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# Oil Price Shocks and Stock Market Returns:

*Evidence from 11 member countries of Organization of Economic Cooperation and Development (OECD)*

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# ABSTRACT

**Title:** Oil Price Shocks and Stock Market Returns: *Evidence from 11 member countries of Organization of Economic Cooperation and Development (OECD)*

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**Key words:** Oil Price Shock, Unit Root, Cointegration, Vector Autoregressive model, Granger Causality, Variance Decomposition, Impulse Response

**Purpose:** The primary purpose of this study is to evaluate the size of impact that oil price shocks have on the stock market returns. The secondary purpose is to investigate which factors have greater influence on stock market returns in recent conditions in comparison to oil price shocks and to explore systematic effect across several countries.

**Methodology:** This study is carried out by applying unrestricted Vector Autoregressive model with Block significance / Granger causality test, Impulse response and Variance decomposition to structure the results and facilitate interpretation.

**Theoretical perspective:** Theoretical framework mainly involves previous studies in the area of oil price movements' influence on stock market return and theories that support the interactions of such factors as oil price movements, short term interest rate, exchange rate, inflation and industrial production.

**Results:** Oil price shocks have negative impacts on all the countries except for Norway (in the sample period 1986-2010 and 1986-2008) and Canada (1986-2010). For the sample period 1986-2010, interest rate shocks have more impact on the real stock returns of most of the countries. But for 1986-2008, oil prices have more significant impact on the real stock returns compared to the interest rate shocks for most of the countries.

**Conclusions:** Oil price shocks have negative impacts on real stock market returns depending on whether the country is a net oil exporting or an importing one. When the economy is in a more stable condition, oil price shocks contribute towards greater variability in real stock returns compared to interest rate shocks.

# ACKNOWLEDGEMENTS

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Kamrul Huda Talukdar
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*Chapter 1*

# Introduction

This initial chapter represents the background, the description, the importance of consideration and the argument of the problem which were chosen for this study

## 1.1 Background

In the recent past, newspaper headlines such as *'Stock Market Slumps As Oil Prices, Japan Recovery Scare Investors'*[1] or *'US Stocks Rally as Oil Prices Fall'*[2] has brought attention to many local and global investors. Since oil price has influence on an economy, it is expected that it also has an influence on the stock market returns. Due to the dynamic movements in the price of oil, a lot of researchers have found it interesting to analyze the dynamic relationships between the oil price shocks[3] and the major macroeconomic variables. But, only a few studies were conducted to observe how oil price could affect the stock market and other financial markets. Among the few researches that were recently conducted, it was evident that stock market returns are influenced by oil price movements. However, oil price is not the only factor in determining the stock market returns. Other factors that could affect the stock returns are interest rates, exchange rates, inflation rates, and industrial production. The following paragraphs discuss how these variables along with oil price could affect the stock prices.

For instance, interest rates can affect stock market returns negatively due to direct or indirect reasons. Through the monetary policy[4], the central banks often use the interest rate as a tool to control inflation. Higher interest rates are expected to control the inflation, by making borrowing costlier and thus restricting the availability of money to spend. But at the same time, higher interest rates mean higher costs for the companies. In his work, Sadorsky (1999)

[1] (Steele 2011)
[2] (Lemer 2008)
[3] Details of oil price shocks are discussed in the later part of the paper
[4] Details of the monetary policy tools are available on the Federal Reserve System's website http://www.federalreserve.gov/monetarypolicy/default.htm

argued that interest rates affect stock prices for three reasons. Firstly, changes in interest rates are changes in the cost incurred for raising debt capital which is a major influence on the level of corporate earnings. This affects the price investors are willing to pay for the stocks. Secondly, movements in interest rates influence the relationship between competing financial assets. Thirdly, some stocks are purchased on margin. Changes in the cost of carrying margin debt influence the desire and/or ability of investors to speculate. As a result, increases in interest rates dampen stock returns. (Sadorsky 1999)

The majority of the companies consume oil as the energy in production and manufacturing of goods and services. If the oil price increases, the production costs for the oil dependent companies should also increase[5]. Thus, the tendency of the oil price increase may affect the investors' decision to invest in a particular company, leading to a fall in the demand for that particular stock. If the demand for stocks goes down, the price of the stocks go down accordingly, thus resulting in a lower stock market returns. Sadorsky (1999) mentioned in his paper that if oil price changes affect economic activity (in our case measured by industrial production), then it will affect the earnings of companies for which oil is a cost of production. In an efficient stock market[6], this increase in oil price will cause an immediate decline in stock prices. Otherwise, in inefficient markets, this oil price increase effects will be in the form of lagged decline in the stock returns.

Stock price may be influenced by exchange rate movements. For instance, if the local currency, say, Swedish Kronor depreciates against a foreign currency say, British Pound, it will increase returns on the foreign currency (the pound). Events like this are expected to induce investors to move funds from domestic country (Sweden) to British assets. Thus a depreciating currency has a negative impact on stock market returns. The opposite would be true for an appreciation of the domestic currency. (Adjasi, Harvey and Agyapong 2008)

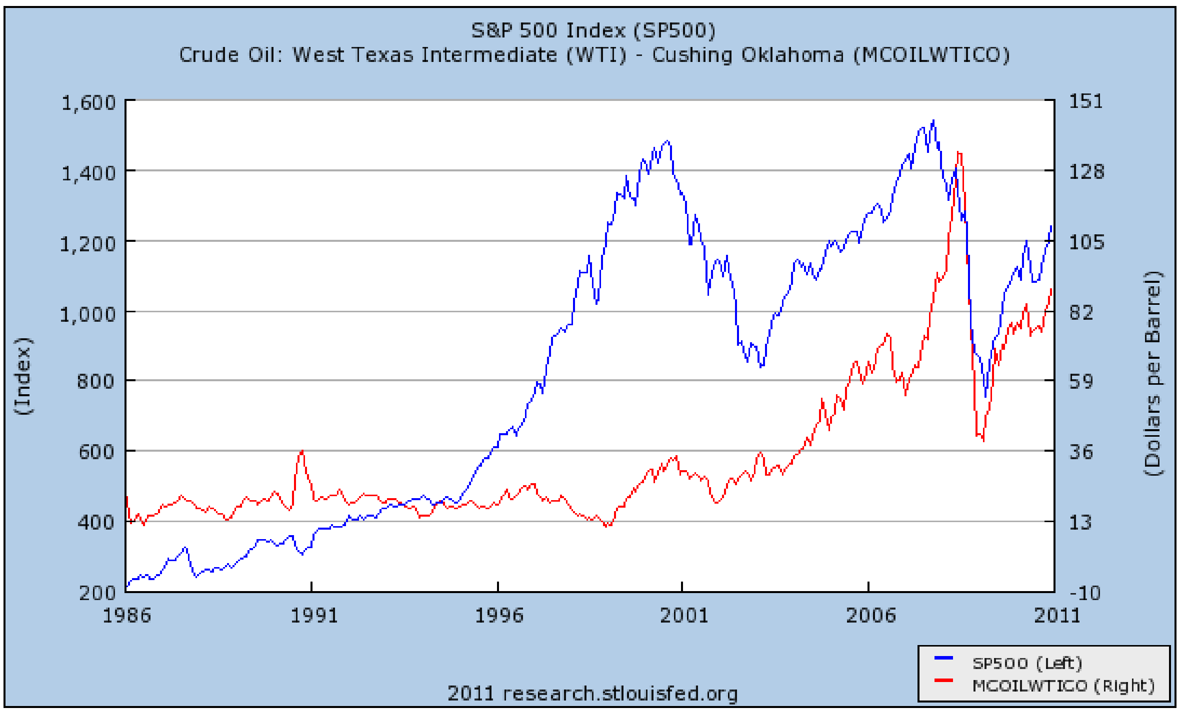
Industrial production is considered as a proxy to the level of real economic activity. It has been theoretically shown that industrial production increases with an economic expansion and decreases with an economic downturn. During economic expansion, as the productive capacity of an economy increases, the ability of the companies to generate cash flow also

[5] assuming that the companies do not hedge the oil price risk

[6] Markets are efficient when investors cannot take advantage in predicting a return on a stock price because no one has access to information (Investopedia n.d.) not already available to everyone else

increases. That is why industrial production would be expected to act as an indicator of predicting a firm's expected future cash flow[7] and thus a positive relationship is expected to exist between industrial production and stock market returns. Fama (1981) concluded that the industrial production growth had a strong contemporaneous impact on the stock returns. (Ozbay 2009)

The graph below illustrates the dynamic nature of West Texas Intermediate (WTI) crude oil price [8] movements during the period of 1986-2010 and the corresponding movements in the S&P Index (SP500).




***Source:*** *Economic Research, Federal Reserve Bank of St. Louis*

**Fig 1:** WTI Crude oil Price and S&P Stock Index during 1986-2010

From the graph, it is evident that the WTI oil price has jumped rapidly especially in 1991[9] and 2001[10]. During the time span 2001-2011, the price of oil had an upward trend reaching the peak in 2008. Then there is a sharp decline in 2009, making the oil price extremely volatile. On the other hand, the US stock market index considerably exhibited volatility (as

[7] Discussion of cash flow based firm equity valuation can be found in the theoretical framework chapter
[8] There are different forms of crude oil and WTI is one of them
[9] Invasion of the US in Kuwait in 1991 led to this price hike
[10] 9/11 incident in New York

can be seen on Fig 1). However, WTI oil price and the stock price seem to move in opposite directions almost for the whole period, i.e. stock price is going down when the oil is going up. For instance, during 1991 there is a sharp rise in the oil price and we can also observe a fall in stock price in the same period. In another instance, if we consider the time periods 1996-1999 and 2002-2004, we see similar scenario. This interesting relationship between oil price and stock prices along with previous research findings places us in an interesting situation to analyze their relationship.

## 1.2 Problem discussion

There are many studies concerning oil price movements and its effect on the economy. Hamilton (1983) investigated that oil price increases were one of the reasons which contributed towards recessions in US, except the recession in 1960. Mork, (1989); Mork, Olsen and Mysen (1994); Lee, Shwan, & Ratti (1995); Ferderer, (1996) studied the influence of asymmetric oil price shocks[11] on economy. Recent investigations concerning impact of oil price shocks on economic activity across several countries comprise Cologni and Manera (2008) and Kilian (2008) on the G-7, Cunado and Perez de Garcia (2005) for Asian countries and Jimenez-Rodriguez and Sanchez (2005) for G-7 and Norway.

Concerning oil price movements and stock market return, few of the studies include Jones and Kaul (1996); Huang, Masulis and Stoll (1996); Sadorsky (1999); Park and Ratti (2008). Jones and Kaul (1996) find that the movements in the Canadian and US stock prices on oil price shocks can be entirely accounted by the impact of these shocks on real cash flows. Huang et al. (1996) found that although oil futures returns influence some individual oil company stock returns, they do not have much effect on broad-based market indices like the S & P 500. Sadorsky (1999) found that positive shocks of oil prices lowers real stock returns, but, after 1986 oil price movements affect real stock returns more than interest rates. Ciner (2001) discovered relationship between real stock returns and oil price futures, but that the connection is non-linear.

Park and Ratti (2008) found that an increase in the volatility of oil prices considerably decreases real stock returns in the same month or during one month. For the US and half of

[11] Positive and negative oil price shocks

the European countries, the impact of oil price shocks on stock market returns is greater than that of the interest rate. They also detected asymmetric effects on real stock returns of both the positive and negative oil price shocks for the U.S. and for Norway, but not for the oil importing European countries.

However, our problem is based on the interesting findings of both Sadorsky (1999) and Park and Ratti (2008), where it was evident that oil price shocks seem to depress stock returns. In addition to the basic finding that stock market returns are depressed by oil price shocks, Sadorsky (1999) also found that after 1986, the effect of oil price shock is more than that of the interest rates. However, the findings were based on US stock market only. Park and Ratti (2008) extended the research by including more countries and finds similar results with Sadorsky (1999). However, then again the time span of the research was limited to 1986-2005. Referring back to Fig.1 we found evidence of oil price being more volatile after 2005. To our knowledge, there has not been any further research conducted based on their findings. This makes it interesting to analyze and extend the findings of both Sadorsky (1999) and Park and Ratti (2008) and to consider more years to analyze their findings. Therefore, our problem is to extend the analysis of their findings for more recent data and for a set of countries[12] which we find it important to analyze.

# 1.3 Purpose

The primary purpose of this study is to evaluate the size of impact that oil price shocks have on the stock market returns. The secondary purpose is to investigate which factors have greater influence on stock market returns in recent conditions in comparison to oil price and to explore systematic effect across several countries. As discussed earlier, if a country's economy is sensitive to oil price and its shocks on the macroeconomic variables, the stock prices are also likely to be sensitive. Availability of such information related to sensitivity of stock prices would be useful for both local and global investors who are likely to take into account of all the significant factors (oil price particularly) and to choose the better country to invest. In addition, this paper is also intended for the academicians, practitioners in the field of finance who would be interested to learn more on this topic. It would allow the investors and firms which are sensitive to oil price shocks to make better decisions related to oil price

[12] Choice of selection of countries is discussed later in the paper

risk hedging. Lastly, it could help the portfolio managers, financial analysts or other market participants who need thorough understanding of the volatility of assets.

# 1.4 Limitation

Our study is based on the approaches which were also used in the previous researches. Other approaches, if considered, might have had different results. In addition, due to limitations of data, the research is conducted only for the 11 countries of the OECD (Belgium, Canada, France, Ireland, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom and United States) without consideration of other countries of OECD. Our sample starts from January 1986 since, according to Sadorsky (1999), oil price shocks became more influential than interest rate on stock market return since 1986. Lastly, to make the cross country comparisons more realistic our sample period ends at 31.12.2010 due to data unavailability of short term interest rates, industrial production, and stock indices of the selected countries.

# 1.5 Thesis Outline

## *Chapter 1-Introduction*

Chapter 1 covers brief theory and background of relationship between oil price movements and stock market return. Then problem was highlighted and described in order to provide main aim of this study. Also motivation why it is interesting and important to study such relationship was given.

## *Chapter 2- Theoretical Framework*

Chapter 2 comprises theories associated with the relationships between oil price movements and stock market return, previous studies in this area with relevant conclusions, results and models which are usually used in this context.

## *Chapter 3-Methodology*

Chapter 3 represents the process of data collection and sources which were used for this purpose. The description of using empirical models is presented with advantages and limitations. Validity and reliability are also discussed.

## *Chapter 4-Results*

In Chapter 4 results of all tested models and its robustness are discussed with conclusions why particular model is the most appropriate to explain relationship between oil price movements and stock market return.

## *Chapter 5- Analysis and argument*

Chapter 5 covers deeper understanding and interpretation of obtained results. Results are compared with results from previous studies in this area and explanation of reason of behind such results.

## *Chapter 6-Conclusion*

Chapter 6 contains conclusion about results and models robustness, suitability of results and models. Also methodological flaws and limitations are taken into account to get more reliable conclusion of results.

*Chapter 2*

# Theoretical Framework

This chapter comprises theories associated with the relationships between oil price movements and stock market return, previous studies in this area with relevant conclusions, results and models which are usually used in this context.

