process has a constant variance.

A non- stationary process arises when one of the conditions for stationarity does not hold.

Testing for unit-roots means testing the hypothesis:

H_0 : ρ= 1 vs H_1:[ρ]< 1

In the following random walk model.

$Y_t = \rho Y_{t-1} + u_t$ where u_t is a white noise error term

We know that if ρ = 1, this is, in the case of the unit root.

A series Y_t integrated of order "d" it must be differenced at least "d" times in order to make it stationary.

If a time series is non-stationary we can study its behavior only for the time period under consideration. The set of time series data will therefore be for a particular episode. As a consequence it is not possible to generalize it to other time period. A non-stationarity series is characterized by a drift parameter that increase with time. The variance and covariance would also not be stable in time. We want to check if the drift is stochastic or deterministic. If the trend in time series is completely predictable and not variable we call it a deterministic trend, whereas if it is not predictable we call it a stochastic trend.

The unit root tests can be performed using two methods. The first method focus on the stochastic part of the drift through the test of Philips-Perron. The second one, which it is used in this paper, concerns the deterministic part, focusing on the existence of a unit root through Augmented Dickey-Fuller (1981) test. The ADF is a test for a unit root in a time series sample. It is an augmented version of the Dickey-Fuller test for a larger and more complicated set of time series models. The ADF statistic, used in the test, is a negative number. The more negative it is, the stronger the rejection of the hypothesis that there is a unit root at some level of confidence. The testing procedure for the ADF test is the same as for the Dickey-Fuller but it is applied to the model

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \cdots + \delta_{p-1} \Delta y_{t-p+1} + \varepsilon_t,$$

where α is a constant, β the coefficient on a time trend and *p* the lag order of the autoregressive process. Imposing the constraints α = 0 and β = 0 corresponds to modelling a random walk and using the constraint β = 0 corresponds to modelling a random walk with a drift.

By including lags of the order *p* the ADF formulation allows for higher-order autoregressive processes. This means that the lag length *p* has to be determined when applying the test. One possible approach is to test down from high orders and examine the t-values on coefficients. An alternative approach is to examine information criteria such as the Akaike information criterion, Bayesian information criterion or the Hannan-Quinn information criterion. In this dissertation the Akaike criterion is used.

The unit root test is then carried out under the null hypothesis $\gamma = 0$ against the alternative hypothesis of $\gamma < 0$. Once a value for the test statistic

$$DF_\tau = \frac{\hat{\gamma}}{SE(\hat{\gamma})}$$

is computed it can be compared to the relevant critical value for the Dickey–Fuller Test. If the test statistic is less (this test is non symmetrical so we do not consider an absolute value) than (a larger negative) the critical value, then the null hypothesis of $\gamma = 0$ is rejected and no unit root is present. (Margaronis, G.. 2011)

3.2 Vector Autoregression (VAR)

The number of optimal lags in a time series is chosen by using VAR model and more specially the Akaike information criterion. Vector autoregression (VAR) is an econometric model used to capture the evolution and the interdependencies between multiple time series, generalizing the univariate AR models. All the variables in a VAR are treated symmetrically by including for each variable an equation explaining its evolution based on its own lags and the lags of all the other variables in the model. Based on this feature, Christopher Sims advocates the use of VAR models as a theory-free method to estimate economic relationships, thus being an alternative to the "incredible identification restrictions" in structural model.

A VAR model describes the evolution of a set of k variables (called endogenous variables) over the same sample period (t = 1, ..., T) as alinear function of only their past evolution. The variables are collected in a k × 1 vector Y_t, which has as the ith element $Y_{i,t}$ the time t observation of variable Y_tFor example, if the ith variable is GDP, then $Y_{i,t}$ is the value of GDP at t.

A (reduced) p-th order VAR, denoted VAR(p), is

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + ... + A_p y_{t-p} + e_t$$

where c is a $k \times 1$ vector of constants (intercept), A_i is a $k \times k$ matrix (for every $i = 1, ..., p$) and e_t is a $k \times 1$ vector of error terms satisfying:

- $E(e_t) = 0$ every error term has mean zero
- $E(e_t e_t^{'}) = 0$ the contemporaneous covariance matrix of error terms is Ω (a $k \times k$ positive definite matrix)
- $E(e_t e_{t-k}^{'}) = 0$ for any non-zero k — there is no correlation across time; in particular, no serial correlation in individual error terms.

Note that all the variables used have to be of the same order of integration. We have so the following cases:

- All the variables are I(0) (stationary): one is in the standard case, i.e. a VAR in level
- All the variables are I(d) (non-stationary) with d>0:
  - The variables are cointegrated: the error correction term has to be included in the VAR. The model becomes a Vector error correction model (VECM) which can be seen as a restricted VAR.
  - The variables are not cointegrated: the variables have first to be differenced d times and one has a VAR in difference. (Margaronis, G.. 2011).

3.3 Johansen Cointegration Test

Johansen's methodology takes its starting point in the vector autoregression (VAR) of order p given by

$$y_t = \mu + A_1 y_{t-1} + ... + A_p y_{t-p} + \varepsilon_t \quad (1)$$

where, y_t is an nx1 vector of variables that are integrated of order one – commonly denoted I(1) - and ε_t is an nx1 vector of innovations. This VAR can be re-written as:

$$\Delta y_t = \mu + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \qquad (2)$$

where, $\Pi = \sum_{i=1}^{p} A_i - I$ και $\Gamma_i = -\sum_{j=i+1}^{p} A_j$

If the coefficient matrix Π has reduced rank *r*<*n*, then there exist *n*x*r* matrices α and β each with rank *r* such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is stationary. *r* is the number of cointegrating relationships, the elements of α are known as the adjustment parameters in the vector error correction model and each column of β is a cointegrating vector. It can be shown that for a given *r*, the maximum likelihood estimator of β defines the combination of y_{t-1} that yields the *r* largest canonical correlations of Δy_t with y_{t-1} after correcting for lagged differences and deterministic variables when present. Johansen proposes two different likelihood ratio tests of the significance of these canonical correlations and thereby the reduced rank of the Π matrix: the trace test and maximum eigenvalue test, shown in equations (3) and (4) respectively.