## 2.1 Oil Price and Stock Returns

Theoretically, there are many ways through which the oil price movements could have an impact on the stock returns. According to Discounted Cash flows (DCF)[13] technique, the value of a stock is equal to the sum of discounted expected future cash flows. These cash flows could directly or indirectly depend on the oil prices. For instance, if there is an unprecedented increase in the oil price, the energy cost for many companies would increase (assuming that these companies do not hedge the oil price risks). As a consequence, the earnings could fall and so as the present cash flows. However, the intrinsic stock value would depend on the future cash flows. While valuing a stock, the investors and the analysts would predict further oil price increases and estimate lower expected future cash flows, resulting in a lower stock value.

There could also be indirect impact of oil prices on the stock returns. For example, if the oil price shocks triggers inflation, the cost of production (material cost, labor cost, and overheads) could increase for most of the companies and consequently, the intrinsic stock values would be depressed duo to lower cash flows. If the stock markets reflect the intrinsic stock values in the stock prices, the price of stocks should fall and thus lead to a decline in stock returns.

[13] A valuation method used to estimate the attractiveness of an investment opportunity (Investopedia n.d.)

## 2.2 Literature Review

Since the global oil crisis in 1970, there has been an increasing amount of studies being conducted to study the effects of oil price shocks on the economy. The studies discussed how the oil price shocks could affect the macroeconomic variables of an economy. Initially, the studies were more focused towards the major economic variables such as inflation, GDP, exchange rates, interest rates and so on. But, only few studies were conducted to observe the effects of oil price shocks on the stock price returns. One of the earliest of studies is of Jones and Kaul (1996) which examines the effect of oil price on the stock prices in the US, Japan, Canada and the UK. They used quarterly data to examine whether the impact in the stock returns due to oil price shocks could be justified by changes in current and future cash flows or expected returns in the international stock markets. The time frame of the studies was 1947-1991 and the empirical findings conclude that there is a lagged effect of oil prices on the aggregate real stock returns. In contrast, Huang et al. (1996) conducted further studies on daily stock returns for the time frame 1979-1990 and found no evidence of any relationship between oil futures prices and aggregate stock returns. Although the stock returns of the oil companies could be affected, there is no real impact on the stock price indices like S&P 500. They used a Vector Autoregressive (VAR) approach to investigate this relationship.

Authors like Sadorsky (1999), Mohan Nandha and Hammoudeh (2007), Park and Ratti (2008) concluded in their findings that increasing oil prices tend to put downward pressure on the stock market index. Sadorsky (1999) used a VAR model to examine the dynamic relationship between oil prices, interest rate, industrial production, consumer price index and stock markets in the US. The research was based on the data from the S&P 500 index starting from January 1950 to April 1996. The research established that the macroeconomic variables are affected in the following ordering: interest rate, oil prices, industrial production and real stock return. His findings include that the stock returns do explain most of its own variance changes. Interest rate shocks have a greater influence on the real stock returns and the industrial production than the oil price shocks. However, when the sample was divided into two sub samples, the more recent sample demonstrated that oil price shocks have significant influence in explaining industrial production and real stock returns variance.

Nandha and Hammoudeh (2007) examined the effect of oil price movements and exchange rate movements into stock markets returns in 15 countries in the Asia-Pacific region surrounding the Asia financial crises of 1997. They used factor model to carry out the research. As a result they discover that only the Philippines and South Korea are oil-sensitive to changes in the oil price in the short run, when the price is expressed in local currency only. No other country indicates sensitivity to oil price measured in US dollar independently whether the oil market is up or down.

Park and Ratti (2008) discover that increase in the volatility of oil prices considerably decrease real stock returns contemporaneously or within one month. For US and half of the European countries, effect of oil price shocks on stock market returns is greater than that of the interest rate. They investigated asymmetric effects on real stock returns of positive and negative oil price shocks for the U.S. and for Norway, but not for the oil importing European countries.

Concerning to alternative models which were used in previous studies, it is possible to indicate the study of Wang-Jui Horng and Ya-Yu Wang (2008) where they used Dynamic Conditional Correlation (DCC) and bivariate assymetric-IGARCH (1,2) to analyze the relationship of the U.S. and the Japan's stock markets under positive and negative of the oil prices' volatility rate. They came to the conclusion that the U.S. and Japan's stock markets have positive relationship and have asymmetrical effects. The variation risks of the two stock market returns also receive the positive and negative of the oil prices' volatility rate.

In study of Sharif, Brown, Burnon, Nixon, Russel (2005) multi-factor model was used to investigate nature and extent of the relationship between oil prices and equity values in the UK. As a result they found that the relationship is always positive, often highly significant and reflects the direct impact of volatility in the price of crude oil on share values within specific sector.

Chiou and Lee (2009) applied Autoregressive Conditional Jump Intensity model to define jump dynamics and volatility between oil and the stock markets. Thus they examine the asymmetric effects of oil prices on stock returns, and also explore the importance of structural changes in this dependency relationship. Using Autoregressive Conditional Jump

Intensity model with structure changes, they came to the conclusion that high fluctuations in oil prices have asymmetric unexpected impacts on S&P 500 returns.

Reboredo (2011) used Markov-switching approach to detect non-linear effect of oil shocks on stock market returns. He showed that an increase in oil prices has a negative and significant impact on stock prices in one state of the economy, whereas this effect is significantly dampened in another state of the economy.

Based on the literature review and the underlying theories, it is noticed that the stock returns are mostly affected by the following major variables: Interest Rates, Oil Price and Industrial Production. The ordering of the causality[14] is as follows: Interest Rate, Oil Price, Industrial Production and Real Stock Return. However, as stated earlier, our problem is based on the interesting findings of both Sadorsky (1999) and Park and Ratti (2008), where it was evident that oil price shocks seem to depress stock returns. In addition to the basic finding that stock market returns are depressed by oil price shocks, Sadorsky (1999) also found that after 1986, the effect of oil price shock is more than that of the interest rates.

Therefore, the interesting results from the previous studies place us in a position to formulate our research questions. Through this study we would like to know the following:

*Research Question 1:* Does oil price shocks have negative impact on the real stock returns?
*Research Question 2:* If so, is the impact that oil price shocks have on the stock returns greater than that of interest rates?

Based on the research questions we formulate the following null hypotheses for our study which are follows:

Hypothesis 1: Oil price shocks have negative impact on the real stock returns
Hypothesis 2: The impact that oil price shocks have on the stock returns are greater than that of interest rates.

[14] Based on (Sadorsky 1999)

*Chapter 3*

# Methodology

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This chapter presents the process of data collection and the sources which were used for this purpose. It also describes the use of the empirical models with advantages and limitations. Validity and reliability are also discussed.

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## 3.1 Sources of information

For the purpose of this study, monthly data of short term interest rates, industrial production and stock return were obtained from Organization for Economic Cooperation and Development (OECD) database (Data from Main Economic Indicator), which has comprehensive data for the following countries: Belgium, Canada, France, Ireland, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom and United States for the sample period 01.1896-12.2010. These countries are 11 members of the 34 member countries of the OECD. The data presented are in monthly frequency and in raw-data form. For West Texas Intermediate (WTI) oil prices, the database of the Energy Information Administration (EIA) of the Department of Energy of the US was utilized and is quoted as WTI Spot Price FOB (Dollars per Barrel). These sites are official and were used for previous researches. We used Libhub to search and collect articles regarding previous studies and theories about the influence of oil price movements on stock market returns. For searching appropriate literature LIBRIS was also explored.

## 3.2 Data collection

In this study we consider only the following 11 countries of all 34 countries of OECD: Belgium, Canada, France, Ireland, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom and United States since they are among the top 20 countries of OECD according to the ranking based on GDP per capita[15]. Sample period is chosen from 01.1986 to 12.2010 since, according to Sadorsky's (1999) study, oil price shocks became more influential than interest rate on stock market return since 1986. Real oil prices were rather constant till the early 1970s. After this period we can observe upward trend in the oil price. The 1986 oil price shock exhibits the first time major oil price decrease. Induced by the Persian Gulf crises, the early 1990s were a time when both large oil price increases and large oil price decreases occurred. Concerning the ending date 12.2010, it was chosen because not all the countries have the available data for short term interest rate, industrial production and stock return after this date.

The reason behind choosing these countries is the fact that the members of the Organization for Economic Cooperation and Development (OECD) produce 69.4 % of the world Gross National Income (GNI) and the member countries have close trade relations[16]. OECD was founded in 1961 in order to promote economic progress and world trade. Now it contains 34 countries as members. OECD realizes an extensive analytical work, makes recommendations to member countries and provides a platform for multi-party negotiations on economic issues. A large proportion of OECD activities are related to counteraction of money laundering, tax evasion, corruption and bribery.

# 3.3 Data description

In this study we use monthly data[17] for real stock returns and are defined as the difference between the continuously compounded returns on stock price index and the inflation rate given by the log difference in the consumer price index. Real stock returns measures the return on investment after taking inflation into account.

$$Real\ Stock\ return = ln\left(\frac{Stock\ price\ index_{t+1}}{Stock\ price\ index_{t}}\right) - ln\left(\frac{Consumer\ price\ index_{t+1}}{Consumer\ price\ index_{t}}\right)$$

World real oil price is calculated with respect to the U.S. Producer Price Index for Fuels & Related Products & Power (PPIENG) in order to take into account of inflation rate. Inflation

[15] based on (CIA World fact Book n.d.)
[16] According to (OECD 2010)
[17] A details of the data description available in the appendix

rate considered for the oil price is given by the log difference in the producer price index. In the later parts of the paper the words *real oil price* and *world real oil price* are used interchangeably.

The world real oil price is calculated as follows:

$$World\ Real\ Oil\ Price = Oil\ Price * \left(1 - ln\frac{PPI_{T+1}}{PPI_T}\right)$$

In the previous studies there were several measures of oil price shocks. We use change in the world real oil price as a proxy for the oil price shocks. When we take the first log difference of world real oil price it becomes a measure of shock since it measures change in the relative price of oil faced by firms. In the rest of the paper, when we refer to oil price shocks we would mean $\Delta Oil_t$ which is calculated as below.

$$\Delta WROP_t = lnWROP_t - ln\,WROP_{t-1}$$

Producer Price Index (PPI) measures the average change over time in the selling prices received by domestic producers for their output. Consumer Price Index (CPI) considers all the price of goods and services in an economy. It measures the average changes in the prices of consumer goods and services purchased by households. The CPI is used in most of the countries by the central monetary authority, usually the central bank, as the key measure of current inflation and is also analyzed to provide information on likely future inflationary expectations.

Share price index that is presented as monthly data are averages of daily quotations. Share price indices have a strong forward-looking component because a stock market's valuation reflects investors' confidence in it and therefore captures perceptions about its future viability

Short term interest rate is usually the rate associated with Treasury bills, Certificates of Deposit or comparable instruments, each of three month maturity. In our case we use 3 month treasury bill rates as the proxy for short term interest rates.

For oil prices we used Cushing, OK WTI Spot Price FOB (Dollars per Barrel) because it is reference sort of oil which is used to determine oil prices on world market. As industrial production we considered Industrial Production Index since is an economic indicator which measures real production output, which includes manufacturing, mining, and utilities. As consistent with previous studies it could be used as an indicator of economic activity.

# 3.4 Reliability and Validity

In order to ensure quality of our work we ensured *reliability* and *validity* of the empirical models used and the relevant data used in the models. *Reliability* is the extent to which an experiment, test, or any other measuring procedure yields the same result on repeated trials. *Validity* on the other hand refers to the degree to which a study accurately reflects or assesses the specific concept that the researcher is attempting to measure.

## 3.4.1 Reliability

To ensure reliability of the empirical model and the data used in the models we took into consideration of the ordering of the variables in the VAR model and selection of the lag lengths in the VAR. In both Sadorsky (1999) and Park and Ratti (2008), the authors have argued and proven that the results are not sensitive to the selection of the number of lags and the ordering of the variables in the VAR model. This measure gives robustness to the model used in the study. In addition, regarding the reliability of the data used, we used the official website of OECD and used their database for the required data.

## 3.4.2 Validity

The choice of empirical models and data sources for the analysis of the relationship between oil price shocks and real stock returns is based upon previous researches on this area. To be specific, Vector Autoregressive Models, Impulse Response and Variance Decomposition have also been commonly applied in the previous studies and are well established as a measure to capture the dynamic relationships between the variables of our interest.

# 3.5 Empirical Models

## 3.5.1 Unit Root Tests

At the beginning of this study, we perform Unit root test to check for the stationarity of the time series data of short term interest rates, industrial production, real stock return and world real oil price at their log levels. The reason for such test is that in Vector Autoregressive model (VAR)[18] we can use only stationary variables. In a VAR model, if we use non-stationary data there is a possibility that it might lead to spurious regressions. Augmented Dickey Fuller Test (ADF), Phillips and Perron, 1988 (PP) and KPSS (Kwiatkowski 1992) are the three unit root tests that we have used. Performing the test we can come to the conclusion whether the variables are stationary or not. Examining for stationarity we can discover whether there is any trend or structural breaks in short term interest rates, industrial production, real stock return and world real oil price.

The null hypothesis of ADF test is that the variables have a unit root at 5% level of significance (non-stationarity). In comparison to ADF test, KPSS test has a null hypothesis of stationarity and an alternative hypothesis of existing one unit root. Phillip and Perron test is almost similar to ADF test but has an automatic correction of ADF which allows for autocorrelated residuals. The test often gives the same conclusions as ADF and has the same important limitation. ADF and PP tests have low power for stationary process but with a root close to the non-stationary boundary. Depending on the results from the unit root testing (i.e. if we find unit roots in the variables), we conduct cointegration test (Johansen test, 1988) to check for common stochastic trend. In each case, the null hypothesis is that the variables have no cointegration at 5% level of significance.

If the variables have unit roots at their log levels, we need to take the first difference of the log level of the variables to induce stationarity.

[18] We discuss VAR in the later part of the paper

## 3.5.2 Cointegration Test

Once the stationarity check is done for the variables we have conducted a Johansen cointegration test for the variables with a unit root to check for any common stochastic trend. Johansen test allows us to test a hypothesis about one or more coefficients in the cointegrating relationship. The trace statistic used to test the cointegrating relationship is as follows:

$$\lambda trace(r) = -T \sum_{i=r+1}^{g} ln(1 - \hat{}\lambda i)$$

$$\lambda_{max}(r, r+1) = -Tln(1 - \hat{}\lambda_{r+1})$$

Where $\lambda i$ are the ordered eigenvalues, $r$ is the number of cointegrating vectors and $g$ is the number of variables. If there are $g$ number of variables there can be at most *g-1*cointegrating vectors. The results from the tests are then tabulated in the order (*r*=0, 1, 2, 3…*g-1*) and for each value of *r* the trace statistics are compared with the critical value to decide on the number of cointegrating vectors. If the trace statistic for *r=0* is smaller than the critical values, the null hypothesis that there is no cointegrating vector is not rejected. In case the trace statistic is larger, the null hypothesis is rejected and we check the same for *r=1* and according come to a solution.

$\lambda trace$ tests the null hypothesis that the number of cointegrating vectors is less than or equal to r against an unspecific alternative. $\lambda_{max}$ tests the null hypothesis that the number of cointegrating vectors is r against an alternative of *r+1*

## 3.5.3 Lag length selection

In order to implement Vector Autoregressive model, firstly, it is necessary to define lag length of the model. It is not easy to determine lag length in VAR model and lag length selection choice may be done according to the Akaike or Schwarz Information criteria or basis of statistical significance.(Verbeek 2004)

There are two common approaches in selecting the lag length: cross-equation restrictions and information criteria. (Brooks 2008) In cross-equation restrictions the procedure is to test the coefficients on a set of lags on all variables for all equations in the VAR at the same time. With the aim of VAR modeling, VAR models should be formed as unrestricted as possible. In the case where equations have different lag lengths, the VAR model becomes restricted and some coefficients, which exceeds number of lags in the shortest equation, are equalized to zero. An alternative approach would be to specify the same number of lags in each equation and to test if restricted VAR has better or worse fit than the unrestricted one. It is possible to do so by using Likelihood ratio test which works as F-test. If the restricted model has much larger error than unrestricted one, then the t-statistic is larger and thus we should reject null hypothesis that restricted model works just as well.

Information criteria require that the distribution of disturbance terms is not assumed to be normal. This approach focuses on the residual sum of squares (RSS) and the penalty in case of loss of degrees of freedom when extra parameters are added. RSS decreases and the penalty value increases when the extra variable is added to model or the additional lag is added. The common information criteria are Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SIC) and the Hannan-Quinn information criterion (HQIC).

The aim of this approach is to select number of lags which minimizes the value of the information criterion. However, there is contentions question concerning which criterion is the best one. To deal with such problem it is probable to compare these information criteria in order to choose an appropriate leg length.

### 3.5.4 Vector Autoregressive Model

We used unrestricted Vector Autoregressive (VAR) model developed by Sims (1980) to investigate the interactions between oil price shocks and stock market return. VAR model allows a multivariate framework where each variable is dependent on the changes in its own lags and the lags of other variables. The following is one equation from the model. In our VAR model we have the following variables: Interest rate (*ir*), Oil Price Shock (*wrop*), Industrial Production (*ip*) and Real Stock Return (*rsr*). For instance, we can express oil price shock in term of its own lags and lags of interest rates, industrial production and real stock returns.

$$WROP_t = \beta_{10} + \beta_{11}WROP_{t-1} + \cdots + \beta_{1k}WROP_{t-k} + \alpha_{11}ir_{t-1} + \ldots + \alpha_{1k}ir_{t-k} + \gamma_{11}ip_{t-1} + \ldots + \gamma_{1k}ip_{t-k} + \delta_{11}rsr_{t-1} + \ldots + \delta_{1k}rsr_{t-k}$$

VAR treats all the variables as jointly endogenous and imposes no priori restrictions on the structural relationships between the variables in the model. Additional variables are included to get more detailed picture of interaction all the variables in the model. Thus we include short term interest rate, industrial production, stock market return and oil price as variables in VAR model.

Vector Autoregressive model has both advantages and drawbacks (Brooks 2008)

*Advantages:*

1. Flexibility: it is not necessary to specify which variables are exogenous or endogenous. They are all endogenous; the “exogenous” variables are the lags.
2. VAR allows the value of variable to depend on more than just its own lags or past disturbances, thus it is more general than univariate ARMA modeling
3. Since only lags are exogenous and lags exist only on RHS there are never any endogeneity problem thus each equation can be estimated separately by regular OLS
4. Forecasts are often better than “traditional”, restricted structural models

*Drawbacks:*

1. VAR is atheoretical (as are basically all time-series models)
2. It is difficult to say which lag length is appropriate
3. Big number of parameters to be estimated. A system of g equations/variables and k lags produces (g+k$g^2$) parameters
4. Results can be very sensitive to exact specification for example lag length
5. Interpretation is often difficult

There are three different techniques to facilitate interpretation and structure the results:

1. Block significance/Grander causality tests
2. Impulse responses
3. Variance decomposition

### 3.5.5 Block significance test / Granger causality

Block significance/ Granger causality test helps to identify which variable affect which in the system. All the lags of a single variable are considered as joint effect, thus test show if all lags of one particular variable have significant effect on any another variable in the system. Causality implies a chronological ordering of movements in the series. This test has some drawbacks (Brooks 2008):

1. Sign of coefficients, direction of effect
2. Only shows if there is statistically significant effect, not economically significant effect, size of the effect

To deal with such drawbacks Impulse responses and Variance decompositions are applied.

### 3.5.6 Impulse response

To perform impulse responses technique we simulate a unit shock to the error term in the equation for one variable and draw how the other variables in the system respond to the shock over $p$ subsequent periods. We assume also that no other shocks occur. Thus $g$-equation can generate $g*g-g$ impulse responses excluding auto-responses.

### 3.5.7 Variance decomposition

Variance decompositions show the proportion of movements in the dependent variables that are due to their own shocks and the proportion due to shocks to the other variables. The $b$-step-ahead variance decompositions for given variable determine the proportion of the forecast error variance of this given variable due to innovations to each explanatory variable for $b = 1, 2\ldots$

### 3.5.8 Ordering

For calculating impulse responses and variance decomposition it is important to choose the right order of variables in the system because, in practice, errors are generally not totally independent although impulse response and variance decomposition assume that VAR error terms are statistically independent. Ordering can be checked by orthogonalizing or recalculating results with different orders.

Due to the finding of previous researches of Sadorsky (1999) and Park and Ratti (2008) that different orders do not affect the results of Impulse response and Variance decomposition, we apply the same order as Sadorsky (1999), Park and Ratti (2008) in this study. The following order is used: interest rate, real oil price, industrial production, real stock return.

*Chapter 4*

# Results

In Chapter 4 results of all tested models and its robustness are given and discussed with conclusion why particular model is the most appropriate to explain relationship between oil price movements and stock market return

## 4.1 Unit root test

To perform unit root tests, firstly, we transform interest rate, real oil price, industrial production in natural logarithm form because relative changes are better to analyze. As a result of all the three unit root tests: ADF, PP and KPSS, we find that real stock return is stationary for all countries. In contrast, interest rate, industrial production and real oil price in natural logarithm forms are non-stationary for all countries. In order to avoid non-stationarity we induce first difference transformation to all the non-stationary variables and then apply the three unit root tests again. Once the first differencing is applied we observe stationarity for interest rate, world real oil price and industrial production in first difference form. Since only stationary variables can be used in Vector Autoregressive Model the following variables are included in the VAR model:

| | |
|---|---|
| *ir* | first difference of natural logarithms of short term interest rate |
| *wrop* | first difference of natural logarithms of world real oil price |
| *ip* | first difference of natural logarithms of industrial production |
| *rsr* | real stock returns |

Tables 1 through 3 summarize[19] the unit root results conduction under ADF, PP and KPSS.

[19] Tables constructed (in summarized form) from e-views output to allow the readers have a overall scenario for all the countries

For ADF test we observe rejection of null hypothesis about non-stationarity if t-statistic is more negative than critical value (Table 1).

Table 1: ADF unit root test result

| *Country* | Interest rate | | World real oil price | | Industrial production | | Real stock return |
|---|---|---|---|---|---|---|---|
| | *log level* | *first log difference* | *log level* | *first log difference* | *log level* | *first log difference* | *log level* |
| Belgium | -0.845884 | -9.955733 | -1.099858 | -13.62343 | -1.427237 | -25.73121 | -12.18341 |
| Canada | -1.695397 | -8.497583 | -1.099858 | -13.62343 | -1.764554 | -6.423283 | -14.88985 |
| France | -0.613776 | -10.16296 | -1.099858 | -13.62343 | -2.222997 | -6.430039 | -14.11259 |
| Ireland | -1.052761 | -7.673764 | -1.099858 | -13.62343 | -1.461054 | -17.65936 | -12.52551 |
| Italy | -0.767022 | -9.456545 | -1.099858 | -13.62343 | -2.535020 | -7.774589 | -13.71807 |
| Netherlands | -0.846242 | -8.852546 | -1.099858 | -13.62343 | -0.817588 | -15.22799 | -12.16276 |
| Norway | -1.437911 | -11.27650 | -1.099858 | -13.62343 | -4.737116 | -19.52572 | -13.83770 |
| Spain | -0.855831 | -6.746474 | -1.099858 | -13.62343 | -1.781065 | -5.308874 | -12.49781 |
| Sweden | -2.455318 | -5.924634 | -1.099858 | -13.62343 | -1.342894 | -18.86256 | -12.00383 |
| United Kingdom | -0.853041 | -5.027416 | -1.099858 | -13.62343 | -2.289457 | -21.98203 | -12.78103 |
| United States | -0.449063 | -10.22533 | -1.099858 | -13.62343 | -1.702243 | -4.444608 | -12.72715 |
| *Critical values*: | | | | | | | |
| 1% level | -3.45 | | | | | | |
| 5% level | -2.87 | | | | | | |
| 10% level | -2.57 | | | | | | |

For PP test we observe rejection of null hypothesis about non-stationarity if t-statistic is more negative than critical value (Table 2).

For KPSS test we observe rejection of null hypothesis about stationarity if t-statistic is larger than critical value (Table 3).

Table 2: PP Unit Root Results

| | Interest rate | | World real oil price | | Industrial production | | Real stock return |
|---|---|---|---|---|---|---|---|
| *Country* | *log level* | *first log difference* | *log level* | *first log difference* | *log level* | *first log difference* | *log level* |
| Belgium | -1.055821 | -10.59393 | -0.871552 | -13.40379 | -1.567249 | -25.97107 | -12.09076 |
| Canada | -1.493584 | -8.504273 | -0.871552 | -13.40379 | -1.424238 | -17.49654 | -14.87453 |
| France | -0.897980 | -10.68026 | -0.871552 | -13.40379 | -2.026634 | -22.14523 | -14.16699 |
| Ireland | -1.301071 | -20.08402 | -0.871552 | -13.40379 | -1.522455 | -34.80835 | -12.55720 |
| Italy | -0.852959 | -10.00098 | -0.871552 | -13.40379 | -2.362958 | -34.80835 | -13.74500 |
| Netherlands | -1.042786 | -9.351320 | -0.871552 | -13.40379 | -1.466892 | -35.89523 | -12.17864 |
| Norway | -1.523458 | -11.81636 | -0.871552 | -13.40379 | -2.379073 | -38.82579 | -13.89051 |
| Spain | -0.582943 | -9.203557 | -0.871552 | -13.40379 | -1.884294 | -24.44421 | -11.73373 |
| Sweden | -1.686580 | -12.01998 | -0.871552 | -13.40379 | -1.342861 | -18.78922 | -11.96655 |
| United Kingdom | -0.184365 | -8.509318 | -0.871552 | -13.40379 | -2.377785 | -21.34129 | -13.82125 |
| United States | -0.403131 | -10.28206 | -0.871552 | -13.40379 | -1.632228 | -16.38073 | -12.60301 |
| Critical values: | | | | | | | |
| 1% level | -3.45 | 5% level | -2.87 | 10% level | -2.57 | | |

Table 3 KPSS Test results

| | Interest rate | | World real oil price | | Industrial production | | Real stock return |
|---|---|---|---|---|---|---|---|
| *Country* | *log level* | *first log difference* | *log level* | *first log difference* | *log level* | *first log difference* | *log level* |
| Belgium | 1.493746 | 0.059897 | 1.635829 | 0.078271 | 1.888818 | 0.023225 | 0.138376 |
| Canada | 1.440590 | 0.035948 | 1.635829 | 0.078271 | 1.747282 | 0.243414 | 0.042056 |
| France | 1.568760 | 0.069601 | 1.635829 | 0.078271 | 1.456399 | 0.178687 | 0.119914 |
| Ireland | 1.687815 | 0.039542 | 1.635829 | 0.078271 | 2.056786 | 0.389011 | 0.319053 |
| Italy | 1.763795 | 0.051307 | 1.635829 | 0.078271 | 0.971546 | 0.241445 | 0.103753 |
| Netherlands | 1.289682 | 0.090546 | 1.635829 | 0.078271 | 2.057763 | 0.054562 | 0.161899 |
| Norway | 1.481750 | 0.035661 | 1.635829 | 0.078271 | 1.470226 | 0.671167 | 0.047859 |
| Spain | 1.787602 | 0.086447 | 1.635829 | 0.078271 | 1.527500 | 0.293094 | 0.180419 |
| Sweden | 1.566185 | 0.029326 | 1.635829 | 0.078271 | 1.926322 | 0.156902 | 0.068849 |
| United Kingdom | 1.338220 | 0.150597 | 1.635829 | 0.078271 | 0.932506 | 0.563450 | 0.135466 |
| United States | 1.019604 | 0.167304 | 1.635829 | 0.078271 | 1.930547 | 0.262211 | 0.133885 |
| Critical values: | | | | | | | |
| 1% level | 0.739 | | | | | | |
| 5% level | 0.463 | | | | | | |
| 10% level | 0.347 | | | | | | |

After performing unit root tests for the first time and discovering non-stationarity for interest rate, world real oil price, and industrial production in logarithm form we apply Johansen test to check for cointegration in order to examine if there is common stochastic trend among the non-stationary variables. The null hypothesis is that the variables have no cointegration at 5% level of significance.

Then we discuss the results from cointegration test. To detect the presence of cointegration it is necessary to compare Trace statistic or Max-Eigen statistic with critical value. If in the first row Trace statistic exceeds the critical value the null hypothesis of no cointegrating vectors is rejected thus there is at least one cointegrated vector since alternative hypothesis is the presence of 1 cointegrated vector. Then we consider second row and compare Trace statistic or Max-Eigen statistic with critical value in the same way but now null hypothesis is presence of one cointegrated vector and alternative hypothesis is existence of 2 cointegrated vectors. If Trace statistic or Max-Eigen statistic is smaller than critical value we do not reject null hypothesis. It means that only one cointegrated vector exists.

As a result of implementing Johansen test we found that there is no cointegration among interest rate, world real oil price, industrial production in Belgium, Canada, Ireland, Netherlands, Norway, United States. In France, Sweden and United Kingdom one cointegrated vector was found for each country (Table 4).

In Italy and in Spain we observe conflict results between Trace statistic and Max-Eigen Statistic. For both countries Trace statistic shows no cointegration but Max-Eigen Statistic detects one cointegrated vector. Due to such results we performed pairwise test for cointegration within each country and discover no cointegration. Thus we can make a conclusion that in Italy and Spain no cointegration exists (Table 8 & Table 9). Applying pairwise test for cointegration in order to find which factors are cointegrated, we detected that in France, Sweden (Table 5 & Table 6) there is cointegration between industrial production and interest rate, in United Kingdom (Table 7) there is cointegration between industrial production and world real oil price. In most of the cases, it is seen that there is no cointegrating relationships between the variables.