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1-\hat{\lambda}_i) \qquad (3)$$

$$J_{\max} = -T \ln(1-\hat{\lambda}_{r+1}) \qquad (4)$$

Here *T* is the sample size and $\hat{\lambda}_i$ is the i largest canonical correlation. The trace test tests the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of *n* cointegrating vectors. The maximum eigenvalue test, on the other hand, tests the null hypothesis of *r* cointegrating vectors against the alternative hypothesis of *r* + 1 cointegrating vectors. Neither of these test statistics follows a chi square distribution in general; asymptotic critical values can be found in Johansen and Juselius (1990) and are also given by most econometric software packages. Since the critical values used for the maximum eigenvalue and trace test statistics are based on a pure unit-root assumption, they will no longer be correct when the variables in the system are near-unit-root processes. Thus, the real question is *how* sensitive Johansen's procedures are to deviations from the pure-unit root assumption.

Although Johansen's methodology is typically used in a setting where all variables in the system are I(1), having stationary variables in the system is theoretically not an issue and Johansen (1995) states that there is little need to pre-test the variables in the system to establish their order of integration. If a single variable is I(0) instead of I(1), this will reveal itself through a cointegrating vector whose space is spanned by the only stationary variable in the model. For instance, if the system in equation (2) describes a model in which where $t\ y$ 1, is I(1) and $t\ y$ 2, is I(0), one should expect to find that there is one cointegrating vector in the system which is given by $\boldsymbol{\beta} = (0\ 1)'$. In the case where $\boldsymbol{\Pi}$ has full rank, all n variables in the system are stationary.

The fact that stationary variables in a system will introduce restricted cointegrating vectors is something that should be kept in mind in empirical work. That is, it is good econometric practice to always include tests on the cointegrating vectors to establish whether relevant restrictions are rejected or not. If such restrictions are not tested, a non-zero cointegrating rank might mistakenly be taken as evidence in favour of cointegration between variables. This is particularly relevant when there are strong prior opinions regarding which variables "have to" be in the cointegrating relationship. An obvious example is the literature on real exchange rates, where cointegration techniques are very common. After finding support for a cointegrating vector in a system, it is almost always the case that the coefficient on the real exchange rate is normalized to one, thereby forcing it to be part of the cointegrating relationship. However, tests of whether all other coefficients in the cointegrating vector are zero are rarely performed. Even rarer are tests of whether the only cointegrating vector is due to the stationarity of some other variable in the system, despite the fact that the proposed determinants of real exchange rates in many cases can be argued to be stationary. The lack of need to *a priori* distinguish between I(1) and I(0) variables is based on the assumption that any variable that is not I(1), or a pure unit-root process, is a stationary I(0) process. This apparent flexibility, therefore, does not make the method robust to nearintegrated variables, since they fall into neither of these two classifications. However, the above specification tests of the cointegrating vector suggest a way of making inference more robust in the potential presence of near-unit-root variables. For instance, considering the bivariate case described above, explicitly testing whether $\beta = (0\ 1)'$ will help to rule out spurious relationships that are not rejected by the initial maximum eigenvalue or trace test. Although we argue that such specification tests should be performed in almost every kind of application, they are likely to be extra useful in cases where the variables are likely to have near-unit-roots and the initial test of cointegration rank is biased. (Hjalmarsson, E., Österholm P., 2007)

3.4 Granger Causality Testing

Regression analysis deals with the dependence of one variable on other variables, it does not necessarily imply causation, but in regressions involving times series data and the situation may be somewhat different. Granger causality is a technique for determining whether one time series is useful in forecasting another. Testing Granger causality involves using F –tests to test whether lagged information on a variable Y provides any statistically significant information about a variable X in the presence of lagged X. If variable X (Granger) causes variable Y, then changes in X should precede changes in Y. Therefore in a regression of Y on other variables (including its own past value) if we include past or lagged value of X and its significantly improves the prediction of Y , then we can say that X (Granger) causes Y. A similar definition applies if Y (Granger) causes X. It is important to note that the statement "Y Granger causes X" does not imply that X is the effect or the result of Y.

In order to test for Granger causality across two variables X*t* and Y*t* we run bivariate regressions with a lag length set as k. These are called unrestricted regressions:

$$X_t = c_1 + \sum_{i=1}^{p} a_{1i} \Delta X_{t-i} + \sum_{i=1}^{p} \beta_{1i} Y_{t-i} + \varepsilon_{1t}$$

$$Y_t = c_1 + \sum_{i=1}^{p} a_{2i} X_t + \sum_{i=1}^{p} \beta_{2i} Y_{t-i} + \varepsilon_{2t}$$

γ_0

$Y = (\sigma^2)$

H_1

For the first equation the Granger Causality is examined by testing the null hypothesis where $E(Y_t) = \mu <$ $Cov(Y_t, Y_{t-k}) = \gamma_k$ $Y_t = \rho Y_{t-1} + u_t$ does not Granger Causality X_t if all $\beta_{1i} = 0 \ (i = 1, 2, 3 \ldots\ldots\ldots p)$ and for the second equation the Granger Causality is examined by testing the null hypothesis where X_t does not Granger Causality Y_t if all $a_{1i} = 0 \ (i = 1, 2, 3 \ldots\ldots\ldots p)$

That is we perform a Wald test with Walds statistics:

$$W = \frac{(SSR_R - SSR_{UR})}{SSR_{UR} / (n - 2k - 1)}$$

is asymptotically distributed as χ^2 under Ho

If we assume that errors ε_{1t} are independent and identically normally distributed we have an exact finite sample F-statistic:

$$F = \frac{W}{q} = \frac{(SSR_R - SSR_{UR}) / k}{SSR_{UR} / (n - 2k - 1)}$$

Where SSR_{UR} is the residual sum of squares of the unrestricted regression above, SSR_R is the residual sum of square of the restricted regression which is the regression without the lags of Y*t*.