The following tables display the results:

**Table 4:** Johansen Cointegration test results all the 14 countries

| Country | Trace statistic | 0.05 Critical value | Max-Eigen Statistic | 0.05 Critical value |
|---|---|---|---|---|
| **Belgium** | | | | |
| None | 24.31003 | 29.79707 | 18.57665 | 21.13162 |
| **Canada** | | | | |
| None | 25.52028 | 29.79707 | 21.03323 | 21.13162 |
| **France** | | | | |
| None | 31.82174 | 29.79707 | 28.36328 | 21.13162 |
| At most 1 | 3.458463 | 15.49471 | 3.434009 | 14.26460 |
| **Ireland** | | | | |
| None | 26.23632 | 29.79707 | 17.44869 | 21.13162 |
| **Italy** | | | | |
| None | 24.90129 | 29.79707 | 21.17550 | 21.13162 |
| At most 1 | 3.725793 | 15.49471 | 3.604193 | 14.26460 |
| **Netherlands** | | | | |
| None | 18.31184 | 29.79707 | 14.15154 | 21.13162 |
| **Norway** | | | | |
| None | 28.36363 | 29.79707 | 18.09379 | 21.13162 |
| **Spain** | | | | |
| None | 27.78573 | 29.79707 | 24.08385 | 21.13162 |
| At most 1 | 3.701881 | 15.49471 | 2.847533 | 14.26460 |
| **Sweden** | | | | |
| None | 33.29507 | 29.79707 | 24.18410 | 21.13162 |
| At most 1 | 9.110973 | 15.49471 | 7.072510 | 14.26460 |
| **United Kingdom** | | | | |
| None | 45.66829 | 29.79707 | 42.11534 | 21.13162 |
| At most 1 | 3.552946 | 15.49471 | 3.542926 | 14.26460 |
| **United States** | | | | |
| None | 17.00225 | 29.79707 | 13.93614 | 21.13162 |

Notes: variables included are interest rates, real oil price and industrial production in log levels. We compare the trace statistic or max eigen statistic with the 0.05 critical vaalue

**Table 5:** Cointegration France

| Pair | Trace statistic | 0.05 Critical value | Max-Eigen Statistic | 0.05 Critical value |
|---|---|---|---|---|
| ***ip&ir*** | | | | |
| **None** | 18.08785 | 15.49471 | 17.60231 | 14.26460 |
| **At most 1** | 0.485546 | 3.841466 | 0.485546 | 3.841466 |
| ***ip&wrop*** | | | | |
| **None** | 9.225911 | 15.49471 | 7.816137 | 14.26460 |
| ***ir&wrop*** | | | | |
| **None** | 7.952889 | 15.49471 | 7.952885 | 14.26460 |

**Table 6:** Cointegration Sweden

| Pair | Trace statistic | 0.05 Critical value | Max-Eigen Statistic | 0.05 Critical value |
|---|---|---|---|---|
| ***ip&ir*** | | | | |
| **None** | 18.37347 | 15.49471 | 16.41314 | 14.26460 |
| **At most 1** | 1.960323 | 3.841466 | 1.960323 | 3.841466 |
| ***ip&wrop*** | | | | |
| **None** | 8.082645 | 15.49471 | 5.112368 | 14.26460 |
| ***ir&wrop*** | | | | |
| **None** | 14.28073 | 15.49471 | 13.34122 | 14.26460 |

**Table 7:** Cointegration United Kingdom

| Pair | Trace statistic | 0.05 Critical value | Max-Eigen Statistic | 0.05 Critical value |
|---|---|---|---|---|
| ***ip&ir*** | | | | |
| **None** | 13.19160 | 15.49471 | 12.48367 | 14.26460 |
| ***ip&wrop*** | | | | |
| **None** | 18.27337 | 15.49471 | 17.68526 | 14.26460 |
| **At most 1** | 0.588108 | 3.841466 | 0.588108 | 3.841466 |
| ***ir&wrop*** | | | | |
| **None** | 8.963291 | 15.49471 | 8.956046 | 14.26460 |

**Table 8:** Cointegration Spain

| Pair | Trace statistic | 0.05 Critical value | Max-Eigen Statistic | 0.05 Critical value |
|---|---|---|---|---|
| ***ip&ir*** | | | | |
| **None** | 9.185505 | 15.49471 | 7.483932 | 14.26460 |
| ***ip&wrop*** | | | | |
| **None** | 12.04596 | 15.49471 | 10.49446 | 14.26460 |
| ***ir&wrop*** | | | | |
| **None** | 9.958069 | 15.49471 | 9.950225 | 14.26460 |

**Table 9** : Cointegration Italy

| Pair | Trace statistic | 0.05 Critical value | Max-Eigen Statistic | 0.05 Critical value |
|---|---|---|---|---|
| ***ip&ir*** | | | | |
| **None** | 9.176538 | 15.49471 | 8.265700 | 14.26460 |
| ***ip&wrop*** | | | | |
| **None** | 10.87818 | 15.49471 | 10.65813 | 14.26460 |
| ***ir&wrop*** | | | | |
| **None** | 8.662950 | 15.49471 | 8.644998 | 14.26460 |

# 4.2 Vector Autoregressive model

The VAR model is then applied to capture the dynamic relationship between the variables. Thereby, there is one equation for each dependent variables and each variable depends on its own lags and lags of the other variable(s) in the system.(Brooks 2008)

$$y_{1t} = \beta_{10} + \beta_{11}y_{1t-1} + \cdots + \beta_{1k}y_{1t-k} + \alpha_{11}y_{2t-1} + \ldots + \alpha_{1k}y_{2t-k} + \gamma_{11}y_{3t-1} + \ldots + \gamma_{1k}y_{3t-k} + \delta_{11}y_{4t-1} + \ldots + \delta_{1k}y_{4t-k}$$

$$y_{2t} = \beta_{20} + \beta_{21}y_{1t-1} + \cdots + \beta_{2k}y_{1t-k} + \alpha_{21}y_{2t-1} + \ldots + \alpha_{2k}y_{2t-k} + \gamma_{21}y_{3t-1} + \ldots + \gamma_{2k}y_{3t-k} + \delta_{21}y_{4t-1} + \ldots + \delta_{2k}y_{4t-k}$$

$$y_{3t} = \beta_{30} + \beta_{31}y_{1t-1} + \cdots + \beta_{3k}y_{1t-k} + \alpha_{31}y_{2t-1}+\ldots+\alpha_{3k}y_{2t-k} + \gamma_{31}y_{3t-1}+\ldots+\gamma_{3k}y_{3t-k}+\delta_{31}y_{4t-1}+\ldots+\delta_{3k}y_{4t-k}$$

$$y_{4t} = \beta_{40} + \beta_{41}y_{1t-1} + \cdots + \beta_{4k}y_{1t-k} + \alpha_{41}y_{2t-1}+\ldots+\alpha_{4k}y_{2t-k} + \gamma_{41}y_{3t-1}+\ldots+\gamma_{4k}y_{3t-k}+\delta_{41}y_{4t-1}+\ldots+\delta_{4k}y_{4t-k}$$

In order to select the best lag length k for VAR model, information criteria approach is utilized. E-views performs the lag length selection tests automatically and shows an optimum result. E-views gives that LR is a sequential modified LR test statistic (each test at 5% level), FPE is a final prediction error, AIC is Akaike information criterion, SC is Schwarz information criterion and HQ is Hannan-Quinn information criterion.

By performing information criteria analysis and comparing results which are given by the different information criterion the following optimal lag length were chosen:

1 for Belgium, 3 for Canada, 1 for France, 2 for Ireland, 1 for Italy, 4 for Netherlands, 4 for Norway, 1 for Spain, 3 for Sweden, 2 for United Kingdom, 2 for United States.

Performing VAR estimates in E-views in addition to lag length selection we know the sign and size of coefficients in VAR model equations for each country. The results of VAR estimates are presented in the appendix.

## 4.3 Block significance/ Granger causality test

In block significance test the null hypothesis is the absence of causality of real stock return on world real oil price. It can be rejected if p-value (Prob.) is less than 0.05 (5% significant level).

Block significance test for the period 01.1986-12.2010 is shown in Table 10.

**Table 10**: Block significance test (01.1986-12.2010)

| Country | P-value |
|---|---|
| Belgium | 0.0632 |
| Canada | 0.2750 |
| France | 0.1887 |
| Ireland | 0.7850 |
| Italy | 0.0090 |
| Netherlands | 0.1776 |
| Norway | 0.3468 |
| Spain | 0.0291 |
| Sweden | 0.0854 |
| United Kingdom | 0.6468 |
| United States | 0.6615 |

The results show that for all countries except Italy and Spain world real oil price do not Granger cause real stock return. It is inconsistent with previous studies where causality of real stock return by world real oil price was evident. It could be because of difference in time period, which were considered. Previous studies examined period since 1986 till 2005. But in third quarter of 2008 Global Financial Crisis affected the OECD countries. Thus we check again if world real oil price Granger causes real stock return for the period 01.1986-08.2008 to study the effect in normal conditions without the influence of unusual conditions which existed during the Global Financial Crisis.

Block significance test for the period 01.1986-08.2008

Table 11: Block significance test (01.1986-08.2008)

| Country | P-value |
|---|---|
| Belgium | 0.0002 |
| Canada | 0.2778 |
| France | 0.0030 |
| Ireland | 0.0119 |
| Italy | 0.0000 |
| Netherlands | 0.0246 |
| Norway | 0.2780 |
| Spain | 0.0000 |
| Sweden | 0.0005 |
| United Kingdom | 0.0496 |
| United States | 0.0062 |

Here it is observable that for all countries except Canada and Norway world real oil price Granger causes real stock return. The volume of oil export of Canada and Norway is much higher than those for the other considering countries of OECD. (Wikipedia n.d.) . Therefore, we find that for oil exporting countries world real oil price does not Granger cause real stock returns.

**Table 12**: Oil Export Statistics for the selected OECD countries

| Country | Oil – exports (bbl/day) |
|---|---:|
| Belgium | 433,7 |
| Canada | 2,001,000 |
| France | 597,8 |
| Ireland | 23,36 |
| Italy | 586,9 |
| Netherlands | 1,660,000 |
| Norway | 2,150,000 |
| Spain | 175,2 |
| Sweden | 231,1 |
| United Kingdom | 1,393,000 |
| United States | 1,704,000 |

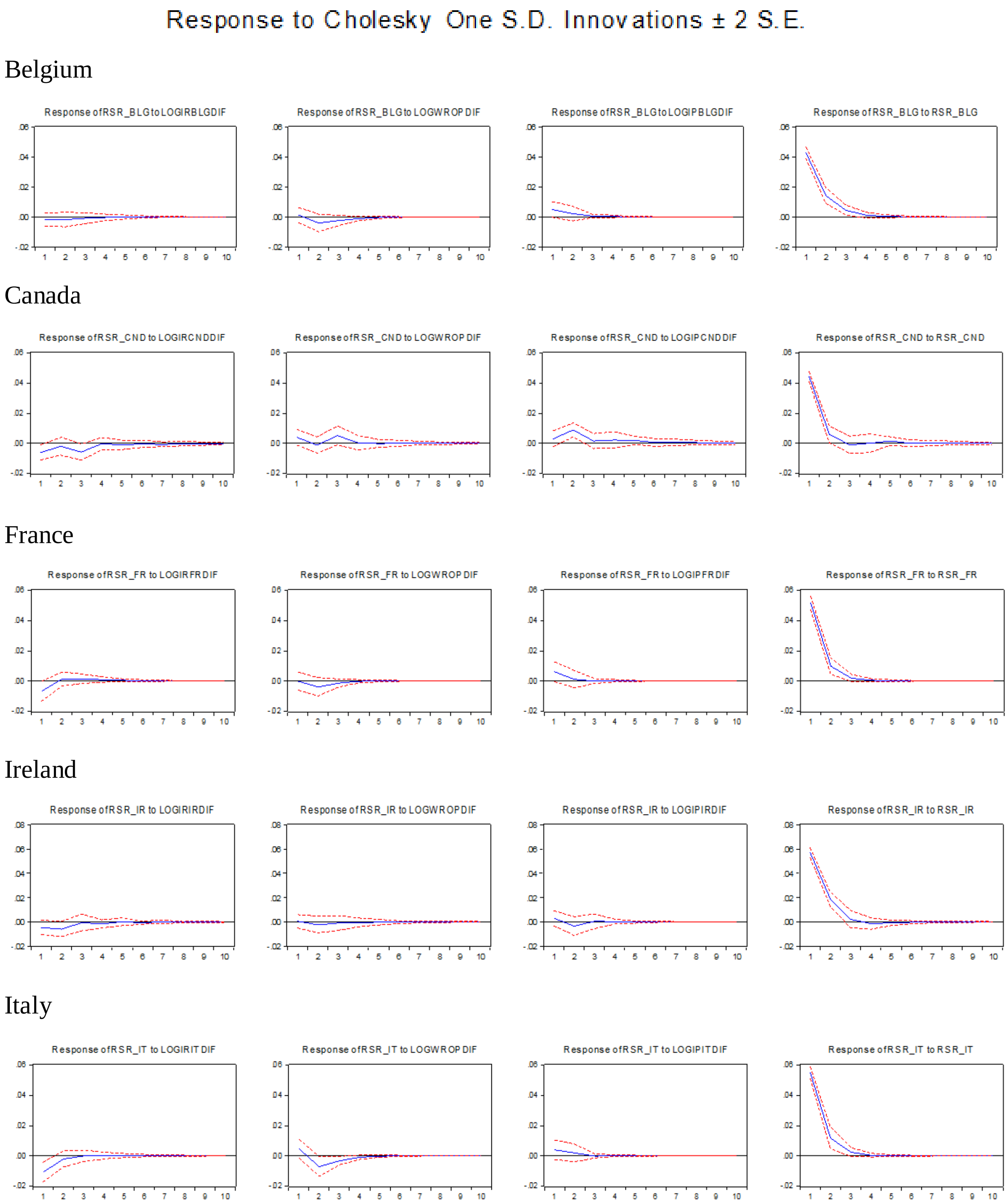
Source: Wikipedia

# 4.4 Impulse Response

## 4.4.1 World real oil price shock

In this section we analyze the results from the impulse responses to assess the impact of world real oil price shock on real stock returns. The ordering of the variables to analyze the oil price shock on real stock returns has been chosen on the basis of Sadorsky (1999) and Park and Ratti (2008). The order is as following sequence: interest rate, world real oil price, industrial production, real stock return. The order of the variables in the VAR model is indicated by the following notation: VAR *(ir,wrop,ip,rsr)*.They found that different orders give the same results.