If the ADF unit root tests have verified that the series on levels are non stationary and the first differences are stationary (first integrated) then the Granger causality tests are performed across the first differences of the series.

$$\Delta X_t = c_i + \sum_{i=1}^{p} a_{1i} \Delta X_{t-i} + \sum_{i=1}^{p} \beta_{1i} \Delta Y_{t-i} + \varepsilon_{1t}$$

(Margaronis, G.. 2011).

CHAPTER 4

DATA ANALYSIS

The data used in this thesis are quarterly basis data of the oil prices and of real GDP growth rates. The sample countries are the G7, each of them is examined separately in terms of the relation between oil prices and economic growth. The period of examination spans from the first quarter of 1990 to fourth quarter of 2007. The specific period is a rather lengthy period that includes significant hikes in oil prices, in particular the oil shock in the beginning of the 1990s due to Iraq invasion in Kuwait, the oil prices increases in the wake of Asian crisis in 1997-1998 and the 2003 crisis determined by Venezuela's political instability and the US attack in Iraq. This kind of lengthy and inclusive sample data allow us to draw reliable conclusions. Furthermore, the specific period have not been examined to an adequate level since on the targeted subject of analysis –the relation between oil prices and economic growth- there have been few papers and analyses conducted. The data concerning the oil prices, in particular Crude Oil-Brent Dated FOB US Dollars per barrel, have been retrieved and downloaded by the Thompson Datastream and the data that involve quarterly growth rates of real GDP, change over previous quarter have been acquired by the OECD StatExtracts databases available through its Library. The option for Brent Oil prices is justified by the fact that international literature mostly uses this index as the most reliable (along with WTI) medium of analysis. Moreover, the specific index for oil is deflated and measure oil prices in real terms and thus, it avoids the undesirable property resulting from nominal oil price definitions. The same applies for GDP index which is also deflated and in real terms.

CHAPTER 5

EMPIRICAL RESULTS

5.1 G7 Countries

Unit root test ADF for Oil

			t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic			-4.386483	0.0008
Test critical values:	1% level		-3.534868	
	5% level		-2.906923	
	10% level		-2.591006	
*MacKinnon (1996) one-sided p-values.				
Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(R_OIL)				
Method: Least Squares				
Date: 02/21/11 Time: 15:34				
Sample (adjusted): 8 72				
Included observations: 65 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R_OIL(-1)	-1.356018	0.309136	-4.386483	0.0000
D(R_OIL(-1))	0.150486	0.279431	0.538543	0.5923
D(R_OIL(-2))	0.146658	0.253829	0.577783	0.5656
D(R_OIL(-3))	0.350374	0.211176	1.659154	0.1025
D(R_OIL(-4))	0.418199	0.156174	2.677780	0.0096
D(R_OIL(-5))	0.231108	0.100391	2.302074	0.0249
C	0.032102	0.018883	1.700015	0.0945
R-squared	0.663069	Mean dependent var		2.99E-05
Adjusted R-squared	0.628214	S.D. dependent var		0.239303
S.E. of regression	0.145913	Akaike info criterion		-0.910174
Sum squared resid	1.234853	Schwarz criterion		-0.676009
Log likelihood	36.58065	Hannan-Quinn criter.		-0.817781
F-statistic	19.02371	Durbin-Watson stat		1.992652
Prob(F-statistic)	0.000000			

Total of G7 countries

According to the tables' analysis, we observe that in the ADF Unit Root test the oil prices are not stationary in the level. The first differences of oil prices are stationary and the growth rate of oil prices and GDP growth rate is stationary in the level, a logical conclusion since we deal with yields. Moreover, we use the stationary series in the sample VAR in order to find the appropriate time lags that will be used in the Johansen test and the Granger Causality, where necessary.

5.2 Germany

Unit root test ADF for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.831107	0.0000
Test critical values:	1% level	-3.534868	
	5% level	-2.906923	
	10% level	-2.591006	

***MacKinnon (1996) one-sided p-values.**

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP)
Method: Least Squares
Date: 02/21/11 Time: 15:47
Sample (adjusted): 3 67
Included observations: 65 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP(-1)	-0.967049	0.165843	-5.831107	0.0000
D(RGDP(-1))	0.029254	0.122220	0.239356	0.8116
C	0.390711	0.100972	3.869486	0.0003

R-squared	0.479489	Mean dependent var	0.012308
Adjusted R-squared	0.462699	S.D. dependent var	0.866382
S.E. of regression	0.635065	Akaike info criterion	1.974877
Sum squared resid	25.00510	Schwarz criterion	2.075234
Log likelihood	-61.18352	Hannan-Quinn criter.	2.014474
F-statistic	28.55689	Durbin-Watson stat	1.866204
Prob(F-statistic)	0.000000		

Akaike information criterion

Lag	AIC
0	0.963209
1	0.946780*
2	1.027607
3	1.110391
4	1.115862
5	1.212820
6	1.151140
7	1.270369
8	1.312179
9	1.441795
10	1.520413
11	1.547908
12	1.460690
13	1.525996
14	1.603042
15	1.381446

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.476277	44.24482	20.26184	0.0000
At most 1	0.023307	1.556482	9.164546	0.8632

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.476277	42.68833	15.89210	0.0000
At most 1	0.023307	1.556482	9.164546	0.8632

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

1 Cointegrating Equation(s): Log likelihood -32.53099

Normalized cointegrating coefficients (standard error in parentheses)

RGDP	LNOIL	C
1.000000	-0.174912	0.157633
	(0.17156)	(0.55543)

Error Correction Model

Cointegrating Eq:	CointEq1	
RGDP(-1)	1.000000	
LNOIL(-1)	-0.052812	
	(0.18981)	
	[-0.27823]	
C	-0.174646	
	(0.60847)	
	[-0.28703]	
Error Correction:	D(RGDP)	D(LNOIL)
CointEq1	-0.867798	0.041339
	(0.19666)	(0.05256)
	[-4.41264]	[0.78656]
D(RGDP(-1))	0.000418	-0.021552
	(0.15825)	(0.04229)
	[0.00264]	[-0.50960]
D(RGDP(-2))	0.008626	0.009501
	(0.11629)	(0.03108)
	[0.07418]	[0.30572]
D(LNOIL(-1))	1.244458	-0.149946
	(0.48131)	(0.12863)
	[2.58556]	[-1.16573]
D(LNOIL(-2))	0.140561	-0.104980
	(0.50626)	(0.13530)
	[0.27765]	[-0.77593]
R-squared	0.518593	0.038818
Adj. R-squared	0.485955	-0.026347
Sum sq. resids	21.07648	1.505290
S.E. equation	0.597686	0.159729
F-statistic	15.88935	0.595691
Log likelihood	-55.26885	29.18465
Akaike AIC	1.883402	-0.755770
Schwarz SC	2.052064	-0.587108
Mean dependent	-0.019688	0.020403
S.D. dependent	0.833628	0.157666
Determinant resid covariance (dof adj.)		0.008972
Determinant resid covariance		0.007625
Log likelihood		-25.58153
Akaike information criterion		1.205673

Schwarz criterion	1.644196

Wald test			
Test statistic	value	df	probability
Chi square	6,685170	2	0,0353

Wald test			
Test statistic	value	df	probability
Chi square	0,975456	2	0,6140

We observe cointegration between GDP and oil prices thus, we can use the Error Correction Model (VEC) in order to examine the short-term and long-term relation among prices. The optimal lags according to the Akaike Information Criterion, is one lag. According to the coefficients of the Johansen test, we observe the existence of a negative relation between GDP and oil prices. The GDP is influenced by the oil prices, since the influence percentage is in absolute prices bigger than 1,65, while in the contrary relationship it is less than 1,65. The analysis shows that there is long-term negative relation between GDP and oil prices, meaning the GDP is influenced by oil prices both in the short and long-term according to the Wald test, since the probability is less than 5% but GDP does not affect oil prices in the long run since the probability is bigger than 5%.

5.3 Canada

Unit root test ADF for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.733435	0.0055
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	
	10% level	-2.588902	
*MacKinnon (1996) one-sided p-values.			

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP)
Method: Least Squares
Date: 02/21/11 Time: 15:34
Sample (adjusted): 2 72
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP(-1)	-0.336533	0.090140	-3.733435	0.0004
C	0.218776	0.080112	2.730885	0.0080
R-squared	0.168059	Mean dependent var		-0.003099
Adjusted R-squared	0.156002	S.D. dependent var		0.492735
S.E. of regression	0.452672	Akaike info criterion		1.280468
Sum squared resid	14.13894	Schwarz criterion		1.344205
Log likelihood	-43.45662	Hannan-Quinn criter.		1.305814
F-statistic	13.93854	Durbin-Watson stat		1.880014
Prob(F-statistic)	0.000385			

Akaike information criterion

Lag	AIC
0	0.640994
1	0.313679
2	0.430555
3	0.494535
4	0.464964
5	0.569628
6	0.415789
7	0.278549*
8	0.385159
9	0.507402
10	0.606302
11	0.670435
12	0.572315
13	0.582642
14	0.624718
15	0.718442

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.123217	15.54480	20.26184	0.1968
At most 1	0.105412	7.129099	9.164546	0.1197
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.123217	8.415697	15.89210	0.4989
At most 1	0.105412	7.129099	9.164546	0.1197

Max-eigenvalue test indicates no cointegration at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

1 Cointegrating Equation(s):	Log likelihood	18.36298	

Normalized cointegrating coefficients (standard error in parentheses)

RGDP	LNOIL	C
1.000000	0.248254	-1.523966
	(0.32594)	(1.01424)

Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LNOIL does not Granger Cause RGDP	65	0.81314	0.5807
RGDP does not Granger Cause LNOIL		1.99758	0.0740

According to the coefficients, we observe positive relation but there is no sign of cointegration between oil prices and GDP, since the probabilities both in the Unrestricted Cointegration Test and in the Maximum Eigenvalue are bigger than 5% and thus, we cannot use VEC. Instead, we use Granger Causality test. The optimal lags according to the Akaike Information Criterion, are seven lags. According to the Granger Causality test we assume that oil prices in a level of significance of 10% does not affect GDP but the contrary is valid, meaning that the GDP affects oil prices.