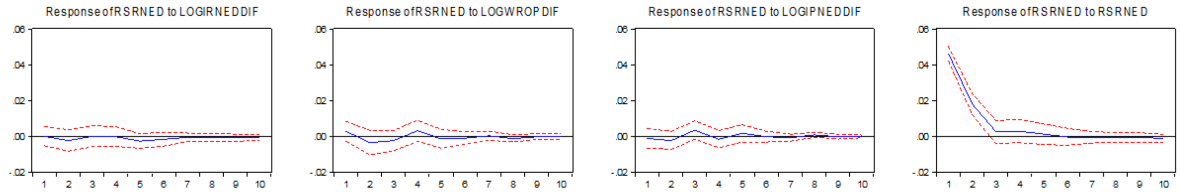
Fig 2(a) and 2(b) show the impulse responses of real stock returns resulting from a one standard deviation shock to interest rate, world oil price shock and industrial production disturbances. Monte Carlo constructed 95% confidence intervals are provided to judge the statistical significance of the impulse response functions. The results for the 11 countries are displayed in two figures (Belgium, Canada, France, Ireland and Italy in Fig. 2(a) and Netherlands, Norway, Spain, Sweden, UK and US in Fig 2 (b)).



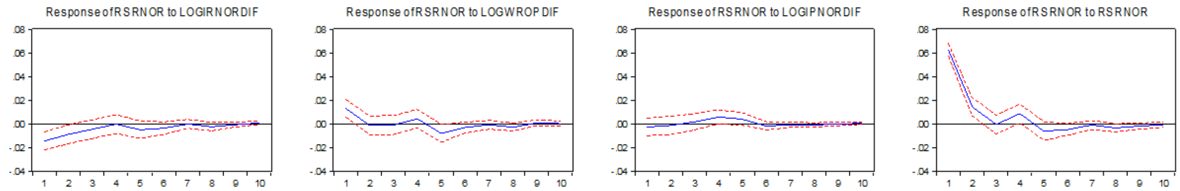

Notes: First Column: interest rate shock; Second Column: World oil price shock; Third Column: Industrial Production Shock; Fourth Column: Real stock returns shock

**Fig 2(a):** Response of real stock returns to interest rate, world real oil price shock and industrial production for Belgium, Canada, France, Ireland and Italy

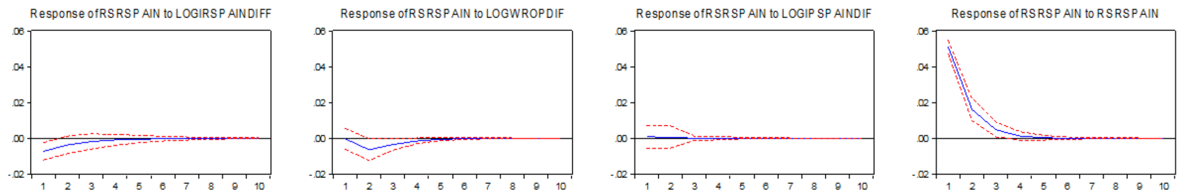
Netherlands



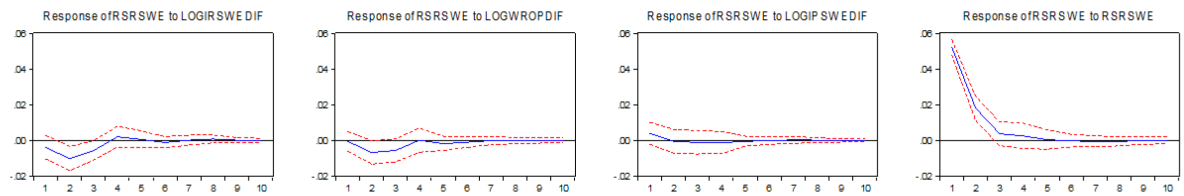

Norway



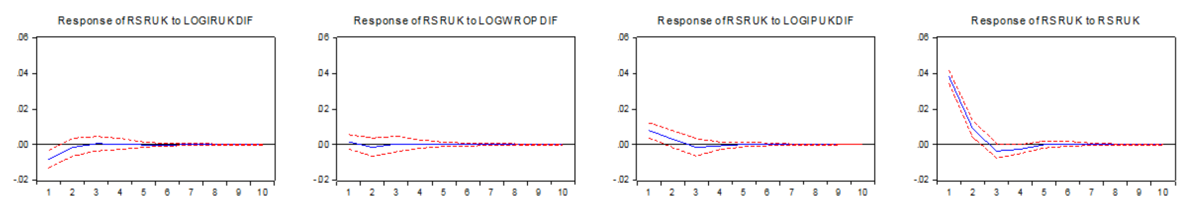

Spain




Sweden




UK




US

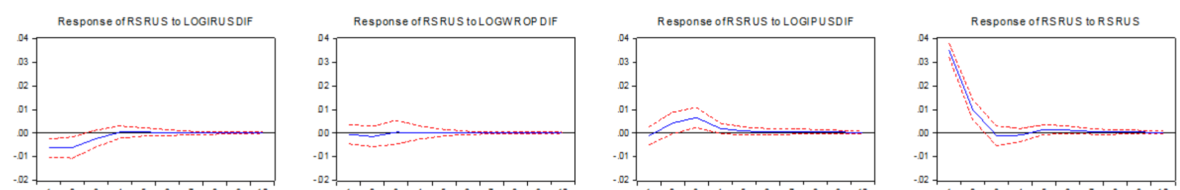



**Fig 2(b)**: Response of real stock returns to interest rate, world real oil price shock and industrial production for Netherlands, Norway, Spain, Sweden, UK and US

The results from the impulse response graphs for the 11 countries are tabulated to have a better glimpse of the cross country comparison.

**Table 13**: Statistically significant impulse response of real stock returns to world oil price shocks, interest rate shocks and industrial shocks (in summarized form)

| | Belgium | Canada | France | Ireland | Italy | Netherlands | Norway | Spain | Sweden | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Interest rate shock | n | n | n | n | n | n | n | n | n | n | n |
| World Real oil price Shock | n* | p | n | n | n* | n* | p | n | n | n* | n |
| Industrial Production shock | p | p | p | n* | p | n | n | n | p | p | p |

Notes: n (p) indicates negative (positive) statistically significant impulse response at 5% level of significance of interest rate shocks, oil price shocks, and industrial production shocks in the same period or in a lag of one month. * denotes negative impact in the next month. * denotes more negative effect in the next month.

From Fig 2(a) & 2(b) and the summarized Table 13, we notice that except for Canada and Norway, an oil price shock has a negative and statistically significant impact on the real stock returns of the nine other countries at 5% level in the same month and/or within one month. In case of world real oil price shock for Italy and Netherlands response of real stock return changes direction and become negative in next lags. In Canada, after positive response we observe small negative one and then positive again. In Belgium and US, the negative impact becomes more evident in the next month. For all the countries, the impulse response shocks revert to zero well within 10 months.

In case of an interest rate shock, the real stock returns are negatively affected[20] for all the countries at 5% significance level. On the other hand, a unit shock to the industrial production to the real stock returns varies from positive to negative for the 11 countries. At a 5% significance level, the shock positively and significantly affects the real stock returns for Belgium, Canada, France, Italy, Spain, Sweden, UK and US. However, for the rest of the

[20] The importance of interest rate in the influence on real stock returns has been discussed earlier in the *background* chapter

countries such as Netherlands, Norway the real stock return is affected negatively. In Ireland negative effect become more evident in next lag. For Spain, there is small positive impact.

These results are very close to previous research of Park and Ratti (2008) where there were negative responses of real stock return due to the oil price shock for all countries except Norway. Here we can see the same situation but except for Norway and Canada.

## 4.5 **Variance Decomposition**

In this section, we discuss the results from the forecast error variance decomposition of real stock returns due to the oil price, interest rate shocks and industrial production shocks.

**Table 14**: Variance decomposition of variance in real stock returns due to world real oil price and interest rate shocks

Percentage of variation in real stock returns due to real oil price shocks and interest rate shocks (10 months horizon)

VAR Model: VAR(ir,wrop,ip,rsr)

| | Due to r | Due to op | Due to ip |
|---|---|---|---|
| Belgium | 0.357304<br>(1.00321)[a] | 1.209738<br>(1.59208) | 1.391972<br>(1.38315) |
| Canada | 3.578797<br>(2.32223) | 1.994378<br>(1.68236) | 4.397467<br>(2.49870) |
| France | 1.762932<br>(1.60965) | 0.590411<br>(1.11770) | 1.349646<br>(1.58121) |
| Ireland | 1.626017<br>(1.46372) | 0.184018<br>(1.06251) | 0.579689<br>(1.07099) |
| Italy | 3.569229<br>(1.92356) | 2.546437<br>(1.65721) | 0.570751<br>(1.19923) |
| Netherlands | 0.709232<br>(1.50385) | 1.620386<br>(1.56050) | 0.994600<br>(1.14891) |
| Norway | 7.100723<br>(3.00588) | 5.509485<br>(2.93170) | 1.342951<br>(1.57231) |
| Spain | 2.380945<br>(1.56866) | 1.873355<br>(1.70184) | 0.034561<br>(0.58454) |
| Sweden | 4.797811<br>(2.51872) | 2.510346<br>(2.47020) | 0.580421<br>(1.36038) |
| UK | 4.156159<br>(2.44476) | 0.290689<br>(0.90137) | 4.425951<br>(2.29411) |
| US | 5.589403<br>(2.86740) | 0.180198<br>(0.94288) | 4.547582<br>(2.76083) |

[a] Monte Carlo constructed standard errors are shown in parenthesis

Notes: Oil Price is measured as first log difference in world real oil price; wrop, ir and ip are the short term interest rate and industrial production in first log difference and rsr is real stock return.

Table 14 demonstrates the forecast error variance decomposition of real stock returns due to the interest rate, oil price and industrial production shocks. Each value in the table are in percentage which shows how much of the unanticipated changes in the real stock returns are due to interest rate shocks, how much due to oil price shocks and how much are due to industrial production shocks. The contribution of oil price shocks in the variability of real stock returns varies from 0.18% (for Ireland and US) to 5.5% (for Norway). In case of interest rate, the contribution ranges from 0.35% for Belgium to 7.1% for Norway. Lastly, for industrial production the contribution varies from 0.03% (Spain) to 4.54% (US).

For instance, if we consider the case of Belgium, 0.36% of the variability of stock returns is due to interest rate shocks, 1.21% due to oil price shocks and 1.39% due to industrial production. This implies that industrial production has more impact on real stock returns. Similarly if we consider the results for the rest of the countries, it is seen that oil price shocks have higher variability in real stock returns (compared to industrial production shocks and interest rate shocks) in Netherlands only. For countries such as Belgium, Canada and UK the industrial production shock has higher impact on the real stock returns compared to the other shocks. In case of the rest of the countries (France, Ireland, Italy, Norway, Spain, Sweden and US) interest rate has the most significant impact on the real stock returns at a 5 % significance level.

These results are inconsistent with previous studies where oil price shocks played the main influence in proportion of variation in real stock returns except for Norway and Sweden where interest rate come out on top. In this study we can see that for the period 1986-2010 the interest rate play main role for almost all countries.

*Chapter 5*

# Analysis and Argument

Chapter 5 covers deeper understanding and interpretation of obtained results. Results are compared with results from previous studies in this area and explanation of reason of behind such results.

Analyzing the results we see that oil price shocks have negative impact in the real stock returns for all the countries except for Norway and Canada. The finding is consistent with that of Park and Ratti (2008). They argue that oil price hikes are beneficial to the Norwegian firms since Norway is a net exporter of oil. They also mentioned Gjerde and Saettem (1999) who also report a positive association between oil prices and Norwegian stock prices.

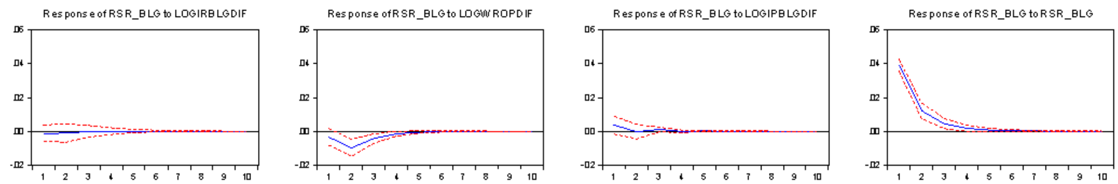
In the previous chapter we discussed that for most of the countries (France, Ireland, Italy, Norway, Spain, Sweden and US) interest rate shock has greater impact on the real stock returns compared to the other shocks. However, this finding is not consistent with the findings of Park and Ratti (2008) and Sadorsky (1999). Sadorsky (1999) and Park and Ratti (2008) found that after 1986 oil price shocks have greater impact on the real stock returns in comparison to interest rate shocks.

To analyze further and to figure out reasons behind the inconsistent findings, we drill down further. Our sample includes monthly data from January 1986 to December 2010 which includes data for the variables during the global financial crisis starting from last quarter of 2008[21]. There is a high chance that the results could have been affected due the crisis. To investigate we perform the impulse response and variance decomposition test for a subsample for the time frame January 1986-August 2008. The results from these tests and the comparisons with the previous are now analyzed.

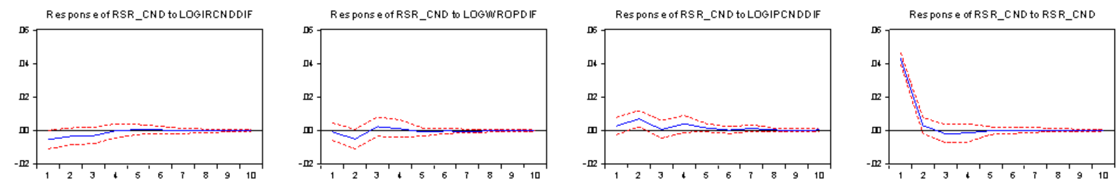
[21] The financial institution crisis hit its peak in September and October 2008 (Wikipedia n.d.)

Response to Cholesky One S.D. Innovations ± 2 S.E.