5.4 The United kingdom

Unit root test ADF for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.411034	0.0006
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	
	10% level	-2.588902	

***MacKinnon (1996) one-sided p-values.**

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(RGDP)				
Method: Least Squares				
Date: 02/21/11 Time: 16:14				
Sample (adjusted): 2 72				
Included observations: 71 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP(-1)	-0.442133	0.100233	-4.411034	0.0000
C	0.265068	0.076576	3.461497	0.0009

R-squared	0.219962	Mean dependent var	-0.007746
Adjusted R-squared	0.208657	S.D. dependent var	0.427685
S.E. of regression	0.380458	Akaike info criterion	0.932883
Sum squared resid	9.987638	Schwarz criterion	0.996621
Log likelihood	-31.11736	Hannan-Quinn criter.	0.958230
F-statistic	19.45722	Durbin-Watson stat	2.116158
Prob(F-statistic)	0.000037		

Akaike information criterion

Lag	AIC
0	-0.347608
1	-0.385714*
2	-0.190972
3	-0.103279
4	-0.002325
5	0.086911
6	0.001846
7	0.020189
8	-0.032040
9	0.084531
10	0.123246
11	0.172484
12	-0.012551

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.230189	20.02076	20.26184	0.0539
At most 1	0.020166	1.446420	9.164546	0.8829

Trace test indicates no cointegration at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.230189	18.57434	15.89210	0.0185
At most 1	0.020166	1.446420	9.164546	0.8829

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

1 Cointegrating Equation(s):	Log likelihood	-16.03284

Normalized cointegrating coefficients (standard error in parentheses)

RGDP	LNOIL	C
1.000000	0.124818	-1.017060
	(0.20708)	(0.66917)

Error Correction Model

Cointegrating Eq:	CointEq1	
RGDP(-1)	1.000000	
LNOIL(-1)	0.237079	
	(0.25202)	
	[0.94073]	
C	-1.412979	
	(0.80779)	
	[-1.74919]	
Error Correction:	D(RGDP)	D(LNOIL)
CointEq1	-0.334728	0.040726
	(0.09838)	(0.05658)
	[-3.40249]	[0.71974]
D(RGDP(-1))	-0.221236	-0.198727
	(0.11143)	(0.06409)
	[-1.98537]	[-3.10054]
D(RGDP(-2))	-0.104496	-0.057059
	(0.10710)	(0.06160)
	[-0.97569]	[-0.92626]
D(LNOIL(-1))	0.178015	-0.229212
	(0.20720)	(0.11918)
	[0.85915]	[-1.92330]
D(LNOIL(-2))	-0.093884	-0.251828
	(0.19310)	(0.11107)

	[-0.48620]	[-2.26739]
R-squared	0.365763	0.247142
Adj. R-squared	0.326123	0.200088
Sum sq. resids	6.170231	2.041317
S.E. equation	0.310499	0.178593
F-statistic	9.227147	5.252351
Log likelihood	-14.61099	23.55088
Akaike AIC	0.568434	-0.537707
Schwarz SC	0.730326	-0.375815
Mean dependent	0.021304	0.023463
S.D. dependent	0.378243	0.199684
Determinant resid covariance (dof adj.)		0.003037
Determinant resid covariance		0.002613
Log likelihood		9.367093
Akaike information criterion		0.105302
Schwarz criterion		0.526220

Wald test			
Test statistic	value	df	probability
Chi square	1,121183	2	0,5709

Wald test			
Test statistic	value	df	probability
Chi square	9,847141	2	0,0073

We witness cointegration between GDP and oil prices thus, we can use the Error Correction Model (VEC) in order to examine the short-term and long-term relation among prices. The optimal lags according to the Akaike Information Criterion, is one lag. According to the coefficients there is positive relation. We observe that GDP is influenced by oil price fluctuations in the long run, since in absolute prices the percentage is bigger than 1,65 while in the contrary relation it is less than 1,65. In the short-term the oil prices does not influence GDP since the probability is bigger than 5%. In the short-term the GDP influences oil prices since the probability is less than 5% according to Wald test for both cases. Hence, there is adverse relationship in the short-term compared to the long term.

5.5 France

Unit root test ADF for GDP

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.535989	0.0098

Test critical values:	1% level	-3.527045
	5% level	-2.903566
	10% level	-2.589227
***MacKinnon (1996) one-sided p-values.**		

Akaike information criterion

Lag	AIC
0	0.259795
1	0.189357
2	0.167159*
3	0.255560
4	0.311901
5	0.399414

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.563579	68,55266	20.26184	0.0000
At most 1	0.151572	11.34151	9.164546	0.825

Trace test indicates no cointegration at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.563579	57,21115	15.89210	0.0000
At most 1	0.151572	11,34151	9.164546	0.7903

Max-eigenvalue test indicates no cointegration at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

1 Cointegrating Equation(s):	Log likelihood	-14,40506

Normalized cointegrating coefficients (standard error in parentheses)

RGDP	LNOIL	C
1.000000	-16,59185	-0.116249
	(1,80884)	(0.23281)

Error Correction Model

Cointegrating Eq:	CointEq1	
RGDP(-1)	1.000000	
LNOIL(-1)	0.107484	
	(0.21251)	
	[0.50579]	
C	-0.743176	
	(0.68129)	
	[-1.09083]	
Error Correction:	D(RGDP)	D(LNOIL)
CointEq1	-0.454924	0.119772
	(0.13939)	(0.06821)
	[-3.26376]	[1.75582]
D(RGDP(-1))	-0.210233	-0.067303
	(0.14925)	(0.07304)
	[-1.40856]	[-0.92141]
D(RGDP(-2))	0.010730	-0.033286
	(0.12358)	(0.06048)
	[0.08683]	[-0.55039]
D(LNOIL(-1))	0.258927	-0.267066
	(0.24292)	(0.11888)
	[1.06588]	[-2.24646]
D(LNOIL(-2))	0.197041	-0.341903
	(0.24070)	(0.11780)
	[0.81860]	[-2.90247]
R-squared	0.337779	0.158849
Adj. R-squared	0.296390	0.106277
Sum sq. resids	9.522819	2.280718
S.E. equation	0.385738	0.188776
F-statistic	8.161107	3.021546
Log likelihood	-29.58242	19.72500
Akaike AIC	1.002389	-0.426812
Schwarz SC	1.164281	-0.264920
Mean dependent	-0.005362	0.023463
S.D. dependent	0.459861	0.199684
Determinant resid covariance (dof adj.)		0.005240
Determinant resid covariance		0.004508
Log likelihood		-9.446896
Akaike information criterion		0.650635
Schwarz criterion		1.071553

Wald test			
Test statistic	value	df	probability
Chi square	1,539584	2	0,4631

Wald test			
Test statistic	value	df	probability
Chi square	0,849555	2	0,6539

We observe cointegration between GDP and oil prices thus, we can use the Error Correction Model (VEC) in order to examine the short-term and long-term relation among prices. The optimal lags according to the Akaike Information Criterion, are two lags. There is negative bidirectional relation according to the Johansen test's coefficients since the percentages in absolute prices are bigger than 1,65. However, there is no short-term relation between the two variables, since both the two probabilities that examine this relation is above 5% according to the Wald test.

5.6 Italy

Unit root test ADF for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.450655	0.0000
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	
	10% level	-2.588902	

***MacKinnon (1996) one-sided p-values.**

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP)
Method: Least Squares
Date: 02/21/11 Time: 16:25
Sample (adjusted): 2 72
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP(-1)	-0.619591	0.113673	-5.450655	0.0000
C	0.201850	0.066932	3.015747	0.0036

R-squared	0.300980	Mean dependent var	-0.011690
Adjusted R-squared	0.290849	S.D. dependent var	0.543010
S.E. of regression	0.457275	Akaike info criterion	1.300700
Sum squared resid	14.42791	Schwarz criterion	1.364437
Log likelihood	-44.17484	Hannan-Quinn criter.	1.326046
F-statistic	29.70964	Durbin-Watson stat	2.042209
Prob(F-statistic)	0.000001		

Akaike information criterion

Lag	AIC
0	0.573740
1	0.4442411
2	0.424672*
3	0.616626
4	0.630485
5	0.694694
6	0.635873
7	0.666454
8	0.730684
9	0.814517
10	0.780394

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.558967	69.67838	20.26184	0.0000
At most 1 *	0.174029	13.19251	9.164546	0.6703

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.558967	56.48587	15.89210	0.0000
At most 1 *	0.174029	13.19251	9.164546	0.6745

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

1 Cointegrating Equation(s):	Log likelihood	-26.13872

Normalized cointegrating coefficients (standard error in parentheses)		
RGDP	R_LNOIL	C
1.000000	-19.51008	0.083701
	(2.18059)	(0.27926)
Adjustment coefficients (standard error in parentheses)		

Error Correction Model

Cointegrating Eq:	CointEq1	
RGDP(-1)	1.000000	
R_LNOIL(-1)	-9.377359	
	(1.67393)	
	[-5.60201]	
C	-0.216312	
	(0.14610)	
	[-1.48056]	
Error Correction:	D(RGDP)	D(R_LNOIL)
CointEq1	-0.179018	0.124652
	(0.06736)	(0.02342)
	[-2.65779]	[5.32157]
D(RGDP(-1))	-0.289024	-0.070484
	(0.12625)	(0.04391)
	[-2.28924]	[-1.60532]
D(RGDP(-2))	-0.010111	-0.038314
	(0.12202)	(0.04243)
	[-0.08286]	[-0.90290]
D(R_LNOIL(-1))	-0.728436	0.064799
	(0.47951)	(0.16676)
	[-1.51913]	[0.38859]
D(R_LNOIL(-2))	-0.209799	-0.147125
	(0.31650)	(0.11007)
	[-0.66288]	[-1.33670]
R-squared	0.294296	0.685656
Adj. R-squared	0.249489	0.665698
Sum sq. resids	14.08831	1.703831
S.E. equation	0.472889	0.164453
F-statistic	6.568139	34.35432
Log likelihood	-42.96631	28.85755
Akaike AIC	1.410774	-0.701693
Schwarz SC	1.573973	-0.538494
Mean dependent	0.003235	-0.012136
S.D. dependent	0.545859	0.284429

Determinant resid covariance (dof adj.)	0.006047
Determinant resid covariance	0.005191
Log likelihood	-14.10444
Akaike information criterion	0.797189
Schwarz criterion	1.221507

Wald test			
Test statistic	value	df	probability
Chi square	2,947398	2	0,2291

Wald test			
Test statistic	value	df	probability
Chi square	0,686948	2	0,2609

According to the tables analysis, there is cointegration between oil prices and GDP and thus, we can use VEC model to examine the long-term and short-term relation of prices. The optimal lags according to the Akaike Information Criterion, are two lags. According to the coefficients form the Johansen test, we observe negative long-term bidirectional relation, since the percentages are bigger in absolute prices than 1,65 in both cases. However, there is no short-term relation between the two variables, since both the two probabilities that examine this relation is above 5% according to the Wald test.

5.7 Japan

Unit root test ADF for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.708972	0.0000
Test critical values:	1% level	-3.525618	
	5% level	-2.902953	
	10% level	-2.588902	

***MacKinnon (1996) one-sided p-values.**

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP)
Method: Least Squares
Date: 02/21/11 Time: 16:03
Sample (adjusted): 2 72
Included observations: 71 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

RGDP(-1)	-0.918312	0.119123	-7.708972	0.0000
C	0.343956	0.102247	3.363985	0.0013

R-squared	0.462735	Mean dependent var	0.016338
Adjusted R-squared	0.454949	S.D. dependent var	1.061389
S.E. of regression	0.783598	Akaike info criterion	2.377923
Sum squared resid	42.36778	Schwarz criterion	2.441661
Log likelihood	-82.41628	Hannan-Quinn criter.	2.403270
F-statistic	59.42824	Durbin-Watson stat	1.677203
Prob(F-statistic)	0.000000		