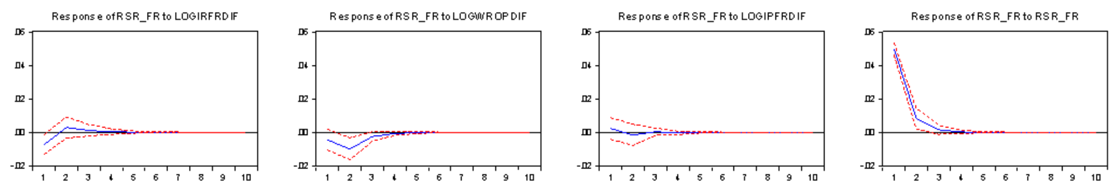
Belgium



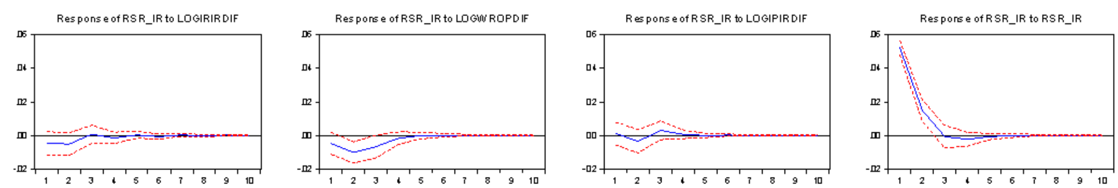

Canada



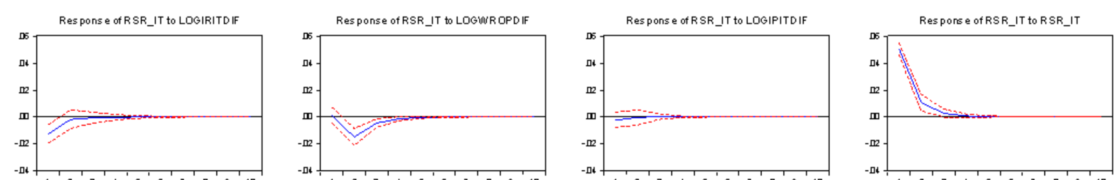

France




Ireland



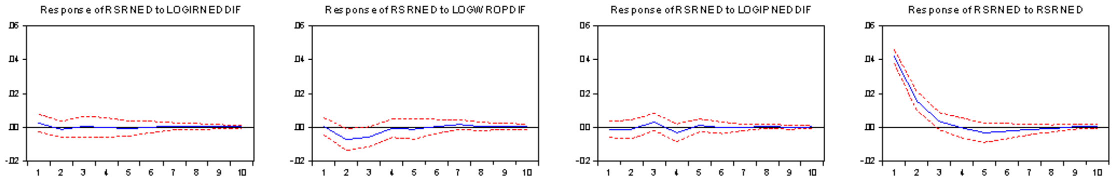

Italy



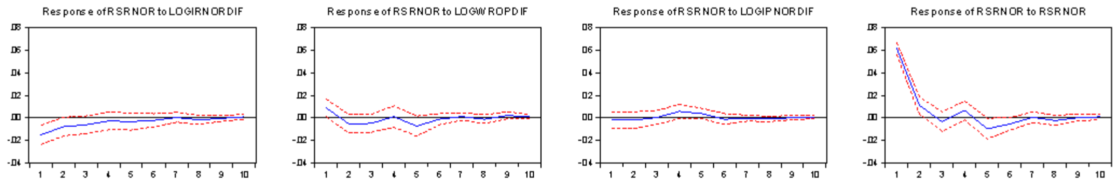

Notes: First Column: interest rate shock; Second Column: World oil price shock; Third Column: Industrial Production Shock; Fourth Column: Real stock returns shock

**Fig 3(a):** Response of real stock returns to interest rate, world real oil price shock and industrial production for Belgium, Canada, France, Ireland and Italy (For 1986- August 2008)

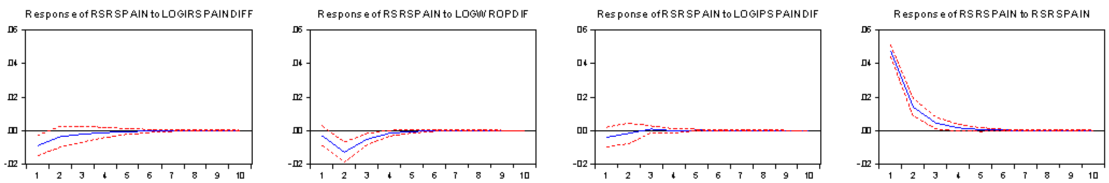
Netherlands



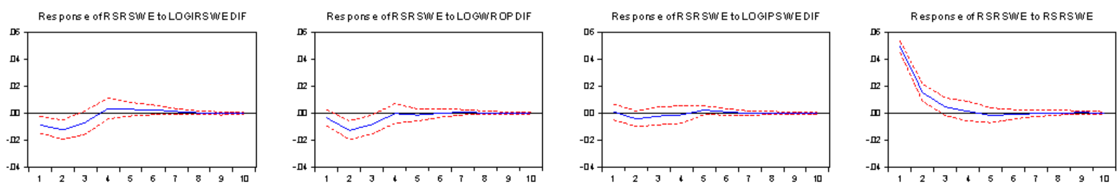

Norway



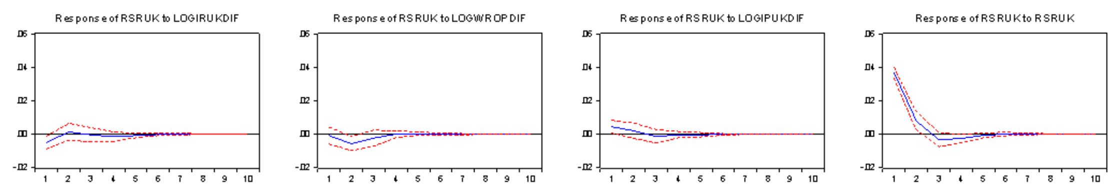

Spain




Sweden




UK




US

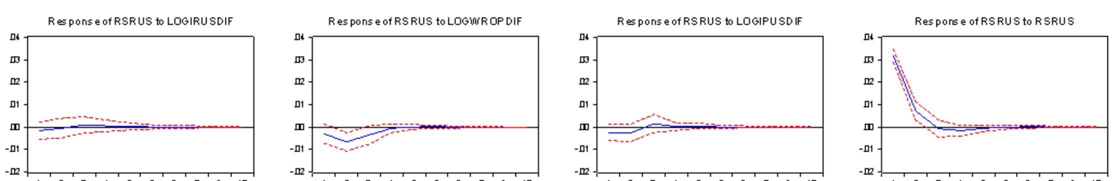



**Fig 3(b)**: Response of real stock returns to interest rate, world real oil price shock and industrial production for Netherlands, Norway, Spain, Sweden, UK and US (For 1986- August 2008)

**Table 15**: Statistically significant impulse response of real stock returns to world oil price shocks, interest rate shocks and industrial shocks (in summarized form)

| | Belgium | Canada | France | Ireland | Italy | Netherlands | Norway | Spain | Sweden | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Interest rate shock | n | n | n | n | n | p | n | n | n | n | n |
| World Real oil price Shock | n | n | n | n | n | n | p | n | n | n | n |
| Industrial Production shock | p | p | p | n | n | n | n | n | n | p | n |

Notes: n (p) indicates negative (positive) statistically significant impulse response at 5% level of significance of interest rate shocks, oil price shocks, and industrial production shocks in the same period or in a lag of one month.

The impulse responses of real stock returns due to shocks in the oil price show consistency with the previous sample (1986-2010) and show that stock returns are negatively affected due to oil price shocks except for Norway. The real stock returns are negatively affected by interest rate shocks in all the countries except Netherlands. So, it is also consistent since the real stock returns are negatively affected by interest rate shocks in all the countries except Netherlands. In France, we can observe positive effect in next lags. In case of industrial production response is negative for all countries except Belgium, Canada, France, Ireland, and United Kingdom. In France and Ireland response become negative in next lag. These results is the same as for the period 1986-2010 for all countries except Italy, Spain, Sweden, US.

In comparison to the previous research of Park and Ratti (2008), for the period till 08.2008, we have similar results: positive response of real stock return due to the oil price shock only for Norway. In other countries the response is negative.

**Table 16:** Variance decomposition of variance in real stock returns due to world real oil price and interest rate shocks (01.1986-08.2008)

Percentage of variation in real stock returns due to real oil price shocks and interest rate shocks (10 months horizon)
VAR Model: VAR(ir,op,ip,rsr)

| | Due to r | Due to op | Due to ip |
|---|---|---|---|
| Belgium | 0.161818<br>(1.02636) | 7.077169<br>(3.27795) | 0.780950<br>(1.15499) |
| Canada | 2.625493<br>(2.06828) | 1.684680<br>(1.65085) | 3.816988<br>(2.56880) |
| France | 2.301086<br>(1.91150) | 4.402125<br>(2.52357) | 0.283348<br>(0.80713) |
| Ireland | 1.648601<br>(1.88421) | 5.510417<br>(3.18777) | 0.740508<br>(1.09251) |
| Italy | 5.299371<br>(2.61853) | 8.037101<br>(2.97045) | 0.172666<br>(0.84851) |
| Netherlands | 0.404797<br>(1.20875) | 4.403207<br>(3.02154) | 1.232248<br>(1.35313) |
| Norway | 7.766415<br>(3.31998) | 4.129674<br>(2.47352) | 1.206288<br>(1.19784) |
| Spain | 3.744591<br>(2.32694) | 7.377804<br>(3.85994) | 0.709113<br>(1.06734) |
| Sweden | 9.269213<br>(3.67409) | 7.526983<br>(3.99092) | 0.944666<br>(1.67167) |
| UK | 2.026920<br>(1.53046) | 2.546966<br>(1.99178) | 1.683896<br>(1.89742) |
| US | 0.346882<br>(1.50969) | 5.619292<br>(3.28370) | 1.296960<br>(1.61840) |

[a] Monte Carlo constructed standard errors are shown in parenthesis

Notes: Oil Price is measured as first log difference in world real oil price; wrop, ir and ip are the short term interest rate and industrial production in first log difference and rsr is real stock return.

Table 16 demonstrates the forecast error variance decomposition of real stock returns due to the interest rate, oil price and industrial production shocks for the sub sample (1986-2008). The contribution of oil price shocks in the variability of real stock returns varies from 1.68% (Canada) to 8.04% (Italy). In case of interest rate, the contribution ranges from 0.16% for Belgium to 9.3% for Sweden. Lastly, for industrial production the contribution varies from 0.17% (Italy) to 3.81% (Canada).

Compared to our previous variance decomposition results if we consider this time the case of Belgium, 0.16% of the variability of stock returns is due to interest rate shocks, 7.08% due to oil price shocks and 0.78% due to industrial production. This implies that oil price shocks have greater impact on real stock returns. Similarly if we consider the results for the rest of the countries, it is seen that oil price shocks have higher variability in real stock returns (compared to industrial production shocks and interest rate shocks) at a 5 % significance level in Belgium, France, Ireland, Italy, Netherlands, Spain, UK and US. For Canada, the industrial production shock has higher impact on the real stock returns compared to the other shocks. In case of rest of the countries (Norway and Sweden) interest rate has the most significant impact on the real stock returns at a 5 % significance level.

After comparison, the results for the subsample (January 1986-August 2008) are consistent with the findings of Park and Ratti (2008) for most of the countries. Similar to ours, they also find that in case of Norway and Sweden interest rates contribute more to the variability of the real stock returns. However, for Italy, in contrast to their findings that interest rates have higher impact, we find oil price (8.04%) to have more significant impact on the real stock returns compared to interest rate (5.3%). Park and Ratti (2008) found oil price to have significant impacts for countries such as Austria, Belgium, US, Finland, France, Germany, Greece and Netherlands and US.

As a summary of results for the period from 01.1986 till 12.2010 we find that movements in oil price do not appear to lead those of real stock return for all countries except Italy and Spain. We also find that oil price shocks have negative influence on real stock returns for all the countries except for Canada and Norway. Interest rate shocks affect real stock returns more than oil price shocks and industrial production shocks for all the countries except Belgium, Canada and Netherlands. In case of Belgium and Canada, it is industrial production shock and for Netherlands it is oil price shock that affects the real stock returns more than the interest rate shocks. When the interest rate shocks and oil price shocks in Belgium and Canada are compared, it is seen that in Belgium, it is oil price shock and in Canada, it is interest rate shock, which have greater variability in real stock returns.

Canada is one of the few developed countries that is a new exporter oil[22]. In both the years 2008 and 2009 Canada's crude oil export is significantly higher than that of the previous years. In 2008 and 2009, it is 2.2 million barrels/day compared to 1.3-1.6 million barrels/day in the previous years[23]. This gives a possible explanation of why Canada's real stock returns are affected differently during the two time periods 1986-2008 and 1986-2010. Positive sign of response can be explained due to benefit of increasing oil prices for the oil producing companies in oil exporting countries. If the profit of such companies goes up and stock returns increase accordingly.

As a summary of results for the sub sample from 01.1986 till 08.2008 which represents period before crisis we find that movements in oil price appear to lead those of real stock return for all countries except Canada and Norway. Also we discovered that oil price shock have negative influence on real stock return for all countries except Norway. Oil price shock affects real stock return more than interest rate shock and industrial production for all countries except Sweden, Norway, and Canada. In Norway and Sweden, it is interest rate shock. In Canada, it is industrial production shock. After comparing oil price shocks and interest rate shocks in Canada it is seen that interest rate shocks have more influence on real stock returns than oil price shocks.

Considering Sweden and Norway, during the two sample periods that we consider, we notice that interest rate has greater influence on real stock return in both the cases. For Sweden, one possible explanation could be the sharp decrease of interest rate from the beginning of 1990 (Zan Yang, Songtao Wang, Robert Campbell 2010). For Norway, it could be explained by the factor that Norway in 1995 created a sovereign wealth fund (Government Pension Fund-Global) (Wikipedia 2011) to control inflation (which can be provoked by excess revenue from oil export) and to reduce the dependence on oil revenue. In Netherlands we can see that oil price shocks have more influence on real stock return during both samples. It could be explained by the lowest level of inflation (1.1%) compared with other considered countries. (Factbook 2011)

The global financial crisis, which reached its peak in September and October 2008, was accompanied by the banks unwilling to lend in the interbank money market. This led to a

[22] (CHANDLER 2011)
[23] (CIA Fact Book n.d.)

sharp jump in the interest rates including the short term interest rates. The central bank of the US and of the European countries had to intervene and adopt zero interest policy through continuous reduction in the interest rates. As a result, an inclusion of the interest rate cuts in the analysis led to the finding that interest rate shocks have more significant impact on the real stock returns compared to the oil price shocks.

After analyzing the results and comparing them with the previous studies, we are now in a position to answer our research questions. Our first question to be answered is whether oil price shocks have negative impact on the real stock returns. From the results it is seen that the oil price shocks do have negative impacts on all the countries except for Norway (in the sample period 1986-2010 and 1986-2008) and Canada (1986-2010)[24]. As a result our null hypothesis that '*Oil price shocks have negative impact on the real stock returns'* is not rejected at a 5 % level. It is therefore, reasonable to say that, if not a net oil exporting country, the real stock returns are expected to be negatively affected in case of an oil price shock.

Our second research question is whether in case the real stock returns are affected negatively, is the effect of the shock in oil prices greater than that of interest rates or not. For the sample period 1986-2010 we get interest rate shocks having more impact on the real stock returns of all the countries except Belgium, Canada and Netherlands. However, when we exclude the data for the global financial crisis period, we find that oil prices have more significant impact on the real stock returns compared to the interest rate shocks for most of the countries except Canada, Norway and Sweden. Thus we can say that oil price shocks do have more significant impacts on the real stock returns compared to the interest rate shocks when the economy is in a more stable situation. Thus our null hypothesis that '*The impact that oil price shocks have on the stock returns are greater than that of interest rates'* is not rejected at a 5 % significance level.

[24] Both Norway and Canada are net oil exporters

# *Chapter 6*

# Conclusion

Chapter 6 contains conclusion about results and models robustness, suitability of results and models. Also methodological flaws and limitations are taken into account to get more reliable conclusion of results.

In concluding remarks, based on the results, it could be stated that oil price shocks have negative impacts on real stock market returns depending on whether the country is a net oil exporting or an importing one. It is expected that the oil importing country's real stock returns are affected negatively due to oil price shocks compared to the oil exporting countries. Our results are consistent with the stated notion. However, to generalize the idea that oil exporting countries' stock returns are affected positively, it is subject to further research considering some more net oil exporting countries.

In addition to that, when the economy is in a more stable condition, oil price shocks contribute towards greater variability in real stock returns compared to interest rate shocks. However, there could be some exceptions as in the case of Canada, Sweden and Norway, where real stock returns variability to oil price stocks are less sensitive compared to the other factors. In all the cases, the results are not sensitive to the ordering of the variables, which shows robustness of the models used and reliability of the results.

For further research, we recommend similar study on a different set of countries, preferably comparison with net oil importing countries with the net oil exporting countries. In addition to that, some further interesting studies could on how the other financial markets (bond, derivatives, etc), other than the stock markets, behave in case of oil price shocks.

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# Appendices

**Appendix A. Data Sources**

Monthly Data: 1986:01-2010:12

Countries: Belgium, Canada, France, Ireland, Italy, Netherlands, Norway, Spain, Sweden, United Kingdom and United States

Nominal Oil Price: Cushing OK WTI Spot Price FOB (Dollars per Barrel) from EIA

World Real Oil Price: Nominal Oil Price deflated by the US PPI for fuel

Producer Price Index (PPI): Producer Price Indices for Fuels and related products (PPIENG) from U.S. Department of Labor: Bureau of Labor Statistics.

Consumer Price Index: CPI for all the countries from OECD database -Main Economic Indicator (MEI).

Industrial Production: Industrial Production Indices for all the countries OECD-(MEI)

Share Price: From OECD MEI for all the countries

Short term Interest Rates: From OECD MEI

## Appendix B VAR coefficients for the period (1986-2010)

### Belgium

| | LOGIPBLGDIF | LOGIRBLGDIF | LOGWROPDIF | RSR_BLG |
|---|---|---|---|---|
| LOGIPBLGDIF(-1) | -0.408026 | -0.026945 | -0.034252 | 0.029110 |
| LOGIRBLGDIF(-1) | 0.027593 | 0.481551 | -0.047469 | -0.013759 |
| LOGWROPDIF(-1) | 0.047653 | 0.099383 | 0.245451 | -0.061600 |
| RSR_BLG(-1) | 0.019358 | 0.177106 | 0.097477 | 0.329601 |
| C | 0.001379 | -0.005004 | 0.004230 | 0.001878 |

### Canada

| | LOGIPCNDDIF | LOGIRCNDDIF | LOGWROPDIF | RSR_CND |
|---|---|---|---|---|
| LOGIPCNDDIF(-1) | -0.037478 | 0.858009 | 0.737609 | 0.983649 |
| LOGIPCNDDIF(-2) | 0.104474 | 1.137177 | 0.125398 | 0.131162 |
| LOGIPCNDDIF(-3) | 0.297951 | -0.113850 | -0.186025 | 0.242561 |
| LOGIRCNDDIF(-1) | 0.027458 | 0.450852 | 0.023299 | -0.038310 |
| LOGIRCNDDIF(-2) | -0.018355 | 0.170852 | -0.040979 | -0.119566 |
| LOGIRCNDDIF(-3) | -0.011702 | -0.080786 | -0.037356 | 0.072277 |
| LOGWROPDIF(-1) | 0.006952 | -0.018872 | 0.181899 | -0.019401 |
| LOGWROPDIF(-2) | -0.003966 | 0.048969 | 0.086450 | 0.072733 |
| LOGWROPDIF(-3) | -0.000257 | 0.023258 | 0.033280 | -0.014711 |
| RSR_CND(-1) | 0.006167 | -0.061079 | 0.011375 | 0.133087 |
| RSR_CND(-2) | 0.011151 | 0.191955 | 0.366752 | -0.050053 |
| RSR_CND(-3) | 0.031004 | 0.190695 | 0.064562 | 0.006224 |
| C | 0.000605 | -0.006166 | 0.001617 | 0.000393 |

**France**

| | LOGIPFRDIF | LOGIRFRDIF | LOGWROPDIF | RSR_FR |
|---|---|---|---|---|
| LOGIPFRDIF(-1) | -0.334819 | 0.266397 | 0.825388 | -0.009523 |
| | | | | |
| LOGIRFRDIF(-1) | 0.023185 | 0.465790 | 0.012979 | 0.054580 |
| | | | | |
| LOGWROPDIF(-1) | 0.021717 | 0.085968 | 0.225552 | -0.052730 |
| | | | | |
| RSR_FR(-1) | 0.025813 | 0.097793 | 0.080316 | 0.190247 |
| | | | | |
| C | 0.000778 | -0.004636 | 0.004301 | 0.002735 |

**Ireland**

| | LOGIPIRDIF | LOGIRIRDIF | LOGWROPDIF | RSR_IR |
|---|---|---|---|---|
| LOGIPIRDIF(-1) | -0.564229 | 0.147172 | -0.190434 | -0.108483 |
| | | | | |
| LOGIPIRDIF(-2) | -0.176374 | 0.070984 | -0.072064 | -0.017578 |
| | | | | |
| LOGIRIRDIF(-1) | -0.005714 | -0.112143 | 0.030024 | -0.039126 |
| | | | | |
| LOGIRIRDIF(-2) | 0.011708 | 0.447485 | -0.013677 | 0.004518 |
| | | | | |
| LOGWROPDIF(-1) | 0.015678 | 0.092264 | 0.206287 | -0.031731 |
| | | | | |
| LOGWROPDIF(-2) | -0.043917 | 0.143174 | 0.106170 | 0.009295 |
| | | | | |
| RSR_IR(-1) | -0.005481 | 0.022559 | 0.073571 | 0.326761 |
| | | | | |
| RSR_IR(-2) | 0.030729 | 0.141534 | 0.173682 | -0.066359 |
| | | | | |
| C | 0.011101 | -0.007909 | 0.005751 | 0.001849 |

**Italy**

| | LOGIPITDIF | LOGIRITDIF | LOGWROPDIF | RSR_IT |
|---|---|---|---|---|
| LOGIPITDIF(-1) | -0.211908 | 0.309788 | 0.295179 | 0.071799 |
| | | | | |
| LOGIRITDIF(-1) | 0.058936 | 0.502678 | 0.027797 | 0.022507 |
| | | | | |
| LOGWROPDIF(-1) | 0.013476 | 0.122192 | 0.227750 | -0.113093 |
| | | | | |
| RSR_IT(-1) | 0.044889 | 0.042803 | 0.056048 | 0.214059 |
| | | | | |
| C | 0.000956 | -0.005620 | 0.005092 | -0.000107 |

**Netherlands**

| | LOGIPNEDDIF | LOGWROPDIF | RSRNED | LOGIRNEDDIF |
|---|---|---|---|---|
| LOGIPNEDDIF(-1) | -0.650472 | -0.047935 | -0.092292 | -0.037409 |
| LOGIPNEDDIF(-2) | -0.491674 | 0.280796 | 0.137385 | -0.056670 |
| LOGIPNEDDIF(-3) | -0.296369 | 0.064531 | -0.045883 | -0.017596 |
| LOGIPNEDDIF(-4) | -0.118624 | 0.363364 | 0.120028 | 0.012774 |
| LOGWROPDIF(-1) | 0.011272 | 0.220499 | -0.064378 | 0.049592 |
| LOGWROPDIF(-2) | 0.009038 | 0.083999 | -0.002953 | 0.070424 |
| LOGWROPDIF(-3) | 0.014956 | 0.061810 | 0.066288 | 0.074573 |
| LOGWROPDIF(-4) | 0.035261 | -0.159186 | -0.045482 | -0.013962 |
| RSRNED(-1) | 0.017191 | 0.035112 | 0.390384 | 0.167544 |
| RSRNED(-2) | 0.051038 | 0.372738 | -0.089076 | 0.077739 |
| RSRNED(-3) | 0.028413 | -0.087193 | 0.105670 | 0.069376 |
| RSRNED(-4) | 0.086971 | 0.100053 | -0.027027 | 0.095900 |
| LOGIRNEDDIF(-1) | 0.024646 | 0.018650 | -0.042790 | 0.440281 |
| LOGIRNEDDIF(-2) | 0.003661 | -0.095613 | 0.043457 | -0.063423 |
| LOGIRNEDDIF(-3) | 0.017032 | 0.035404 | -0.040205 | 0.122708 |
| LOGIRNEDDIF(-4) | -0.026375 | -0.102650 | -0.033961 | 0.128879 |
| C | 0.002712 | 0.002424 | 0.001218 | -0.004186 |

**Norway**

| | LOGIPNORDIF | LOGWROPDIF | RSRNOR | LOGIRNORDIF |
|---|---|---|---|---|
| LOGIPNORDIF(-1) | -0.496426 | 0.014670 | -0.024182 | -0.111689 |
| LOGIPNORDIF(-2) | -0.295344 | -0.086064 | 0.045492 | 0.007757 |
| LOGIPNORDIF(-3) | -0.267688 | 0.172367 | 0.221737 | -0.112096 |
| LOGIPNORDIF(-4) | -0.179713 | 0.001055 | 0.208382 | -0.000703 |
| LOGWROPDIF(-1) | -0.042154 | 0.179278 | -0.061301 | 0.061827 |
| LOGWROPDIF(-2) | 0.005228 | 0.102357 | 0.016168 | 0.059104 |
| LOGWROPDIF(-3) | -0.004228 | 0.032392 | 0.048640 | -0.002729 |
| LOGWROPDIF(-4) | 0.025347 | -0.143705 | -0.091473 | -0.010047 |

| | | | | |
|---|---|---|---|---|
| RSRNOR(-1) | -0.009517 | 0.128220 | 0.230254 | -0.047508 |
| | | | | |
| RSRNOR(-2) | 0.031061 | 0.216489 | -0.058494 | 0.071547 |
| | | | | |
| RSRNOR(-3) | 0.013606 | -0.018698 | 0.173095 | 0.051705 |
| | | | | |
| RSRNOR(-4) | -0.007085 | 0.008756 | -0.160092 | 0.102736 |
| | | | | |
| LOGIRNORDIF(-1) | 0.007348 | 0.094618 | -0.093284 | 0.331821 |
| | | | | |
| LOGIRNORDIF(-2) | -0.018294 | -0.048327 | -0.024876 | 0.035709 |
| | | | | |
| LOGIRNORDIF(-3) | -0.003711 | 0.028837 | 0.059362 | 0.212482 |
| | | | | |
| LOGIRNORDIF(-4) | -0.024000 | -0.047746 | -0.101574 | -0.039644 |
| | | | | |
| C | 0.002838 | 0.003445 | 0.003931 | -0.004020 |

**Spain**

| | LOGIPSPAINDIF | LOGWROPDIF | RSRSPAIN | LOGIRSPAINDIFF |
|---|---|---|---|---|
| LOGIPSPAINDIF(-1) | -0.433201 | 0.028437 | 0.025481 | -0.056751 |
| | | | | |
| LOGWROPDIF(-1) | 0.036314 | 0.234410 | -0.086640 | 0.079822 |
| | | | | |
| RSRSPAIN(-1) | 0.047186 | 0.071673 | 0.315467 | 0.091142 |
| | | | | |
| LOGIRSPAINDIFF(-1) | 0.022792 | 0.063940 | -0.010104 | 0.591763 |
| | | | | |
| C | 0.000675 | 0.005071 | 0.002425 | -0.004318 |

**Sweden**

| | LOGIPSWEDIF | LOGWROPDIF | RSRSWE | LOGIRSWEDIF |
|---|---|---|---|---|
| LOGIPSWEDIF(-1) | -0.219499 | 0.577187 | -0.122677 | 1.129885 |
| | | | | |
| LOGIPSWEDIF(-2) | -0.172649 | -0.181437 | 0.075015 | 0.538769 |
| | | | | |
| LOGIPSWEDIF(-3) | 0.010585 | -0.160800 | -0.020881 | 1.050562 |
| | | | | |
| LOGWROPDIF(-1) | 0.010075 | 0.163728 | -0.093728 | 0.089666 |
| | | | | |
| LOGWROPDIF(-2) | 0.015038 | 0.127834 | -0.023029 | 0.158392 |
| | | | | |
| LOGWROPDIF(-3) | 0.025497 | 0.079515 | 0.063130 | 0.143834 |
| | | | | |
| RSRSWE(-1) | 0.032515 | 0.011491 | 0.343589 | 0.222531 |
| | | | | |
| RSRSWE(-2) | 0.044422 | 0.266463 | -0.022333 | 0.006526 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| RSRSWE(-3) | 0.042872 | 0.037295 | 0.076918 | 0.025001 |
| | | | | |
| LOGIRSWEDIF(-1) | 0.019298 | 0.007406 | -0.086870 | 0.352831 |
| | | | | |
| LOGIRSWEDIF(-2) | 0.008872 | -0.049434 | 0.012344 | -0.181202 |
| | | | | |
| LOGIRSWEDIF(-3) | 0.019246 | -0.068181 | 0.027340 | 0.249519 |
| | | | | |
| C | 0.002072 | 0.000270 | 0.003602 | -0.011944 |

## United Kingdomn

| | LOGIPUKDIF | LOGWROPDIF | RSRUK | LOGIRUKDIF |
|---|---|---|---|---|
| LOGIPUKDIF(-1) | -0.338307 | 0.429064 | 0.140371 | 0.952366 |
| | | | | |
| LOGIPUKDIF(-2) | -0.118155 | 0.187196 | -0.079051 | 0.724576 |
| | | | | |
| LOGWROPDIF(-1) | 0.014819 | 0.197385 | -0.027575 | 0.052803 |
| | (0.00702) | (0.05751) | (0.03169) | (0.03404) |
| | [ 2.11127] | [ 3.43247] | [-0.87013] | [ 1.55120] |
| | | | | |
| LOGWROPDIF(-2) | 0.008250 | 0.108278 | 0.016428 | 0.032479 |
| | | | | |
| RSRUK(-1) | 0.020038 | 0.046954 | 0.230311 | 0.204016 |
| | | | | |
| RSRUK(-2) | 0.007424 | 0.343237 | -0.151401 | 0.075778 |
| | | | | |
| LOGIRUKDIF(-1) | 0.033538 | 0.087994 | 0.005662 | 0.581354 |
| | | | | |
| LOGIRUKDIF(-2) | 0.002457 | -0.132171 | -0.013571 | -0.036872 |
| | | | | |
| C | 0.000608 | 0.002982 | 0.001789 | -0.005457 |

**United States**

| | LOGIPUSDIF | LOGWROPDIF | RSRUS | LOGIRUSDIF |
|---|---|---|---|---|
| LOGIPUSDIF(-1) | 0.060981 | 1.635525 | 0.788172 | -0.608546 |
| | | | | |
| LOGIPUSDIF(-2) | 0.251865 | 0.307821 | 0.851998 | 2.756832 |
| | | | | |
| LOGWROPDIF(-1) | 0.002718 | 0.174576 | -0.022128 | 0.153630 |
| | | | | |
| LOGWROPDIF(-2) | 0.000100 | 0.106514 | 0.018030 | 0.000975 |
| | | | | |
| RSRUS(-1) | 0.013228 | 0.023728 | 0.283186 | 0.265885 |
| | | | | |
| RSRUS(-2) | 0.048690 | 0.429677 | -0.106259 | 0.359206 |
| | | | | |
| LOGIRUSDIF(-1) | 0.010964 | 0.011704 | -0.058879 | 0.427981 |
| | | | | |
| LOGIRUSDIF(-2) | 0.003049 | -0.114373 | -0.003709 | 0.017697 |
| | | | | |
| C | 0.001166 | -0.001454 | -0.000713 | -0.012192 |