Akaike information criterion

Lag	AIC
0	1.417998
1	1.395094*
2	1.452821
3	1.468685
4	1.504873
5	1.571400
6	1.410348
7	1.516246
8	1.538500
9	1.668930
10	1.756941
11	1.843039
12	1.855292
13	1.677820
14	1.719298
15	1.761243

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.475648	47.33215	20.26184	0.0000
At most 1	0.020837	1.495047	9.164546	0.8743

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.475648	45.83710	15.89210	0.0000

At most 1	0.020837	1.495047	9.164546	0.8743

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
*** denotes rejection of the hypothesis at the 0.05 level**
****MacKinnon-Haug-Michelis (1999) p-values**

1 Cointegrating Equation(s):	Log likelihood	-67.35961	

Normalized cointegrating coefficients (standard error in parentheses)

RGDP	LNOIL	C
1.000000	-0.233787	0.384669
	(0.20420)	(0.65989)

Error Correction Model

Cointegrating Eq:	**CointEq1**	
RGDP(-1)	1.000000	
LNOIL(-1)	-0.155457	
	(0.16184)	
	[-0.96056]	
C	0.262253	
	(0.51876)	
	[0.50554]	
Error Correction:	D(RGDP)	D(LNOIL)
CointEq1	-0.879160	0.133431
	(0.19076)	(0.04953)
	[-4.60876]	[2.69394]
D(RGDP(-1))	-0.050694	-0.086587
	(0.14927)	(0.03876)
	[-0.33961]	[-2.23404]
D(RGDP(-2))	-0.134662	-0.011496
	(0.11270)	(0.02926)
	[-1.19491]	[-0.39288]
D(LNOIL(-1))	0.195051	-0.287611
	(0.44072)	(0.11443)
	[0.44258]	[-2.51340]
D(LNOIL(-2))	0.601948	-0.335535
	(0.42387)	(0.11006)
	[1.42014]	[-3.04877]
R-squared	0.524909	0.249598
Adj. R-squared	0.495216	0.202698
Sum sq. resids	30.18010	2.034658
S.E. equation	0.686705	0.178302

F-statistic	17.67777	5.321900
Log likelihood	-69.37789	23.66360
Akaike AIC	2.155881	-0.540974
Schwarz SC	2.317773	-0.379082
Mean dependent	-0.014493	0.023463
S.D. dependent	0.966535	0.199684
Determinant resid covariance (dof adj.)		0.014070
Determinant resid covariance		0.012104
Log likelihood		-43.52397
Akaike information criterion		1.638376
Schwarz criterion		2.059295

Wald test			
Test statistic	value	df	probability
Chi square	2,035925	2	0,3613

Wald test			
Test statistic	value	df	probability
Chi square	7,630979	2	0,0220

In the case of Japan, we observe existence of cointegration and thus, we can use the VEC model to examine the long-term and short-term relation of prices. The optimal lags according to the Akaike Information Criterion, is one lag. According to the coefficients of Johansen test, we observe a negative bidirectional relation between oil prices and GDP, since we observe from the Error Correction model (VEC) that both the two variables is statistically significant, with the GDP influenced more by the oil prices than the oil prices influence GDP in the long-term since in both cases the percentages in absolute prices are above 1,65. Moreover, in the short-term the oil prices does not influence the GDP since the probability is above 5%. But the GDP influences oil prices in the short-term since the probability is less than 5%.

5.8 The USA

Unit root test ADF for GDP

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.806059	0.0045
Test critical values:	1% level	-3.527045	
	5% level	-2.903566	
	10% level	-2.589227	
***MacKinnon (1996) one-sided p-values.**			

Augmented Dickey-Fuller Test Equation				
Dependent Variable: D(R_GDP)				
Method: Least Squares				
Date: 02/21/11 Time: 14:58				
Sample (adjusted): 3 72				
Included observations: 70 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
R_GDP(-1)	-0.544679	0.143108	-3.806059	0.0003
D(R_GDP(-1))	-0.261457	0.117127	-2.232257	0.0289
C	0.395804	0.119885	3.301515	0.0015
R-squared	0.414561	Mean dependent var		0.004571
Adjusted R-squared	0.397085	S.D. dependent var		0.647183
S.E. of regression	0.502522	Akaike info criterion		1.503556
Sum squared resid	16.91938	Schwarz criterion		1.599920
Log likelihood	-49.62445	Hannan-Quinn criter.		1.541833
F-statistic	23.72203	Durbin-Watson stat		1.935174
Prob(F-statistic)	0.000000			

Akaike information criterion

Lag	AIC
0	0.771991
1	0.756486*
2	0.760827
3	0.842896
4	0.933465
5	0.942879
6	0.852536
7	0.909676
8	0.949173
9	1.032060
10	1.128054
11	1.142669
12	1.045594
13	1.092935
14	1.153239
15	1.110556

Johansen Approach

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.387040	36.10147	20.26184	0.0002
At most 1	0.018835	1.350071	9.164546	0.8994
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				

* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.387040	34.75140	15.89210	0.0000
At most 1	0.018835	1.350071	9.164546	0.8994

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

1 Cointegrating Equation(s):	Log likelihood	-35.29261

Normalized cointegrating coefficients (standard error in parentheses)

R_GDP	LN_OIL	C
1.000000	0.202542	-1.367953
	(0.16113)	(0.52070)