**Appendix C**

**VAR coefficients for the period (1986-2008)**

**Belgium**

| | LOGIRBLGDIF | LOGWROPDIF | LOGIPBLGDIF | RSR_BLG |
|---|---|---|---|---|
| LOGIRBLGDIF(-1) | 0.297856 | -0.035591 | 0.027399 | 0.007929 |
| | | | | |
| LOGWROPDIF(-1) | 0.057983 | 0.119440 | 0.031070 | -0.129982 |
| | | | | |
| LOGIPBLGDIF(-1) | -0.123020 | -0.155862 | -0.443825 | -0.067211 |
| | | | | |
| RSR_BLG(-1) | 0.078381 | -0.130084 | -0.006761 | 0.308536 |
| | | | | |
| C | -0.002315 | 0.008078 | 0.001869 | 0.003385 |

**Canada**

| | LOGIRCNDDIF | LOGWROPDIF | LOGIPCNDDIF | RSR_CND |
|---|---|---|---|---|
| LOGIRCNDDIF(-1) | 0.597278 | 0.053312 | 0.026394 | -0.075447 |
| | | | | |
| LOGIRCNDDIF(-2) | -0.054763 | 0.036475 | -0.016728 | -0.046971 |
| | | | | |
| LOGIRCNDDIF(-3) | -0.071536 | -0.087829 | -0.014946 | 0.033352 |
| | | | | |
| LOGWROPDIF(-1) | -0.065106 | 0.106447 | -0.001133 | -0.066476 |
| | | | | |
| LOGWROPDIF(-2) | 0.086934 | 0.050550 | -0.008669 | 0.040497 |

| | | | | |
|---|---|---|---|---|
| LOGWROPDIF(-3) | -0.022912 | 0.108819 | -0.008249 | 0.023211 |
| LOGIPCNDDIF(-1) | 0.524956 | 0.507556 | -0.090590 | 0.815294 |
| LOGIPCNDDIF(-2) | 0.721107 | 0.499622 | 0.062398 | 0.181792 |
| LOGIPCNDDIF(-3) | -0.221660 | 0.237958 | 0.313305 | 0.566422 |
| RSR_CND(-1) | -0.081217 | -0.095157 | 0.003562 | 0.066989 |
| RSR_CND(-2) | 0.191118 | 0.239785 | -0.000981 | -0.067647 |
| RSR_CND(-3) | 0.096053 | 0.050782 | 0.015414 | 0.001428 |
| C | -0.004204 | 0.003317 | 0.001089 | 0.000868 |

**France**

| | LOGIRFRDIF | LOGWROPDIF | LOGIPFRDIF | RSR_FR |
|---|---|---|---|---|
| LOGIRFRDIF(-1) | 0.286838 | 0.079279 | 0.010423 | 0.101071 |
| LOGWROPDIF(-1) | 0.035763 | 0.119401 | -0.005313 | -0.133033 |
| LOGIPFRDIF(-1) | 0.046953 | 0.113883 | -0.441457 | -0.184671 |
| RSR_FR(-1) | 0.017015 | -0.023429 | 0.000709 | 0.165347 |
| C | -0.001678 | 0.007596 | 0.001360 | 0.004107 |

**Ireland**

| | LOGIRIRDIF | LOGWROPDIF | LOGIPIRDIF | RSR_IR |
|---|---|---|---|---|
| LOGIRIRDIF(-1) | -0.184370 | 0.047392 | -0.022063 | -0.034627 |
| LOGIRIRDIF(-2) | 0.394583 | 0.016665 | -0.001849 | 0.010571 |
| LOGWROPDIF(-1) | 0.028966 | 0.116508 | 0.003187 | -0.128087 |
| LOGWROPDIF(-2) | 0.107865 | 0.039296 | -0.037330 | -0.046820 |
| LOGIPIRDIF(-1) | 0.131977 | -0.182609 | -0.576580 | -0.096373 |
| LOGIPIRDIF(-2) | 0.018499 | -0.126583 | -0.166776 | 0.025217 |
| RSR_IR(-1) | -0.049370 | -0.071645 | -0.013048 | 0.287456 |
| RSR_IR(-2) | 0.086364 | 0.075539 | 0.012632 | -0.110299 |
| C | -0.004353 | 0.009436 | 0.012311 | 0.004469 |

## Italy

| | LOGIRITDIF | LOGWROPDIF | LOGIPITDIF | RSR_IT |
|---|---|---|---|---|
| LOGIRITDIF(-1) | 0.327022 | 0.080957 | 0.026886 | 0.051750 |
| LOGWROPDIF(-1) | 0.092734 | 0.118043 | -0.014906 | -0.223078 |
| LOGIPITDIF(-1) | 0.041476 | -0.094815 | -0.317502 | 0.008347 |
| RSR_IT(-1) | -0.048485 | -0.054832 | 0.014823 | 0.208991 |
| C | -0.003883 | 0.007955 | 0.001412 | 0.001800 |

## Netherlands

| | LOGIRNEDDIF | LOGWROPDIF | LOGIPNEDDIF | RSRNED |
|---|---|---|---|---|
| LOGIRNEDDIF(-1) | 0.356142 | 0.025389 | 0.037196 | -0.040140 |
| LOGIRNEDDIF(-2) | -0.127283 | -0.027882 | 0.016657 | 0.046274 |
| LOGIRNEDDIF(-3) | 0.111428 | 0.062556 | 0.013950 | -0.028870 |
| LOGIRNEDDIF(-4) | 0.109057 | -0.125218 | -0.023756 | 0.005370 |
| LOGWROPDIF(-1) | 0.004832 | 0.168817 | 0.003945 | -0.115424 |
| LOGWROPDIF(-2) | 0.071291 | 0.005365 | -0.001545 | -0.033207 |
| LOGWROPDIF(-3) | 0.049645 | 0.098457 | -0.004610 | 0.035606 |
| LOGWROPDIF(-4) | 0.022743 | -0.133976 | 0.020387 | -0.018357 |
| LOGIPNEDDIF(-1) | 0.054331 | -0.060498 | -0.688021 | -0.036360 |
| LOGIPNEDDIF(-2) | 0.029277 | 0.318963 | -0.528561 | 0.130076 |
| LOGIPNEDDIF(-3) | 0.050875 | 0.140371 | -0.313935 | -0.094708 |
| LOGIPNEDDIF(-4) | 0.048579 | 0.373233 | -0.122492 | 0.066636 |
| RSRNED(-1) | 0.118235 | -0.141936 | -0.016111 | 0.370026 |
| RSRNED(-2) | 0.063889 | 0.318939 | 0.025385 | -0.069897 |
| RSRNED(-3) | 0.121412 | -0.104710 | 0.032275 | 0.011849 |
| RSRNED(-4) | 0.018284 | 0.140236 | 0.073226 | -0.058610 |
| C | -0.003122 | 0.005312 | 0.003338 | 0.003483 |

**Norway**

| | LOGIRNORDIF | LOGWROPDIF | LOGIPNORDIF | RSRNOR |
|---|---|---|---|---|
| LOGIRNORDIF(-1) | 0.265050 | 0.042847 | 0.005376 | -0.096937 |
| | | | | |
| LOGIRNORDIF(-2) | 0.051259 | -0.011846 | -0.013775 | -0.084577 |
| | | | | |
| LOGIRNORDIF(-3) | 0.214461 | 0.051608 | -0.015667 | 0.027827 |
| | | | | |
| LOGIRNORDIF(-4) | -0.073257 | -0.021786 | -0.049139 | -0.073268 |
| | | | | |
| LOGWROPDIF(-1) | 0.036074 | 0.139156 | -0.036522 | -0.101459 |
| | | | | |
| LOGWROPDIF(-2) | 0.073498 | 0.052961 | 0.016658 | -0.032206 |
| | | | | |
| LOGWROPDIF(-3) | -0.026078 | 0.065821 | -0.019921 | 0.020963 |
| | | | | |
| LOGWROPDIF(-4) | -0.029091 | -0.125278 | 0.011751 | -0.064733 |
| | | | | |
| LOGIPNORDIF(-1) | -0.130559 | -0.059079 | -0.532282 | -0.064788 |
| | | | | |
| LOGIPNORDIF(-2) | -0.066276 | -0.117668 | -0.332535 | -0.037506 |
| | | | | |
| LOGIPNORDIF(-3) | -0.149143 | 0.116102 | -0.285950 | 0.151384 |
| | | | | |
| LOGIPNORDIF(-4) | -0.055748 | -0.040525 | -0.196569 | 0.173051 |
| | | | | |
| RSRNOR(-1) | -0.086561 | 0.044611 | -0.018295 | 0.178228 |
| | | | | |
| RSRNOR(-2) | 0.001819 | 0.136475 | 0.024409 | -0.095707 |
| | | | | |
| RSRNOR(-3) | 0.020444 | -0.025801 | 0.005377 | 0.141585 |
| | | | | |
| RSRNOR(-4) | 0.110422 | 0.032104 | -0.005803 | -0.197157 |
| | | | | |
| C | -0.001555 | 0.006513 | 0.004434 | 0.007138 |

**Spain**

| | LOGIRSPAINDIFF | LOGWROPDIF | LOGIPSPAINDIF | RSRSPAIN |
|---|---|---|---|---|
| LOGIRSPAINDIFF(-1) | 0.447825 | 0.161230 | 0.001784 | 0.008362 |
| | | | | |
| LOGWROPDIF(-1) | 0.029589 | 0.103510 | 0.014398 | -0.179163 |
| | | | | |
| LOGIPSPAINDIF(-1) | -0.158326 | -0.363398 | -0.481052 | -0.033514 |
| | | | | |
| RSRSPAIN(-1) | 0.035092 | -0.047737 | 0.029062 | 0.293134 |
| | | | | |
| C | -0.002068 | 0.008789 | 0.001570 | 0.004421 |

**Sweden**

| | LOGIRSWEDIF | LOGWROPDIF | LOGIPSWEDIF | RSRSWE |
|---|---|---|---|---|
| LOGIRSWEDIF(-1) | 0.222762 | -0.006333 | 0.031383 | -0.158811 |
| LOGIRSWEDIF(-2) | 0.065028 | -0.049218 | 0.009350 | -0.004463 |
| LOGIRSWEDIF(-3) | -0.040141 | -0.034401 | 0.010450 | 0.112175 |
| LOGWROPDIF(-1) | 0.069302 | 0.103914 | -0.015144 | -0.175908 |
| LOGWROPDIF(-2) | 0.077042 | 0.068538 | 0.010128 | -0.042482 |
| LOGWROPDIF(-3) | -0.012815 | 0.129322 | 0.007407 | 0.072275 |
| LOGIPSWEDIF(-1) | 0.658839 | 0.252051 | -0.292056 | -0.306688 |
| LOGIPSWEDIF(-2) | 0.146401 | -0.264512 | -0.266673 | 0.007556 |
| LOGIPSWEDIF(-3) | 0.006167 | -0.345603 | -0.050232 | -0.104744 |
| RSRSWE(-1) | 0.049589 | -0.085637 | 0.023770 | 0.308000 |
| RSRSWE(-2) | -0.020652 | 0.254860 | 0.022791 | -0.001991 |
| RSRSWE(-3) | 0.054200 | 0.032005 | 0.041151 | 0.047590 |
| C | -0.005920 | 0.004886 | 0.003551 | 0.005472 |

**UK**

| | LOGIRUKDIF | LOGWROPDIF | LOGIPUKDIF | RSRUK |
|---|---|---|---|---|
| LOGIRUKDIF(-1) | 0.461286 | -0.021490 | 0.025181 | 0.080189 |
| LOGIRUKDIF(-2) | -0.057782 | 0.153882 | 0.003065 | -0.083762 |
| LOGWROPDIF(-1) | 0.015068 | 0.120880 | -0.005080 | -0.080215 |
| LOGWROPDIF(-2) | 0.035477 | 0.047006 | 0.000875 | -0.010880 |
| LOGIPUKDIF(-1) | 0.482377 | 0.031936 | -0.403653 | 0.129934 |
| LOGIPUKDIF(-2) | 0.543312 | 0.177820 | -0.145674 | -0.137200 |
| RSRUK(-1) | 0.079836 | -0.129642 | -0.001102 | 0.216212 |
| RSRUK(-2) | 0.023455 | 0.312706 | -0.003907 | -0.153177 |
| C | -0.002501 | 0.006755 | 0.001069 | 0.002777 |

**US**

| | LOGIRUSDIF | LOGWROPDIF | LOGIPUSDIF | RSRUS |
|---|---|---|---|---|
| LOGIRUSDIF(-1) | 0.428891 | -0.056583 | 0.014380 | 0.021407 |
| LOGIRUSDIF(-2) | 0.047438 | 0.084211 | 0.007499 | 0.014594 |
| LOGWROPDIF(-1) | 0.093367 | 0.122314 | -0.000785 | -0.088913 |
| LOGWROPDIF(-2) | 0.014459 | 0.051094 | -0.006670 | -0.025278 |
| LOGIPUSDIF(-1) | 1.193636 | 1.063601 | -0.007633 | -0.401873 |
| LOGIPUSDIF(-2) | 0.637544 | -0.041524 | 0.236484 | 0.445998 |
| RSRUS(-1) | 0.159438 | -0.224031 | 0.008374 | 0.226775 |
| RSRUS(-2) | 0.181003 | 0.410765 | 0.025522 | -0.092508 |
| C | -0.007792 | 0.004010 | 0.001590 | 0.004382 |

# List of Figures

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# List of Abbreviations and Acronyms Used

| | |
|---|---|
| **ADF** | Augmented Dickey Fuller |
| **AIC** | Akaike's Information criteria |
| **ARMA** | Autoregressive Moving Average |
| **CPI** | Consumer Price Index |
| **DCC** | Dynamic Conditional Correlation |
| **DCF** | Discounted Cash Flow |
| **EIA** | Energy Information Administration |
| **FPE** | Final Prediction Error |
| **GDP** | Gross Domestic Product |
| **GNI** | Gross National Income |
| **HQIC** | Hannan-Quinn Information Criterion |
| **IGARCH** | Integrated Generalized Autoregressive Conditional Heteroskedasticity |
| **KPSS** | Kwiatkowski–Phillips–Schmidt–Shin |
| **MEI** | Main Economic Indicator |
| **OECD** | Organization of Economic Cooperation and Development |
| **OLS** | Ordinary Least Squares |
| **PP** | Phillips and Perron |
| **PPI** | Producer Price Index |
| **RSS** | Residual Sum of Squares |
| **SIC** | Schwarz's Information criteria |
| **UK** | United Kingdom |
| **US** | United States |
| **VAR** | Vector Autoregressive |
| **WTI** | West Texas Intermediate |