Error Correction Model

Cointegrating Eq:	CointEq1	
R_GDP(-1)	1.000000	
LN_OIL(-1)	0.302503	
	(0.19354)	
	[1.56297]	
C	-1.670956	
	(0.62031)	
	[-2.69372]	
Error Correction:	D(R_GDP)	D(LN_OIL)
CointEq1	-0.671477	0.115447
	(0.16071)	(0.06248)
	[-4.17810]	[1.84781]
D(R_GDP(-1))	-0.136051	-0.085674
	(0.16025)	(0.06230)
	[-0.84900]	[-1.37525]
D(R_GDP(-2))	0.184757	-0.030675
	(0.12547)	(0.04878)
	[1.47251]	[-0.62888]
D(LN_OIL(-1))	0.030947	-0.295103
	(0.32239)	(0.12533)

	[0.09599]	[-2.35458]
D(LN_OIL(-2))	0.582637	-0.328967
	(0.31133)	(0.12103)
	[1.87143]	[-2.71803]
R-squared	0.477851	0.163734
Adj. R-squared	0.445216	0.111468
Sum sq. resids	15.00359	2.267471
S.E. equation	0.484181	0.188227
F-statistic	14.64258	3.132675
Log likelihood	-45.26606	19.92597
Akaike AIC	1.456987	-0.432637
Schwarz SC	1.618879	-0.270745
Mean dependent	0.010435	0.023463
S.D. dependent	0.650048	0.199684
Determinant resid covariance (dof adj.)		0.007731
Determinant resid covariance		0.006651
Log likelihood		-22.86719
Akaike information criterion		1.039629
Schwarz criterion		1.460547

Wald test			
Test statistic	value	df	probability
Chi square	3,625884	2	0,1632

Wald test			
Test statistic	value	df	probability
Chi square	2,047209	2	0,3593

In the case of the USA, we observe cointegration and hence, we can use the VEC model to examine the long-term and short-term relation of prices. The optimal lags according to the Akaike Information Criterion, is one lag. According to the coefficients of Johansen test, we observe a positive bidirectional relation between oil prices and GDP in the long run since in both cases the percentages in absolute prices are above 1,65. In the short term the one variable does not influence the other, since the probabilities in both case are above 5% according to Wald test.

CHAPTER 6

CONCLUSIONS

According to the empirical results written down in the previous section, we draw the following conclusions. The results mainly suggest the existence of a relation- albeit different but with some common characteristics across the G7 countries. In all countries except for Canada, there is cointegration between oil prices and GDP in the long-term. In all countries except for Canada there is bidirectional relation in the long-term. In Germany, France, Italy and Japan the relation between oil prices and GDP is negative. In Germany the relation is unidirectional in the short-term where the oil prices affect the GDP. In the UK and in Japan there is unidirectional relation in the short-term where the GDP affects oil prices. In Canada, the UK and in the USA the relation is shown positive. In the case of Canada there is unidirectional relation where the GDP influences oil prices.

More specifically, in the case of Germany, the relation between oil prices and economic growth is bidirectional and negative in the long-term. And in the short-term only the oil prices affect the GDP. This can be justified by the fact that Germany is a highly industrialized country which is a net importer of oil. The oil guzzling Germany demands and imports big amounts of crude oil to feed its enormous industry appetite for oil.

In the case of Canada, the relation between the oil prices and the economic growth is unidirectional and positive since the GDP affect oil prices and the oil prices do not affect the GDP. This can be justified by the fact that Canada is an oil exporting country and higher oil prices can affect positively the growth of Canada GDP.

In the case of the United Kingdom there is long-term bidirectional positive relation between oil prices and growth since the oil affects the GDP in the long run but non in the short run. The GDP affects the oil prices in the short term. This can be justified by the fact that UK is an oil exporting country, the largest net exporter of oil in the European Union, although compared to Canada its oil resources are not so large and moreover it controls other countries oil resources and that is why in the long run the oil prices affect the GDP.

In the case of Japan, there is a negative bidirectional relation between oil prices and GDP. In the short term the oil prices do not influence the GDP but the GDP influences oil prices in the short term.

In Italy, there is long run negative bidirectional relation but there is no short-term relation between the two variables.

In the case of France, there is negative bidirectional relation in the long-term but there is no short-term relation between the two variables.

In the case of USA -which is the third largest crude oil producer but about half of the petroleum it uses it is imported-, we observe a positive bidirectional relation between oil prices and GDP in the long run. This empirical result agrees with recent literature (Balke S., Broewn, S. and Yucel, M., 2010) and can be explained by the fact of the reducing energy intensity of the US economy, the more stable aggregate demand, the greater flexibility of the US economy –labor and financial markets included, better monetary policies and previous experience with energy price shocks. The effect of oil price shocks on US economic activity seems to have changed since the mid 1990's because of the aforementioned co-determinants which have moderated the relationship between oil prices shocks and economic activity. In the USA from the second half of the 20th century, natural gas experienced rapid development and coal began to expand again and in the late 20th century, forms of energy-hydroelectric power and nuclear electric power were developed and supplied significant amounts of energy. Petroleum usage grew slowly to its peak in 1972 and then subsided. In general, the USA was mostly self-sufficient in energy (US Energy Information Administration). Furthermore, the oil prices are best understood as endogenous. Moreover, it agrees with Kilian (2007) arguing that rise in oil prices since the mid 1990s have had lesser effect on economic activity because the rise ensues from an increase in global oil demand and Elekdag and Laxton (2007) from productivity gains which boost economic growth which in turn pushes oil prices upwards. According to Balke S., Broewn, S. and Yucel, M. (2010) strong economic growth and rising oil demand is found in China, India, Europe and the United States has put tremendous upward pressure on oil prices and the effects on economic activity and growth can be different from those during the 1980s and the 1970s where the relation was negative, since from the mid 1990's the oil prices are being driven by forces other than supply shocks.

Finally, according to Lee, C. and Chiu, Y. (2010), already mentioned in the literature review**,** the US and Canada there is the substitute relationship between nuclear energy and oil and this is also in a small part explaining the positive relationship in these two countries.

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